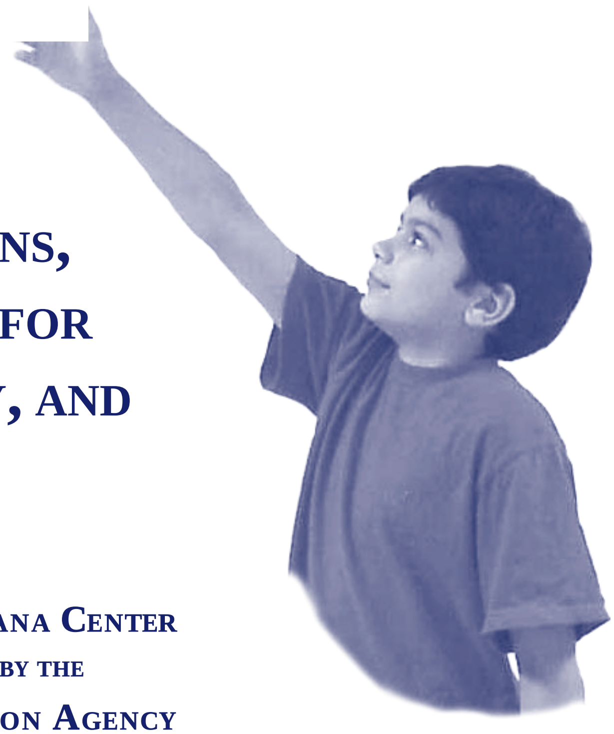
TEXAS SAFETY STANDARDS

Kindergarten
through
Grade 12



A GUIDE TO LAWS, RULES, REGULATIONS, AND SAFETY PROCEDURES FOR CLASSROOM, LABORATORY, AND FIELD INVESTIGATIONS

CHARLES A. DANA CENTER

FUNDED BY THE

TEXAS EDUCATION AGENCY

TEXAS SAFETY STANDARDS

KINDERGARTEN

THROUGH

GRADE 12

A Guide to Laws, Rules, Regulations and Safety Procedures for Classroom, Laboratory, and Field Investigations

Second Edition
2000

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Produced by the Charles A. Dana Center at the University of Texas at Austin in conjuction with the Division of Curriculum and Professional Development of the Texas Education Agency.

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INQUIRY OPENS THEIR MIND...

...GUIDE THEIR JOURNEY SAFELY

Dedicated to the children of the Charles A. Dana Center...

Rachael Bushn
Erin Cole
Kim Collins
Traci Collins
Christine Evans
Ruby Youker Shell
Julie Tran
Cara Westbrook
Erica Westbrook
Adan Yanez

TABLE OF CONTENTS

Chapter III: Field Investigations and Activities

Chapter IV: Facilities

Chapter V: Safety Equipment and Supplies

Chapter VI: Chemical Safety

Chapter VII: Health Concerns

Chapter VIII: Safety Training

Appendices

Bibliography

Index

1949 ★ 50th Anniversary ★ 1999

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Jim Nelson
Commissioner of Education

January 7, 2000

To the Administrator and Science Teacher Addressed:

Citizens of our state are dependent upon science as never before. Our economy is in the midst of a transformation in which peoples' livelihoods depend less upon what they can produce through their labor and more on what they can produce through their ideas. Science leads the way in this conceptual-based economy. Scientific literacy is an essential tool for every Texas citizen.

The Texas Essential Knowledge and Skills require students to understand and do science. Students must not only learn content, they must understand the processes associated with science, including observation, model building, and inquiry. These science skills can best be understood through active learning practiced in the science classroom as well as in field and laboratory experiences. As we encourage students to collect data and carry out investigations, we must be aware of their safety.

The purpose of this document is to provide guidelines for developing a safety program both at the campus and district level. A commitment to safety demands a team effort with everyone, from administrators to support staff, teachers, parents, and students alike, sharing the responsibility for safety.

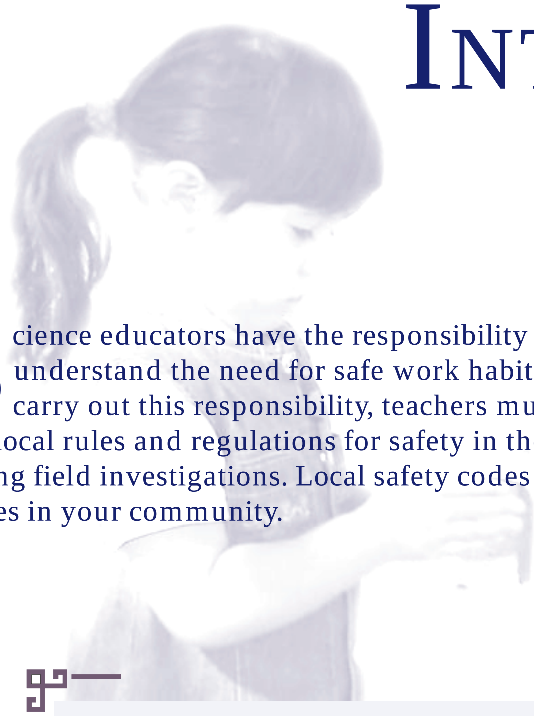
As we move forward into the millennium, we must help our students learn and use science in a safe environment.

Sincerely yours,

Jim Nelson
Commissioner of Education

Celebrating 50 Years of Service to Public Education

Introduction



Science educators have the responsibility to teach by example and to help students understand the need for safe work habits and interactions with the environment. To carry out this responsibility, teachers must have a working knowledge of federal, state, and local rules and regulations for safety in the science classroom and laboratory, as well as during field investigations. Local safety codes can be acquired from the city government offices in your community.

> *"Teachers of science must know and apply the necessary safety regulations in the storage, use, and care of the materials used by students. They adhere to safety rules and guidelines that are established by national organizations such as the American Chemical Society and the Occupational Safety and Health Administration, as well as by local and state regulatory agencies. They work with the school and district to ensure implementation and use of safety guidelines for which they are responsible, such as the presence of safety equipment and an appropriate class size. Teachers also teach students how to engage safely in investigations inside and outside the classroom."*
>
> National Research Council, Position Statement, 1996

Conditions Affecting Safe Science Classrooms

Overcrowding and Safety

Overcrowding in science classrooms and laboratories, where equipment and chemicals are used, should be a safety concern for *every* teacher and administrator. Otherwise, overcrowded conditions could result in liability problems for the school district.

Overcrowding that results in injury has led to charges of negligence in some states. For example, the school's principal and a teacher were accused of negligence in the 1981 case, *Bush v. Oscoda Area Schools*.

National Science Teachers Association's recommendation for maximum class size

Elementary School.........22 per class
Middle School..........24 per class
High School..........24 per class

The following excerpt from *Bush v. Oscoda* illustrates the legal and safety problems that can result from overcrowded science classrooms.

A 14 year-old girl was severely burned when the plastic jug of alcohol she was carrying exploded. The jug was used to transport alcohol to fill portable alcohol burners in a science class. Because of overcrowded conditions, the science class was being taught in a non-science classroom. The parents sued the school district resulting in a verdict against the principal of the school and the science teacher. The principal was found negligent for scheduling a science class in a room that was not properly equipped for science instruction. The teacher was found negligent for conducting the class in unsafe and inadequate conditions.

Bush v. Oscoda Area Schools, 1981

The correlation between the frequency of accidents and the number of students in a laboratory at one time is supported by data. According to Macomber, 1961, these data show that accidents become more frequent and more serious as the class size increases. Similar results were documented by Ward and West in a study conducted in Texas schools.

Distribution of Laboratory Accidents by Seriousness and Class Size

Class Size	Number of Instructors	% of Total Instructors	Minor Accidents	Moderate Accidents	Serious Accidents
Under 10	1	0.7	100	0.0	0.0
11–20	5	6.4	77.8	22.2	0.0
21–30	95	67.9	60.0	37.9	2.1
Over 30	35	25.0	42.9	40.0	17.1

Ward and West (1990), and West (1991)

Researchers have found that in a standard science laboratory where students regularly conduct investigations, more accidents occur when students have less than 41 square feet of working space and when there are more than 22 students in one class (Ward and West, 1990).

"The number of students assigned to each laboratory class should not exceed 24. Students must have immediate access to the teacher in order to provide a safe and effective learning environment."

Council of State Science Supervisors: *Laboratory Safety*, 1991

OVERCROWDING AND STUDENT ACHIEVEMENT

There is strong evidence that correlates overcrowded public schools to decreased student achievement. Students can gain a deeper understanding of science concepts when they are able to apply science processes in a laboratory setting. However, the laboratory must be safe, and students must have adequate space to conduct science investigations and activities.

Overcrowding may force a teacher to reduce or eliminate the amount of time allowed for students to do hands-on science. In addition, it becomes more difficult for teachers to maintain discipline when they must supervise larger numbers of students.

The National Science Teachers Association recommends the following amount of space for specialized classroom / laboratory combinations and for a standard science laboratory.

Classroom Type	Elementary School	Middle School	High School
Classroom / laboratory	45 square feet / student	50 square feet / student	60 square feet / student
Science laboratory	40 square feet / student	45 square feet / student	50 square feet / student

Adequate space is required for safe and effective science instruction. The Texas Administrative Code, §61.103. *School Facilities Standards*, defines the number of pupils in a classroom as 22 for elementary school and 25 for middle and high schools.

General classrooms are required to have a minimum of:

- 36 square feet per pupil or 800 square feet available per classroom for Prekindergarten–Grade 1
- 30 square feet per pupil or 700 square feet available per classroom for Grades 2–5
- 28 square feet per pupil or 700 square feet available per classroom for Grades 6-12

Specialized science lecture / laboratory room shall have a minimum of:

- 41 square feet per pupil or 900 square feet per lecture / laboratory room at the elementary school level
- 50 square feet per pupil or 1000 square feet per lecture / laboratory room at the middle school level
- 50 square feet per pupil or 1200 square feet per lecture / laboratory at the high school level

Safety Is Everyone's Responsibility

SCIENCE STUDENTS

Science students should not expect the teacher to "shoulder the entire responsibility" for a safe learning environment in the science classroom and laboratory. Each student can contribute to the safety of others and help maintain an atmosphere of safe learning by accepting a few basic responsibilities.

STUDENT RESPONSIBILITIES

1. Read and study the science activity or laboratory investigation before coming to class.
   - Ask questions about the activity before beginning the exercise.
   - Identify and understand the hazards and necessary precautions you need to take.
   - Understand the concept of the investigation, and know how to proceed with the investigation.
2. Know and follow all safety rules prior to the first investigation.
   - Read, understand, and sign the safety contract (see Appendix D).
   - Wear the appropriate protective equipment, such as goggles and laboratory aprons.
   - Tie back long hair to keep it away from chemicals, open flames, and equipment.
   - Tie back or remove articles of clothing or jewelry that could touch chemicals or flames during investigations.
   - Wear shoes that enclose the feet—no sandals or open-toe shoes.
   - Never eat or drink anything while in the laboratory.
   - Locate the safety equipment, such as the eyewash station, and know how to use it correctly.
   - Know where the exits are located and the proper procedures to be followed in an emergency.
   - Wear splash-proof safety goggles until all chemicals have been returned, glassware cleaned, and equipment properly stored.
3. Be alert in the laboratory. Watch for potential problems, and report unsafe situations immediately. Do not work alone in the laboratory.
4. Do not attempt unauthorized activities. Work only on authorized activities that are related to the investigation.
5. If a chemical spill occurs, report it immediately and follow the teacher's instructions.
   - Move quickly from the site.
   - Wash off chemicals that have splashed onto the skin or clothing for 15 minutes using large amounts of water in the safety shower or eye/face wash station.
6. Keep your area clean. Clean up the area at the end of the class. Dispose of biological and chemical waste properly.
7. Do not enter preparatory or equipment storage rooms or chemical storerooms.
8. Always wash your hands for at least 20 seconds with soap and warm water before leaving the laboratory.

SCIENCE TEACHERS

Classrooms and science laboratories may be crowded, increasing the probability of accidents occurring. Advance planning and preparation is one of the best safety practices a teacher can use to reduce the probability of accidents.

TEACHER RESPONSIBILITIES

1. Understand each science laboratory or field investigation in advance.
   - Carefully read and scrutinize all investigations and activities for safety procedures and materials the students will be handling.
   - Read and understand the information on Materials Safety Data Sheets (MSDS) related to chemicals or other hazardous materials that will be used in the laboratory.
   - Seriously consider all the hazards discussed in the MSDS and determine if the chemicals are safe for students to use. Consider substitute chemicals or procedures.
   - Do a trial laboratory experience if you have not done the investigation before.
   - Remember, teachers and students are to wear protective eyewear and clothing when appropriate.
   - Anticipate what could go wrong during a typical laboratory experience, and take measures to reduce the probability of an accident occurring.
2. Have regular pre-laboratory activities before taking students into a laboratory setting. Go over all safety precautions in the investigation, and answer questions and concerns before beginning the activity.
3. Label all chemicals correctly and clearly (see Chapter VI).
4. The materials to be used during the laboratory investigation should be arranged carefully and placed in a safe area for students to use.
5. Maintain order and discipline during the activity. Safety rules are to be obeyed by all students.
6. Monitor the laboratory room or field site. Work with students to correct any procedure or behavior that is not safe.
7. Students should promptly clean up their areas while wearing safety goggles. Chemicals and biological wastes should be disposed of correctly.
8. If accidents do occur, follow the school district's policy and guidelines on administering first aid and reporting the accident. Do not wait to write a report of what caused the accident, injuries, action taken, and results. A more accurate description can be made soon after an accident occurs.

SCIENCE CHAIRS AND LEAD TEACHERS

The science chair and lead teacher must make safety a high priority. They should monitor safety in the laboratory, preparatory room, and storage room.

CHAIR AND LEAD TEACHER RESPONSIBILITIES

1. Develop a monthly schedule for inspecting laboratory facilities, preparatory and equipment rooms, and storage rooms. Identify problem areas, and develop plans to improve safety.
2. Discuss with the science teachers the school district's procedures for proper disposal, labeling, and handling of chemicals.

3. Announce additions to the MSDS library as new chemicals and hazardous materials are added to the department. Each teacher should be made aware of the hazards of new chemicals.

4. Work with teachers to keep students in compliance with the safety rules. The chairperson and lead teacher should set and model high standards of safety.

5. Assist with emergency actions that are needed for laboratory accidents, assistance to the injured person, and the cleaning up of chemical spills, broken glassware, and fires. Planning and advance preparation will help everyone to stay calm and think clearly if an accident does happen.

6. Work with science teachers to report and investigate accidents. The purpose of the investigation is to determine the cause and make corrections, if possible; not to place blame.

7. It should be the responsibility of the science chair to maintain a file and record of documented accidents.

SCIENCE SUPERVISORS

The science supervisor has considerable responsibility in directing the science curriculum of the school district. The science supervisor should work closely with chairpersons and lead teachers on the science safety program and serve as a liaison between central administrators and school campuses. Most of the responsibilities related to safety are those of the science supervisor. The science supervisor should conduct annual safety professional development and provide safety updates to the science teachers regularly.

SUPERVISOR RESPONSIBILITIES

1. Assist the science chair and lead teacher on each campus with meeting the requirements of the Hazard Communications Act.

2. Monitor all laboratory facilities for required safety equipment. The safety equipment needs to be installed correctly and function properly. An annual check of each campus, including chemical storerooms and preparatory and equipment rooms, should be part of the routine tasks (see Appendix E).

3. Work with the campus science chair and lead teacher to review science laboratory and field investigations for safe practices and safe use of materials. Consider alternate investigations in cases where existing conditions might compromise safety.

4. Require an annual chemical inventory on each campus. Materials Safety Data Sheets must be kept on all chemicals in the school's science work area.

5. Discuss with teachers the school district's process and procedure for properly disposing of chemicals and biological waste. Teachers should be made aware of their obligation to follow designated procedures for chemical waste disposal.

6. Be well informed of the laws, rules, and regulations concerning safety, and conduct professional development on safety.

7. Become active in state and national science organizations for access to current safety information.

ADMINISTRATORS

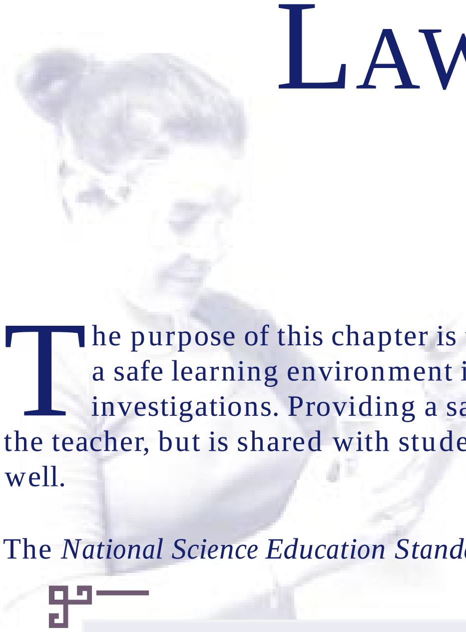
A school district's administrators, whether on the campus or in the district's central offices, have a crucial role in assuring that students and teachers work and learn in an environment that is safe.

ADMINISTRATOR RESPONSIBILITIES

Develop a district safety policy, and provide a safety program that includes

1. implementing the school district's safety program;
2. supporting professional development on safety;
3. developing emergency procedures;
4. ensuring that science classes do not have more than 24 students and do not exceed the number of work stations in a laboratory room;
5. providing laboratory facilities with two exits, proper lighting and ventilation, master utility cutoff valves, and safe, sufficient, properly located electrical outlets;
6. providing necessary safety equipment, such as eye/face wash stations, fume hoods, safety showers, fire extinguishers, safety eyewear, fire blankets, chemical spill kits, etc.;
7. conducting annual inspections and a maintenance program to ensure safe working conditions;
8. producing safety policies that can be adopted by the local school board and implemented on all campuses;
9. maintaining compliance with the Hazard Communications Act; and
10. providing the district's procedures for proper disposal of chemicals and biological wastes.

Texas Education Agency, *Science Laboratory Safety and Chemical Waste Disposal for Texas Teachers*, 1990



Laws, Rules, and Regulations

The purpose of this chapter is to present the laws, rules, and regulations necessary for a safe learning environment in science laboratories, classrooms, and field investigations. Providing a safe environment for students is not the responsibility of the teacher, but is shared with students and building and central office administrators as well.

The *National Science Education Standards* recommends approaching safety as…

> *… "a fundamental concern in all experimental science. Teachers of science must know and apply the necessary safety regulations in the storage, use, and care of the materials used by students. They adhere to safety rules and guidelines that are established by national organizations such as the American Chemical Society and the Occupational Safety and Health Administration, as well as by local and state regulatory agencies. They work with the school and district to ensure implementation and use of safety guidelines for which they are responsible, such as the presence of safety equipment and an appropriate class size. Teachers also teach students how to engage safely in investigations inside and outside the classroom."*
>
> National Research Council, National Academy of Science, 1996

As science educators, teachers have the responsibility to show by example and to teach the need for safe work habits and interaction with the environment. To understand this responsibility, teachers must have a working knowledge of federal, state, and local laws, rules, and regulations including the actions required by you and others under these requirements. The federal and state laws are very specific about what safety requirements are to be used in the science laboratory and classroom. Local safety codes can be can be acquired from the city government offices in your community.

A summary of the relevant laws, rules, and regulations related to safety in Texas' schools is presented in this chapter. For the complete version of each of these laws, rules, and regulations (see Appendix A).

Federal Law

Individuals with Disabilities Education Act

Public Law (P.L.) 105-17. A school district must ensure that students with disabilities are not excluded from participation in, or denied the benefits of, its services, programs, and activities (Least Restrictive Environment). It must also ensure that they are not subjected to discrimination by the school system. Therefore, certain modifications in laboratory design may be necessary to accommodate a students with disabilities so that they may participate in laboratory investigations safely.

STATE
LAWS, RULES, AND REGULATIONS

AUTHORITY OF THE STATE BOARD OF EDUCATION

The State Board of Education (SBOE) is assigned specific rulemaking authority under the Texas Education Code (TEC). SBOE rules are codified under the Texas Administrative Code (TAC). The TAC is the official compilation of all final state agency rules published in the Texas Register. Following its effective date, a SBOE rule is entered into the TAC under Title 19, Part II. Title 19 is Education, and Part II is the Texas Education Agency. Under the Texas Education Code, the Commissioner of Education is also authorized to adopt rules governing specified areas of education. Commissioner's rules are also part of the TAC, Title 19, Part II.

TEXAS EDUCATION CODE, TITLE 19

REMOVAL OF A DISRUPTIVE STUDENT

Chapter 37. Discipline: Law and Order. A teacher may remove a student from the classroom or laboratory and send the student to the principal's office for disruptive behavior to maintain effective discipline and a safe environment.

PROTECTIVE EYE DEVICES

Chapter 38. Protective Eye Devices in Public Schools. Teachers and students are required to wear protective eye devices during science investigations or activities where harmful materials or substances are being used. Local school districts must adopt rules designating when protective eye devices should be worn and the type necessary under these conditions. This requirement applies to anyone observing a science investigation or activity where protective eye devices are required to be worn by the teacher and students.

EDUCATOR'S CODE OF ETHICS

Chapter 247. The Code of Ethics and Standard Practices for Texas Educators requires educators to:

- comply with written local board policies, state regulations, and other applicable state and federal laws.
- make reasonable efforts to protect the student from conditions detrimental to learning, physical health, mental health, or safety.
- not exclude a student from participation in a program, deny benefits to a student, or grant an advantage to a student on the basis of race, color, sex, disability, national origin, religion, or family status.

TEXAS ADMINISTRATIVE CODE, TITLE 19, PART II

SCHOOL FACILITIES STANDARDS

Chapter 61. Commissioner's Rules Concerning School Facilities. Standards for science classrooms and combination lecture / laboratories are defined in this chapter of the Texas Administrative Code.

Square feet per room measurements

> The net footage of a room that will house 22 students at the elementary level and 25 students at the middle or high school level. The net square footage of a room includes exposed storage space, such as cabinets or shelving, but does not include hallway space or storage space, such as closets or preparation offices.

Space, minimum square footage requirements

> Specialized classrooms. Science lecture / lab shall have a minimum of 41 square feet per pupil or 900 square feet per room at the elementary school level; 50 square feet per pupil or 1,000 square feet per room at the middle school level; 50 square feet per pupil or 1,200 square feet per room at the high school level.

TEXAS ESSENTIAL KNOWLEDGE AND SKILLS

Chapter 112. Required Curriculum. Safety during laboratory and field investigations is required beginning with Kindergarten and continuing through Grade 12. The Texas Essential Knowledge and Skills for Science require that as part of the regular instruction in science, students participate in and conduct investigations. For example:

- Kindergarten-Grade 5, students participate and conduct laboratory investigations following home and school safety procedures that are environmentally appropriate and follow ethical practices.

- Grades 6-8, students conduct field and laboratory investigations using safe, environmentally appropriate, and ethical practices.

- Grades 9-12, the students, for at least 40% of instructional time, conduct field and laboratory investigations using safe, environmentally appropriate, and ethical practices.

40% LABORATORY AND FIELD REQUIREMENT

Chapter 74. Curriculum Requirements. In addition to the requirements found in the Texas Essential Knowledge and Skills for Science, The State Board of Education defined the percentage of the instructional time that is to be laboratory instruction. High school courses shall include at least 40% hands-on laboratory investigations and field work using appropriate scientific inquiry.

TEXAS DEPARTMENT OF HEALTH

TEXAS ADMINISTRATIVE CODE, TITLE 25, PART I

FACE AND EYE PROTECTION STANDARDS

Chapter 295. Standards for Face and Eye Protection in Public Schools. This chapter applies to teachers and students in Texas public schools participating in science courses and laboratories where potentially hazardous activities exist. The law requires that:

- local school boards and administrators furnish eye protectors of the type suitable for the work performed.
- eye protection equipment be worn when there is a reasonable probability of injury to the body
- the eye protectors be kept clean and in good repair.
- teachers and students who wear corrective lenses must be provided goggles that can be worn over corrective spectacles without disturbing the adjustments of the spectacles.

HAZARDOUS SUBSTANCES

Chapter 501. Description of Hazardous Substance. This chapter defines the kinds of hazardous substances that may be found in the science laboratory. It clarifies that public school employees are not required to comply with the Occupational Safety and Health Administration (OSHA) standard on hazardous substances.

It clarifies that students are not defined as employees for the purpose of the Texas Hazard Communications Act. Therefore, the Act is not applicable to students in their capacity as students. (July 21, 1993 ruling of the Texas Attorney General, Opinion No. DM-239)

HAZARD COMMUNICATIONS ACT (HAZCOM)

Chapter 502. Hazard Communications Act. This chapter requires that:

- a chemical manufacturer is required to provide Material Safety Data Sheets (MSDS) to employers who acquire hazardous chemicals. It further requires employers to maintain a legible copy of a current MSDS for hazardous chemicals used in the workplace that are legible, accurate, and readily available to employees on request at each workplace.
- labels are to be on existing containers of hazardous chemicals. Employees may not be required to work with hazardous chemicals from unlabeled containers.
- an education and training program for all employees who use or handle hazardous chemicals be established. It requires employers to maintain a written hazard communication program that specifies certain contents of the program, who is to receive training and maintain training records.
- employers post and maintain adequate notice informing employees of their rights under the Hazard Communications Act.

VOLUNTARY INDOOR AIR QUALITY GUIDELINES FOR PUBLIC SCHOOLS

Chapter 297. Voluntary Indoor Air Quality Guidelines. This set of guidelines presents three voluntary recommendations.

- Establish guidelines for initial program development, a management plan, and school board review for program status and future needs of public schools.

- Develop a written preventive maintenance program for a healthy learning environment for students.
- Recommends considerations for students with allergies or chemical intolerances, handling of foods, garbage storage and disposal, smoking, and reporting of conditions that are not conducive to clean air.

Texas State Law

Civil Practice and Remedies Code, Title 5

Safety and Tort Law

The obligation to comply with legal safety requirements and recommendations affords school districts the opportunity and means to provide exemplary science learning in a safe environment. The potential for lawsuits increases when the school district fails to provide these safe conditions for teachers and students.

Texas governmental entities are generally immune from tort liability under the doctrine of sovereign immunity. However, governmental immunity can be waived under certain instances as found in the Texas Tort Claims Act, Civil Practice and Remedies Code 101.001 et. Seq. Professional employees may be held liable in circumstances involving: use of excessive force in the discipline of students; negligence resulting in bodily injury to students; or the operation, use, or maintenance of any motor vehicle.

A "tort" is a wrong or injury to a person or property with the standard of proof being the preponderance of evidence.

Negligence is defined as conduct that falls below a standard of care established by law to protect others against an unreasonable risk or harm. Situations where a person could be found negligent include:

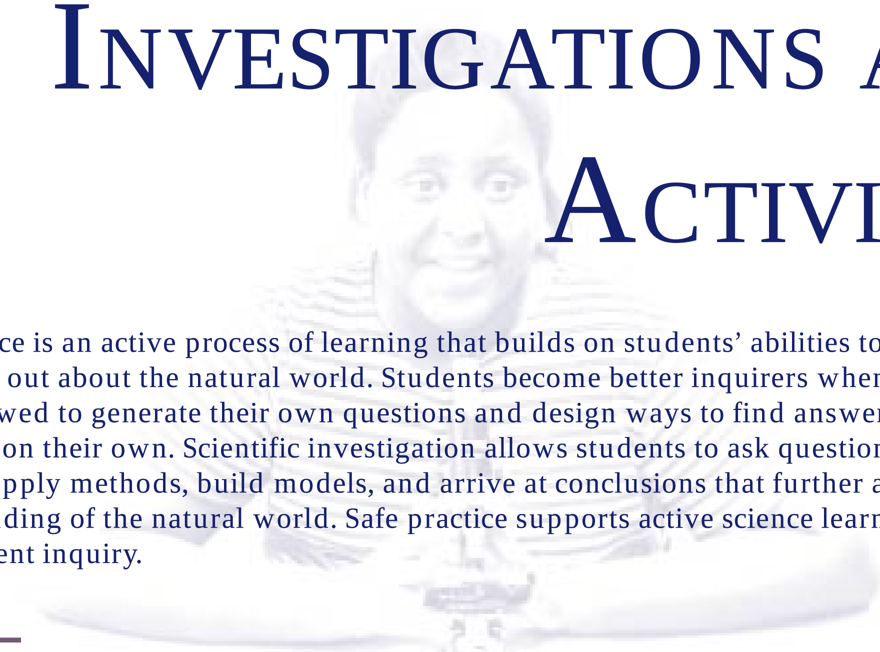
- doing that which should not have been done or the committing of an unlawful act (malfeasance). For example, forcing a student to assume an unnecessary risk is malfeasance.

- the failure to do what should be done (nonfeasance). For example, inadequate facilities or lack of proper facilities could be considered nonfeasance.

Public educators are expected to minimize the risk of accidents to students in science classrooms and laboratories. According to the National Science Teachers Association...

> *"The accident rate in schools is 10-50 times higher than that of the chemical industry. Research goes beyond the headlines to look at the factors that accompany school accidents, which include:*
>
> - *inadequate or poorly designed working space, overcrowding, and too few work stations*
> - *teachers with poor course work preparation*
> - *teachers who are teaching more than two preparations at the same time*
> - *inadequate safety training."*
>
> NSTA, *Guide to School Science Facilities*, 1999

Laboratory Investigations and Activities



Science is an active process of learning that builds on students' abilities to inquire and find out about the natural world. Students become better inquirers when they are allowed to generate their own questions and design ways to find answers to those questions on their own. Scientific investigation allows students to ask questions from which they can apply methods, build models, and arrive at conclusions that further an understanding of the natural world. Safe practice supports active science learning and independent inquiry.

> *"Laboratory experience is so integral to the nature of science that it must be included in every science program for every student. Hands-on science activities can include individual, small, and large group experiences."*
>
> NSTA: *Laboratory Science*, 1990

Learning through Laboratory Experiences

Science learning experiences occur in the classroom, in the field, and in the laboratory. Through these experiences students discover facts, concepts, and laws of science, much as scientists do in their professional lives. Classroom activities provide students with hands-on materials and procedures designed to help them experience various facets of the natural world. Field experiences allow students to explore, observe, and investigate aspects of the natural world that cannot be brought into the classroom learning environment.

Laboratory-based investigations allow students to inquire, explore, and observe natural-world phenomena that are brought into the classroom specifically to facilitate student investigations. Teachers at all grade levels require a wide range of materials and instruments to facilitate student investigations. Safety, therefore, is an essential part of the planning process, whether the learning experiences occur in the classroom, in the field, or in the laboratory.

What Is a Laboratory Investigation?

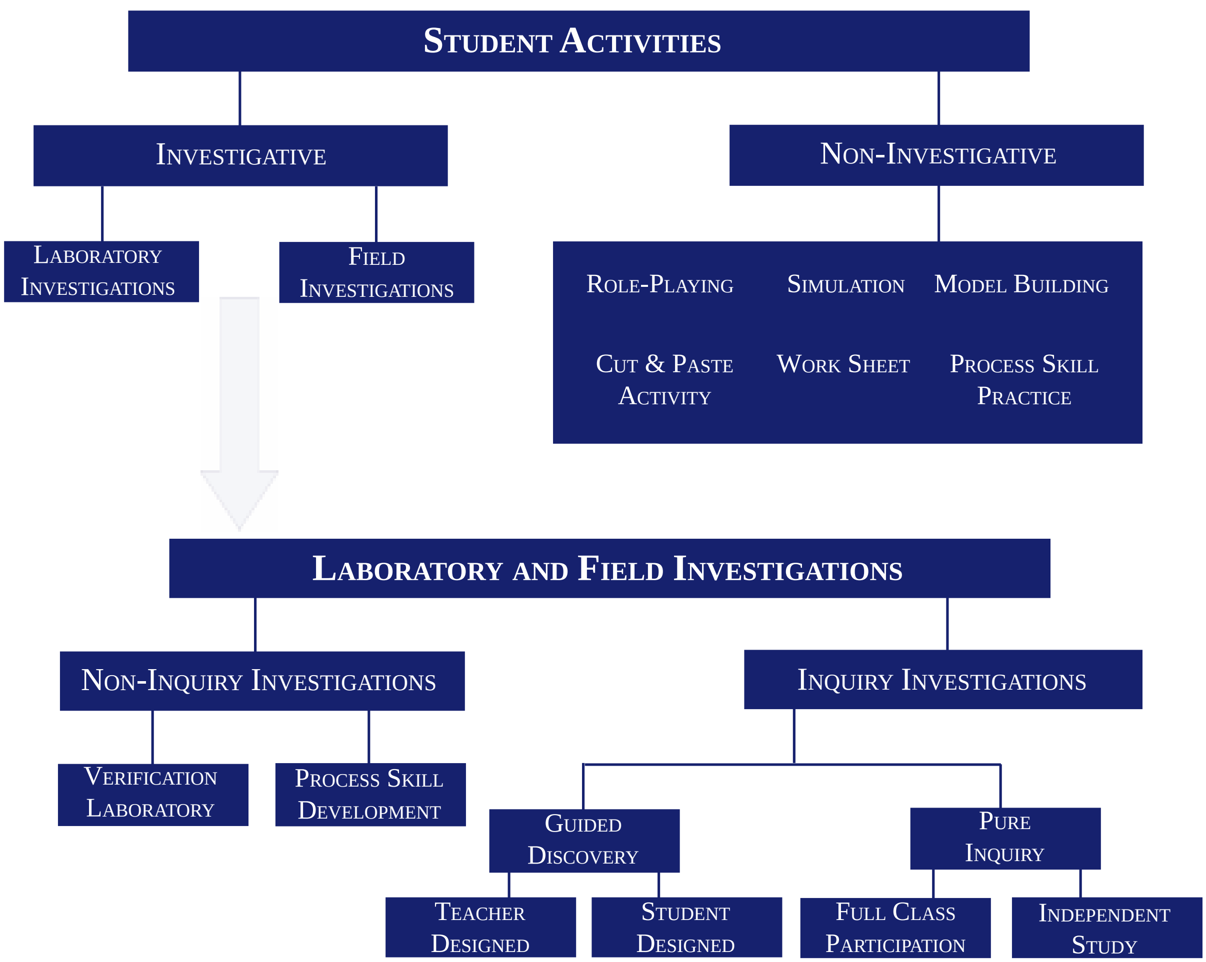
Laboratory settings accommodate different types of instructional strategies and allow teachers and students to take responsibility for the structure and sequence of an investigative activity.

Examples of different types of laboratory investigations include the following.

- **Verification laboratory:** In this type of laboratory investigation, the student determines the cause, effect, nature, or property of a phenomenon through hands-on experience under controlled conditions. The teacher constructs a laboratory procedure, and the student follows the directions—and, if successful, confirms known results.
- **Guided discovery:** The teacher presents students with a problem, and the teacher or student develops a research design to test a hypothesis related to the problem. The teacher guides the process until the student has successfully tested the hypothesis.
- **Pure inquiry**: Students find answers for themselves and become involved in learning how to learn.
- **Process skill practice**: The objective is to teach a manipulative laboratory skill. These skills may be integrated with another activity.
- **Process skills development**: Students have opportunities to apply scientific processes to scientific investigations and problem-solving activities.
- **Independent Study**: This arrangement allows students the opportunity to explore in greater depth an area of interest not normally studied by an entire class.

Texas Education Agency, *Planning a Safe and Effective Learning Environment*, 1985

The following flow chart identifies the types of student activities that include laboratory and field investigations.



WHAT QUALIFIES AS A LABORATORY INVESTIGATION?

A laboratory investigation consists of pre-laboratory activities, the laboratory experience, and post-laboratory activities. Pre-laboratory activities introduce students to the laboratory experience. Students can gain important information about a science concept, plan strategies for conducting a successful investigation, and discuss techniques that they may use during the investigation.

The laboratory experience is the hands-on portion of the investigation that involves the students' direct participation in activities such as analyzing information gathered during the laboratory experience, drawing conclusions, and producing graphs, maps, charts, or spreadsheets to assist them with communicating their findings.

Conclusions may lead to a need for further investigations, which students and teachers can discuss and plan during the post-laboratory activities.

Demonstrations are an important method of introducing a science concept or reinforcing a student's understanding of the concept, but demonstrations are not considered laboratory investigations.

DEMONSTRATIONS ARE NOT CONSIDERED LABORATORY INVESTIGATIONS.

Similarly, computer laboratory simulations are not considered laboratory investigations, but they are important instructional strategies in a hands-on experience.

LABORATORY EXPERIENCES IN KINDERGRATEN–GRADE 2

Laboratory-based experiences begin in the early grades when students ask questions, plan and conduct simple, descriptive investigations, extend their senses through the use of tools, construct reasonable explanations, and communicate their findings.

Science experiences in these early grades allow students to inquire, explore, and observe phenomena that are brought into the classroom specifically to stimulate student investigations.

Teachers know that students in kindergarten through grade 2 become better inquirers when they are allowed to generate their own questions and design ways to answer those questions on their own by actively doing science.

Students should follow home and school safety procedures when participating in classroom investigations. They should demonstrate safe practices while learning to use and conserve resources and materials (see Appendix H).

"The elementary science program must provide opportunities for children to develop understandings and skills necessary to function productively as problem-solvers in a scientific and technological world.

Elementary school children learn science best when they are involved in first-hand exploration and investigation and inquiry/process skills are nurtured."

NSTA: *Elementary Science*, 1991

Laboratory Experiences in Grades 3–5

Laboratory-based experiences in kindergarten through grade 2 required the students to plan and implement descriptive investigations by asking well-defined questions, formulating hypotheses, and selecting the equipment and materials needed to conduct the investigations.

Students in grades 3–5 can generate their own questions and design ways to find answers to those questions on their own. They can collect information by observing and taking measurements, and analyze and interpret that information to develop reasonable explanations about the results.

Students should be able to communicate valid conclusions and, when possible, incorporate graphs, tables, maps, and charts to organize and evaluate information.

When conducting field and laboratory investigations, students should follow home and school safety procedures as well as environmentally appropriate and ethical practices.

Students should demonstrate safety practices during the field and laboratory investigations and make wise choices in the use and conservation of resources.

Laboratory Experiences in Grades 6–8

Laboratory-based experiences in the earlier grades allowed students to inquire, explore, and observe things that were brought into the classroom specifically to stimulate student investigations.

Middle-grade students will become better inquirers when they are allowed even more freedom to generate their own questions and design ways to find answers to those questions on their own. Students in grades 6–8 should have the freedom to select and use equipment and technology to implement investigative procedures.

By grade 8, students should be able to plan and implement descriptive and experimental investigative procedures, collect data, organize, analyze, evaluate, make inferences, and predict trends in evidence. They should be able to communicate valid conclusions effectively and use tools to construct graphs, tables, maps, and charts.

Students should demonstrate safe practices that are environmentally appropriate and ethical as they conduct laboratory investigations and do fieldwork.

Laboratory Experiences in Grades 9–12

High school teachers should expect students to be better science learners when they are allowed the freedom to generate their own questions and design ways to find answers to those questions on their own. Students in ninth-grade science should already have had numerous field- and laboratory-based science experiences from kindergarten through grade 8, and they will have used a wide range of science materials and instruments.

By grade 9, the students should be able to demonstrate many of the new science concepts they are learning. They should be able to plan and implement descriptive and experimental investigative procedures in which they select equipment and technology to facilitate their investigations.

Specialized equipment and procedures facilitate students' conceptual understanding of complex concepts, many of which require special precautions in order to assure student safety in the laboratory.

LABORATORY MANAGEMENT TECHNIQUES

Classroom management techniques maximize and reinforce proper behavior and safety in the science laboratory.

Essential knowledge, concept mastery, and process skill development have high priority in the science laboratory and depend on effective strategies for maximizing learning. Fortunately, the techniques that maximize learning also promote safety. The following represents a list of recommended laboratory management techniques.

1. Maintain fair and consistent classroom discipline to prevent unsafe conditions from being created during laboratory investigations.

2. Establish routine procedures for conducting a laboratory investigation that promote an orderly and safe environment. Ask different students in each laboratory group to

    - obtain materials from a supply area,
    - return materials at the completion of a laboratory investigation, and
    - record data, if class data are needed.

3. Explain and post the expectations for orderly conduct in the classroom, laboratory, and field. Teachers should always model appropriate classroom, laboratory, and field procedures.

4. Explain and post safety rules for the classroom, laboratory, and field. Students and parents should complete and return a signed safety contract before students begin investigations.

5. Explain the consequences of unsafe behavior.

6. Before each laboratory investigation, review the safety rules for using laboratory equipment and facilities.

7. Prior to the investigation, arrange for the proper disposal of wastes.

8. Keep up with current information on safety and class procedures, and practice those procedures consistently.

9. Examine laboratory investigations and equipment for appropriateness and safety.

10. Review with the students the procedures for using the laboratory. Discuss safety rules and precautions before the investigation begins.

11. Promote a positive attitude. Students should not fear doing experiments, using reagents, or using equipment, but should have a positive attitude toward safe laboratory procedures.

12. Adjust procedures for students with emotional, physical, or educational problems to capitalize on the contributions they are able to make.

13. When a substitute teacher is in charge, create an alternate lesson plan that does not involve laboratory work.

14. Monitor continuously for maximized learning and safe conditions.

15. Plan post-lab activities for after the laboratory work has been completed.

16. Clean the work areas thoroughly and regularly.

17. Develop procedures to be followed in case of an accident.

18. Establish procedures for asking students to leave the laboratory when they demonstrate unacceptable behavior.

Paraphrased from *Secondary Science Safety*, by J. G. Gerlovich, T. F. Gerard, B. Shriver, G. E. Downs, and L. C. Flinn, Jr. and from *Science Laboratory Techniques*, by R. B. Bartholomew and F. E. Crawley.

EVALUATING SAFETY IN LABORATORY INVESTIGATIONS

Laboratory investigations and experiments are handed down from one teacher to another, given away at conferences, downloaded from the internet, and found in journals. But how does the teacher know that the laboratory investigation is safe for the students to use?

To evaluate how safe an investigation is, consider these guidelines before allowing students to conduct an unfamiliar investigation. Remember, the teacher should always complete the investigation before approving it for student use.

WHAT CAN BE DONE IN ADVANCE?

- Do not assume that investigations published in laboratory manuals or journals, or acquired from other teachers, are safe.
- Always read and check new investigations carefully.
- Appropriate safety symbols should be present in the investigation to alert students of a hazardous precaution.
- The investigation should inquire into, investigate, illustrate, or analyze a scientific concept or principle in a safe manner or method.
- Check the equipment or setup to be used and the glassware for proper assembly and cracks.
- Know all the actions and reactions that should occur between the chemicals to be used, and investigate unexpected reactions that might occur.
- Know the hazards of all substances used in the activity. Material Safety Data Sheets (MSDS) and other safety references should be consulted.
- Know the hazards of predicted products and other possible products.
- The correct amounts of substances and concentrations of solutions should be clearly stated in the directions.
- Substances with a high hazard rating should not be used in science labs. Substitute safer compounds for the hazardous substance.
- Check the electrical equipment for proper grounding, frayed wires, and safe connections.
- All precautions must be thoroughly discussed in the pre-lab session with the students.
- The students should be aware of what to do with the products that are formed and any remaining materials.
- The investigation must be clearly written so that students understand exactly what to do and how to carry out the activity.

Texas Education Agency, *Science Laboratory Safety and Waste Disposal for Texas Science Teachers*, 1990

RESPONDING TO A LABORATORY ACCIDENT

Being prepared for accidents will help decrease the possibility of an accident becoming more severe or of other injuries occurring. In the event of an accident, action must be taken quickly to minimize the effects of the accident. It is strongly recommended that teachers receive professional training in cardiopulmonary resuscitation (CPR), first aid, pelvic thrust (Heimlich maneuver), and other emergency procedures.

Planning for an emergency should involve the entire organization within your school: administrators, maintenance staff, custodial staff, office staff, nurse, teachers, students, and parents. Every area and event should be included in the planning, including the school building and grounds, field trips, etc.

COMMON EMERGENCIES

Possible emergencies that teachers may respond to include . . .

- small to moderate fires
- chemical reactions that result in an explosion
- serious burns resulting from exothermic reactions
- serious chemical burns
- ingestion of hazardous chemicals
- electrical shocks from equipment
- chemical spills resulting from broken containers
- minor to serious cuts

IF AN ACCIDENT OCCURS

1. Attend to the injured person(s) immediately.

2. Administer first aid in the laboratory to . . .

   - stop the flow of blood in the case of a cut, and
   - wash off any caustic chemicals on the body or in the eyes.

Special Note: Teachers should wear protective gloves before handling victims who are bleeding.

3. If the injury is a cut or an abrasion . . .

   - Wash the injured area thoroughly.
   - Place a compress on the wound to stop the flow of blood.
   - Replace the compress with a sterile bandage if the injury is minor.
   - Accompany the student to the nurse's office if the injury is moderate or severe.
   - Follow the proper procedures to clean up blood.

4. If the injury is the result of chemicals . . .

   - Rush the injured person to the safety shower (safety showers should be within 10 seconds of any student—approximately 50 feet away).
   - Immediately drench the entire area with a continuous flow of water for 15 minutes.
   - Send a student to alert the school's nurse or to get another teacher.
   - Use a spill kit to contain and remove the chemicals.

5. If foreign materials or chemicals have entered the eye . . .

   - Rush the student to the dual eyewash station (eye/face washes should be within 10 seconds of any student).
   - Remember, the student will have difficulty seeing, so guide them to the eye/face wash station.
   - Rinse the open eyes with a continuous stream of tepid water (60–90°F) for 15 minutes.
   - Send a student to alert the school's nurse or another teacher.

6. If the person has ingested hazardous material . . .

   - Rush the person to the nurse's office.
   - The nurse should contact the Poison Control Center.
   - If a chemical was ingested, consult the MSDS in your department.
   - If the person's injury is severe, accompany him or her to the nurse's office.

7. The nurse should assume responsibility for providing help at this point by . . .

   - administering additional first aid,
   - contacting the parents, and
   - pursuing additional treatment if necessary (information is on students' emergency health cards).

8. If the nurse is not available, the teacher is obligated to follow through with accident procedures to protect the student from further injury.

   - The teacher or nurse should call the student's parents to advise them of the severity of the accident and to ask their permission to proceed with treatment as needed.

   - If the parents cannot be reached, the teacher must act in accordance with the situation. The student's emergency health card gives permission for emergency care to be administered. The teacher should call a physician and, upon the physician's advice, seek treatment for the injured student.

9. After the injured person has been cared for and any chemical spill contained, the teacher needs to fill out an accident report for their own protection even if it is not required by the school district (see Appendix D).

10. If the injury is the result of electrical shock . . .

    - Separate the person from the electrical source carefully. Use the master control switch.
    - Call for emergency medical aid immediately.
    - Check for breathing and pulse immediately.
    - Start CPR if necessary.
    - Check for entrance and exit burns. Treat burns as you would a thermal burn.
    - There may be two burns present—one where the power entered the body and the other where it exited. Some burns are large and below the skin.
    - Keep the injured person warm, quiet, and lying down.
    - The injured person may stop breathing after being shocked by high-frequency electrical currents or being struck by lightening.
    - The injured person may be unconscious, dazed, weak, or confused, with an irregular pulse.

CAUSES OF LABORATORY ACCIDENTS

To prevent accidents, it is necessary to identify the causes of accidents. The school's, teacher's, and students' actions (or lack thereof) can contribute to many laboratory accidents.

WHEN THE SCHOOL OR THE TEACHER IS AT FAULT

1. Failure to thoroughly plan and conduct a safe activity

   - Failure to incorporate safety into the activity
   - Use of unnecessary hazardous chemicals
   - Following unsafe procedures and methods
   - Failure to plan for disposal of waste or hazardous chemicals
   - Lack of teaching experience and safety training
   - Failure to use and maintain discipline
   - Failure to enforce safety rules

2. Failure of the teacher to give adequate, clear instructions or perform thorough inspections of equipment

   - Incorrect instructions given to students, or students did not understand the instructions before beginning the activity
   - Failure to inspect equipment
   - Failure to monitor students during the activity

3. Unsafe activity design, chemicals, or equipment
   - Unsafe or improper planning of the activity
   - Improper or poorly designed equipment
   - Failure to check to see if chemicals were suitable or safe to use

4. Failure to provide safe laboratory work areas
   - Inadequate facilities: poor lighting and ventilation
   - Inadequate or inappropriate work space
   - Only one exit in laboratory
   - Improper storage area
   - Inadequate maintenance and poor housekeeping

5. Proper safety equipment not provided or maintained
   - Failure to provide fire extinguishers
   - Failure to maintain safety equipment
   - Failure to provide safe equipment and materials
   - Lack of safety equipment: goggles, lab aprons, fume hoods, showers, eye/face wash stations

WHEN THE STUDENT IS AT FAULT

1. Failure to follow instructions and use safe practices
   - Safety rules not followed
   - Precautions and procedures not followed
   - Failure to understand what is to be done
   - Lack of knowledge of the hazards
   - Doing unauthorized experiments
   - Working without approval
   - Being disorderly
   - Failure to have equipment approved by the teacher
   - Failure to follow teacher's instructions

2. Failure to use personal protective equipment
   - Failure to wear eye protection
   - Improper clothing and shoes
   - Failure to use fume hoods
   - Improper use of protective equipment

3. Improper use of equipment or chemicals
   - Failure to follow precautions
   - Incorrect use of chemicals
   - Use of wrong chemicals
   - Failure to follow instructions using an instrument
   - Failure to monitor experiment or equipment in operation

4. Physical condition of the student
   - Student was ill.
   - Student was fatigued—not attentive or alert.
   - Student was under the influence of alcohol or other drugs.
   - Student had poor manual dexterity or skills.

5. Mental attitude and knowledge
   - Failure to understand the experiment
   - Lack of knowledge needed to do the experiment
   - Lack of good judgment
   - Too rushed—resulted in clumsy work habits
   - Tried to use a shortcut that was hazardous
   - Inability to work cooperatively with other students
   - Tried procedures that were not safe
   - Uncontrolled anger or impulsive actions
   - Failure to remain calm and in control

Other Factors

1. Equipment or materials with unknown defects

   - Chemicals contaminated
   - Chemical mislabeled
   - Equipment with unknown defect
   - Unknown tampering with equipment before use

2. Other influences

   - Weather—electrical surges or other weather damage
   - Failure of local power plants.
   - Vandalism of equipment

Texas Education Agency, *Science Laboratory Safety and Chemical Waste Disposal for Texas Science Teachers*, 1990

Field Investigations and Activities

Science learning experiences occur in the classroom, in the laboratory, and in the field. Through these experiences, students discover facts, concepts, and laws of science, much as scientists do in their professional lives. Field investigations provide students with first-hand experience by allowing them to explore, observe, and investigate natural-world phenomena that cannot be brought into the classroom learning environment. Direct observation in a field setting can provide a stimulating and rewarding experience for the students and the teacher. However, field experiences require materials and procedures in order for students to experience various facets of the natural world. In addition, safety guidelines must be maintained to ensure a productive experience for all participants.

> *"School districts should develop and implement safety procedures for laboratory investigations and field trips. Teachers should learn safe procedures for laboratory activities and field trips and follow them as a matter of policy."*
>
> NSTA: *Field and Laboratory Liability*, 1985

What Is a Field Investigation?

Field experiences or investigations are an integral part of any science program. The importance and relationship of field investigations to the curriculum of the natural sciences cannot be minimized and, in many cases, is essential for the application of key concepts. Significant gains in learning may be achieved only through field experiences in some instances.

Field investigations take students out of the school setting and into industries, universities, governmental agencies, arboretums, zoos, museums, and natural areas to discover the applications of science in technology and research. Career awareness is an important result of these experiences.

A field experience may have several purposes and serve a variety of instructional objectives.

Field investigations should

- contribute to the understanding of science concepts in the natural world,
- allow students to experience what real scientists do,
- provide an opportunity to collect real data,
- model real applications of science, and
- connect science disciplines to future careers.

Experiences gained during a field investigation can motivate students to learn more about what they have observed and can serve to bridge the gap between the written text and the actual experiences of working in a natural setting.

> The Texas Essential Knowledge and Skills for Science require students in Kindergarten–Grade 8 to conduct science investigations in the classroom, laboratory, and field. In Grades 9–12, laboratory and field investigations are to comprise at least 40% of their instructional time.

HOW DO YOU PLAN FOR A FIELD INVESTIGATION?

Emphasize safety on any field excursion. Teachers and administrators should consider the following recommendations prior to student participation in fieldwork. This list was adapted from Manitoba Education and Training's *Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions*, April 1997.

Why are you planning this excursion?

- Does the science activity support what the students are learning in the state science standards?
- Are the activities connected to learning experiences?

When do you plan to take the excursion?

- Is there adequate time to plan this trip?
- Will relevant information be provided to students before the investigation occurs?
- Is there adequate time after the trip to do a wrap-up or analysis?
- Are there any potential conflicts with the selected date?
- Does the selected date indicate the need for special clothing or supplies?
- Is there a contingency plan for inclement weather conditions?

What do you expect your students to learn from this experience?

- Have you established objectives for this field investigation?
- Have you selected appropriate activities and instructional approaches?
- Have you and your students completed background research?
- Will students be required to complete a project on the trip?
- Are your expectations about student behavior clear and realistic?

How are you going to get to the site?

- Will transportation be required?
- Is appropriate transportation both available and affordable?
- Can the students actively engage in learning during the trip to the site?

Where do you plan to go with your class?

- Is the site accessible to all students?
- Is the permission of landowners or officials required in order to visit this site?
- Is there an admission fee?
- Does the site have facilities such as bathrooms, lunch areas, shelters, and meeting space?
- Are there appropriate emergency facilities nearby?
- Is it possible for the teacher to visit the site before the field investigation?

What safety precautions are required?

- Do you have adequate first-aid kits readily available?
- Do you have fire prevention equipment?
- Will students be given additional safety training before the trip?
- Is a cellular phone available for making emergency calls?
- Are copies of the permission and medical forms with the teacher?

How long will this trip take?

- Can time be used efficiently?
- Is there too much to do in the time available?
- Is time provided for students to relax?

What is the effect on the rest of the school?

- Will someone have to cover your other classes?
- Will a substitute be required?
- Will others have to change their planned activities?
- Will students miss other important events or activities while on the field investigation?

Who is helping you supervise the students during the field investigation?

- Have group supervisors been identified?
- Has the class been divided into teams or working groups?
- Are there enough supervisors for the number of students and the activities?
- Are there parents with expertise who could be present during the field investigation?

Have parental consents been received for each student?

- What forms are necessary for parents to give consent and provide emergency information?

Has the trip been approved by the appropriate administrators?

- Do you know the district's procedure for getting approval for field investigations?
- Have the appropriate administrators given their approval?
- Is additional insurance needed?

Do any students have special health concerns?

- Have you talked with the school nurse to determine whether any students have specific health concerns?
- Are there any students who may need to take medication while on the trip?

Have you discussed the following safety precautions with the students?

- Wearing proper clothing and shoes
- Using insect repellent
- Identifying poisonous plants
- Preventing overexposure to the sun
- Taking drinking water to prevent dehydration
- Reporting and responding to accidents
- Using a buddy system

Have you made plans to evaluate the field investigation?

- Will sponsors give feedback about the successes of the trip?
- Will students have an opportunity to evaluate the field trip?

Have you included these items in a parental consent letter?

√ Which students are going and how many
√ Purpose of the excursion
√ Educational opportunities the trip offers
√ Destination of the trip
√ Method of transportation
√ Time and date of departure
√ Time and date of return
√ Types of activities planned
√ Names of teachers and supervisors
√ Special skills of supervisors
√ Clothing requirements
√ Lunch plans, meal arrangements
√ Required materials and supplies
√ Anticipated costs, payments due
√ Risks involved
√ Description of contingency plan
√ Due date for permission forms
√ Due date for medical information forms
√ Time, place for planning meeting with parents

Additional information concerning preparations for field investigations can be found in Appendix E.

WHAT SHOULD BE DONE UPON ARRIVAL AT THE SITE?

Once you have arrived, give students specific information concerning safety before any work begins.

Do the students understand what is expected of them?

- Have students been given clear objectives and expectations?
- Do they know the timelines for their projects?
- Do they know who will be in their group and who their supervisor will be?
- Does everyone have a buddy, and has the teacher established periodic checks?

What should students do if an accident occurs?

- Do students understand the procedures for reporting accidents?
- Do students know where the teachers and supervisors will be located?
- Does everyone know where the first-aid kit is located and who is authorized use the kit?

Has the use of safety equipment been reviewed?

- Has the use of safety equipment been reviewed with the students and supervisors?
- Do students know where personal safety equipment is located, such as safety goggles?

Are students aware of any on-site hazards?

- Have they identified any poisonous plants?
- Have they taken precautions against insect bites?

WHAT AWAITS STUDENTS AT THE SITE?

Poisonous plants are a common hazard that students and supervisors may encounter when on a field trip in a natural area. Coming into contact with poisonous plants can cause allergic reactions, dermatitis, or ingestion reactions.

Some of the most common poisonous plants are poison ivy (*Toxicodendron radicans*), poison oak (*Toxicodendron quercofolium*), and poison sumac (*Toxicodendron vernix*). (See Appendix E for a listing of other poisonous plants). Each of these plants can cause severe dermatitis—itching and oozing sores, swelling of the throat and mouth, weakness, and fever. The degree of plant poisoning can range from minor skin irritation to long-lasting inflammation or blisters, depending on the person's sensitivity to the poison.

To help reduce the chance of infection, students should always wash with soap and water to remove the plant oils immediately after returning from a field experience. Students who are sensitive to these plants should take a change of clothing to reduce the probability of reaction.

Allergies are the result of an individual's sensitivity to airborne materials such as algae, fungus spores, and pollen grains. It is probably impossible to protect students from allergies. Hay fever, asthma, and other allergy-related respiratory diseases can cause serious complications, so teachers should identify students who suffer from these reactions prior to the field trip. The teacher should carry medications sent by the parents so they can respond immediately if a student has an allergic reaction.

Many plants are highly toxic when ingested. Poisoning may result from ingesting seeds, fruits, stems, leaves, flowers, etc., from the plant. The state of the plant's growth, its size, the physical condition of the individual person, and the time of year can affect the seriousness of the poisoning.

The National Science Teachers Association's publication *Safety in the Secondary Science Classroom* provides a valuable set of standards for how to work with plants in the laboratory and what to do upon encountering unknown plants in the field.

1. *Never eat unknown berries, seeds, fruits, or other plant parts.*
2. *Never rub any sap or fruit juices onto the skin or into an open wound.*
3. *Never inhale or expose your skin or eyes to the smoke of any burning plant.*
4. *Never pick strange wildflowers or cultivated plants unknown to you.*
5. *Never eat food after handling plants without first scrubbing your hands with soap and water.*

In the event that a student ingests a plant and becomes ill, use the following procedure to prevent a more serious condition from occurring.

1. Call the physician listed on the student's emergency information form or call a local doctor if the student's physician is unavailable.

2. Be prepared to provide the doctor with the following information:

   - name of the plant (if unknown, collect samples)
   - a complete description of the plant
   - when the student ate the plant
   - student's age, weight, height
   - symptoms the student is exhibiting
   - what part of the plant and how much was ingested

3. Be prepared to transport the student to the nearest hospital.

Plants that are known to be poisonous when ingested are blue-green algae that "bloom," or become very prominent, in polluted water. Also, many species of "toadstools" (mushrooms) are poisonous. It is very difficult to distinguish the edible varieties from the poisonous ones. Some of the more common poisonous mushrooms include *Amanita, Clitocybe, Lactarius, Lepiota,* and *Russula.*

When ingested, these poisonous varieties can cause extreme abdominal pain and vomiting, loss of muscular coordination, and hallucinations. It is extremely important to identify accurately the ingested plant so that proper treatment can be administered.

In addition to plants and fungi, a variety of animals—insects, snakes, and mammals—may be hazardous to some students. Teachers need to know which of their students might react to insect bites and to be prepared to take immediate action. Long-sleeved shirts and blouses may reduce the chance of bites and stings from mosquitoes, ticks, mites, and chiggers. Additional precautions, such as using insect repellents, may further reduce the probability of insect bites.

The threat of snakebites is a serious problem in some areas of the state. In Texas, the venomous snakes include rattlesnakes, copperheads, cottonmouths, and coral snakes. The handling of any snake should be discouraged, and students should never attempt to handle venomous snakes.

Studying natural phenomena in the field is an important part of science instruction. It helps students to make the connection between what they study in the classroom and what occurs in the natural world. Direct observations and investigations can motivate students to go beyond classroom instruction, and the knowledge they acquire in this way may never be forgotten.

SEVERE WEATHER SAFETY GUIDELINES

Severe weather can occur quickly and without warning. It is important for teachers to follow the recommended safety guidelines if severe weather should develop during a field investigation. The National Oceanographic and Atmospheric Administration (NOAA) has developed the *Severe Weather Safety Guide*. The following recommendations have been adapted from NOAA's guidelines.

TORNADO SAFETY

Tornadoes are among the most violent atmospheric phenomena on the planet and can generate winds of 200–300 m.p.h. The following are instructions for what teachers and students should do when a tornado threatens to occur during a field investigation.

IN SMALL BUILDINGS

Go to the basement (if available) or to an interior room on the lowest floor, such as a closet or bathroom. Wrap yourself in overcoats or blankets to protect yourself from flying debris.

IN SCHOOLS, HOSPITALS, OR FACTORIES

Go to interior rooms and halls on the lowest floor. Stay away from glass-enclosed places and areas with wide-span roofs, such as auditoriums and warehouses. Crouch down and cover your head with your hands.

IN HIGH-RISE BUILDINGS

Go to small interior rooms or halls. Stay away from exterior walls and glassy areas.

IN CARS OR SCHOOL BUSES

Abandon them immediately!! Most deaths from tornadoes occur in cars. If you are in a car or school bus, leave the vehicle and go to a substantial structure or designated shelter.

IF NO SUITABLE STRUCTURE IS NEARBY

Lie flat in the nearest ditch or depression and use your hands to cover your head.

FLASH FLOOD SAFETY

Floods and flash floods are the number one weather-related killer, causing at least 140 deaths in the U. S. each year. Floods can occur quickly and be extremely dangerous to anyone on a field investigation.

INSIDE

If ordered to evacuate, or if water is rising, leave immediately and get to higher ground.

OUTDOORS

- Go to higher ground immediately! Avoid small rivers and streams, low spots, canyons, dry riverbeds, etc.
- Do not try to walk through flowing water that is more than ankle deep.
- Do not allow students to play in streams, drainage ditches or viaducts, storm drains, or other flooded areas.

IN A VEHICLE

Do not drive through flooded areas!

The majority of deaths caused by flash flooding are due to people driving through flooded areas. Water only one foot deep can displace 1500 pounds. Two feet of water can EASILY carry most automobiles. Roadways concealed by floodwaters may not be intact.

LIGHTNING SAFETY

Do you know what to do if you are caught in the open during a thunderstorm, or if you feel a tingling or your hair standing on end? Lightning causes around 100 deaths in the U. S. annually (more than hurricanes and tornadoes combined). Even if no rain is falling, lightning can strike up to several miles away from a thunderstorm.

OUTDOORS

If lightening occurs during a field investigation, go to a safe shelter immediately, such as the inside of a sturdy building. A hard-top automobile or school bus with the windows up can also offer fair protection.

If you are in a boat or swimming, get out of the water immediately and move to a safe shelter away from the water. If you are in a wooded area, seek shelter under a thick growth of relatively small trees.

If you feel a tingling, or if your hair stands on end, squat with your head between your knees. Do not lie flat.

Avoid isolated trees or other tall objects, bodies of water, sheds, fences, convertible automobiles, tractors, and motorcycles.

FACILITIES

Science facilities that are designed and built to promote safe and effective science instruction can help prevent safety-related problems. This chapter offers an introduction to the minimum recommendations for designing safe science facilities. The references and resources listed at the end of this chapter provide more extensive information. The Science Facility Safety Checklist (see Appendix E) provides a useful summary of science facilities for public schools.

THE SCIENCE LABORATORY

ADEQUATE SPACE

One of the most important requirements for science facilities is sufficient space in both new and renovated science areas. Studies have shown that the number of accidents increases significantly when the floor space per student in a pure laboratory is less than 41 square feet. The National Science Teachers Association recommends allowing 60 square feet per student. Using technology and meeting the needs of physically impaired students and teachers rerquires additional space. In industrial laboratories, the recommendation is to allow 200 square feet per researcher.

In existing facilities where additional physical space is not an option, the recommended way to create a safer learning environment is to decrease the size of the classes so that each student has at least 50 square feet of working space. No class should exceed 24 students, assuming the laboratory is at least 1200 square feet.

In renovated or new facilities, Texas Administrative Code §61.1033, *School Facilities Standards,* gives requirements for elementary, middle-school, and high-school combination lecture / laboratory science facilities (see Appendix A for full text).

The “square foot per pupil” requirement is defined as the net interior space of a room divided by the maximum number of pupils to be housed in that room during a single class period. The “square foot per room” measurement is the net square footage of a room that will house 22 students at the elementary level and 25 students at the middle and high school levels. The net square footage of room includes exposed storage space but does not include hallway space or storage space, such as preparation offices.

The school district is required to provide the instructional space called for in the district’s educational specifications. The school district may satisfy the requirements by using the minimum “square foot per pupil” or the “square foot per room” measurement, as appropriate.

Additional space is needed to accommodate the use of technology and to meet the needs of physically impaired students and teachers. The estimated space required is an additional 15 square feet per computer station, 12 square feet per monitor / VCR / videodisc player, and 20 square feet per physically impaired student station.

EQUIPMENT SECURITY

The combination lecture/laboratory science room is either a room in which both laboratory and traditional science classroom instruction occurs or a room that is furnished with science laboratory furniture and where traditional science activities also occur.

Some of the most serious injuries occur when students remove chemicals from unsecured science classrooms or preparation/equipment storerooms. The solution is simple: Don't store chemicals, including poisons, anywhere other than in a designated, locked storeroom.

There are other materials and equipment that should be kept in secured storage as well. These include items such as balances, microscopes, sharp objects (syringes, scissors, scalpels, razors, etc.), lasers, and the teacher's portable Direct Current (DC) unit.

FIRE SAFETY

The National Fire Protection Association's Life Safety Code 101 was developed ". . . to establish minimum requirements that will provide a reasonable degree of safety from fire in buildings and structures." The aspects of Life Safety Code 101 that pertain to science rooms include egress, fire extinguishers, smoke alarms, and water sprinkler systems.

There should be two clearly marked emergency exits in each science room and preparation/equipment storage room. According to NFPA 45, the Standard on Fire Protection for Laboratories, public school science classrooms, including the support rooms, are in the Class C hazard lab group that is required to have a second exit for any laboratory 1000 square feet or larger. One of the exits can be a window if the room is on the ground level and the window is large enough for an adult to escape through it.

All exits must be unobstructed. The laboratory and preparation rooms should be unlocked when in use, but should remain locked when not in use.

Fire extinguishers should be placed in a visible location at every exit. The laboratory should have an ABC fire extinguisher and a BC fire extinguisher in the preparation/equipment storage room.

A fireproof fire blanket should be located near the fire extinguisher in a visible, eye-level location that is clearly marked and easily accessible.

If there is no outside window, an emergency light should be available in both the laboratory and the preparatory room. If night classes are held in the room, an emergency light is needed, even if the room has windows.

A functioning fire-alarm system throughout the building is required, and fire drill procedures must be posted and practiced.

ELECTRICAL SAFETY

Compliance with the National Fire Protection Association's National Electrical Code (NFPA 70) is the best means of eliminating potential electrical fires. Electrical fires are one of the most frequent types of fires and typically result from the overuse of electrical circuits or the use of extension cords. A sufficient number of electrical outlets should be provided (including outlets for computer use), so that the use of extension cords and loose electrical cords can be avoided. Generally, two duplex outlets per lab station plus a minimum of two duplex outlets per non-lab station wall are recommended.

Science equipment, such as a hot plate, requires a separate outlet per item. Therefore, it is important to provide a sufficient number of electrical outlets so that circuits are not overloaded and do not constantly short-circuit. Because the computer requirements vary, the general rule of thumb is to consider the educational goals that require the use of computers and other technology when determining the electrical needs for a science classroom. All outlets should be tested to determine if the wiring is correct.

All utilities should have emergency and master utility shut-off controls for each science classroom. The controls should be easily accessible to the teacher—located near the teacher's station, if possible—but not too easily accessible to students. Laboratory utility shut-off controls should be clearly labeled with the type of utility and the room number to which the control is connected. Ground-fault circuit interrupters (GFCI's) should be installed on all outlets in a science room to protect against major shock and electrical fires by preventing short-circuits.

Additionally, outlets should be grounded and located away from sinks and other water sources.

No DC lines are needed, and the hazard they prevent is greater than the benefits they offer. Instead, small, dry-cell batteries are recommended in today's science curriculum.

PREPARATION ROOM AND EQUIPMENT STORAGE

ADEQUATE SPACE

Just as space is important in the design of the science classroom, it is also an important safety consideration in the design of storage facilities for equipment, materials, and chemicals. Today's science curriculum requires the use of many and diverse types of technology, equipment, and materials. Therefore, the facilities should provide sufficient storage space and diverse sizes and shapes of storage areas.

Additionally, the quantity and diverse types of equipment and materials that are used in different types of science courses (physical, chemical, biological, earth / space) require additional storage. Consideration should be given to the storage of odd-shaped items such as skeletons, carts, aprons, charts, distilling units, chromatographs, centrifuges, water baths, ice makers, microwave ovens, and air tracks.

CHEMICAL STORAGE

In a rare cases where the chemical inventory includes flammables that need to be refrigerated, the refrigerator must be spark-free to decrease the possibility of a thermostat arc igniting the stored flammables. A traditional home refrigerator does not have the thermostat housed in a spark-proof casing.

Store chemicals in a designated room that is separate from the preparation / equipment storeroom. The room should have continuous ventilation that exhausts the air at a rate of six air changes per hour to the outside and does not recirculate the air back into the general system. The shelves should be made entirely of wood, plastic, or other corrosion-resistant material, including the shelf supports.

If the room is to store corrosives, keep in mind that any metal item will corrode. The acid cabinet must be either nonmetal or corrosion-resistant coated metal. No electrical outlets or breaker boxes should be in the room.

The wooden shelves should be a maximum of 12 inches deep and tightly anchored to the wall. Containers should not be stored more than two deep. Sufficient space should be provided so that chemicals arranged in compatible families have approximately two to three inches of space between them. In a room that is approximately 50 square feet, at least 36 linear feet of storage is needed in addition to the separate acid and flammable storage cabinets.

There is some disagreement about the need for lips on the shelves. Lips prevent containers from rolling off and spilling their contents. On the other hand, lips can catch the bottom of a container being removed, causing the contents to be spilled or dropped.

The acid cabinet should be vented to the outside to prevent a buildup of toxic fumes. Any venting of chemical fumes must be to the outside away from any intake duct. A separate nitric acid compartment or cabinet must be provided to separate nitric acid from the other inorganic acids or readily oxidized substances.

An approved flammables cabinet is needed for volatile chemicals such as alcohol. The flammables cabinet **should not be vented** unless there are significant problems with fumes. An approved cabinet is designed to protect the flammables from an outside heat or fire source so that there is no danger to firefighters. Poisons should be kept in a locked cabinet.

Countertops should be chemical resistant. It is not recommended to have countertops that are not chemical resistant because of warping, dents, and holes that will appear on their surface. They do not resist daily wear and may become stained after a brief period of usage.

GAS CYLINDERS

Although gas cylinders are rarely found in science classes today, they are particularly hazardous. Because they are extremely heavy metal items, they must be well-secured to the wall, preferably to a support stud. They can cause serious injury, or even death, if they fall on a child. An additional hazard occurs if the valve becomes defective, as the cylinder can literally become a missile that can penetrate walls. These cylinders are more frequently used by vocational students, booster clubs, and Little League volunteers.

VENTILATION

Ventilation should be carefully designed in four areas: the science classroom, the preparation / equipment storeroom, the chemical storeroom, and the fume hood. The science classroom should be vented to the outside away from the intake vents and the air should not be recirculated back into the building's general system. The air should be ventilated at a rate of four air changes per hour. Emergency exhaust ventilation with a manual switch should be available in case an acute buildup of fumes occurs during laboratory investigations. If the fan is wall-mounted, fan guards are recommended.

The preparation / equipment storeroom should be ventilated according to the same criteria that are used for the classroom. No chemicals should be stored in the classroom or the preparation / equipment storeroom because of three problems: security, corrosion to metal, and toxic impact on human health.

There should be a separate room dedicated to the storage of chemicals. It must be ventilated at a rate of six air changes per hour minimum, according to standards of the Occupational Safety and Health Administration (OSHA). The air should be vented to the outside of the building at a sufficient distance from the air intakes to prevent recirculation. If the ventilation unit is wall mounted, it should be equipped with a fan guard.

The chemical storage room should be separate from the preparation / equipment storeroom for three reasons:

(1) to protect human health,
(2) to prevent students from stealing chemicals, and
(3) to prevent the corrosion of metal equipment frequently found in preparation rooms, such as balances, microscopes, etc., emergency utility cutoff, and electrical panels.

Fume hood ventilation should follow the same guidelines and be vented to the outside and away from intake vents. A fume hood should be available for use in every chemistry classroom and every high school science classroom where the students use hazardous chemicals. A fume hood for teacher use should also be located in every secondary school preparation / equipment storeroom. Advanced Placement® chemistry requires two fume hoods or an island type that provides two or more individual workstations.

Fume hoods should be placed at least 10 feet from doors, windows, and vents. They should not be placed in a main traffic aisle or used as a chemical storage area. Most importantly, the ventilation system must be adequately engineered. If two hoods are used, there should be at least two feet between them, and there should be no interference with the draw of the air ducts. The sash level should be marked for a draw of 80 to 120 linear feet per minute of air movement with the date of measurement (ASHRAE 110 testing standard and ANSI Z9.5 standard).

SAFETY SYMBOLS

There is no approved or official set of safety symbols; however, there are many familiar ones (see Appendix G). The important idea is to apply the safety symbols in such a way as to encourage students and adults to use chemicals, equipment, and materials more safely in science classrooms, preparation / equipment storerooms, and chemical storerooms. Safety symbols can be found at various sources, including commercially purchased safety posters, Web sites, and science supplies and equipment company catalogs. Large signs with safety symbols are recommended because they tend to be more noticeable and easier to remember during an emergency.

Use safety symbols judiciously and in a well-thought-out, discriminating manner. Label all fire hazard equipment (extinguisher, blanket) clearly and place it near the exit.

Similarly, the first-aid equipment (ADA eye / face wash and shower kit) should be located together in one area and clearly labeled with safely symbols. This is particularly needed in Grades 9–12.

RENOVATING EXISTING SCIENCE FACILITIES

If the renovation of existing science facilities is more than cosmetic and is greater than 50%, the construction should meet the same standards that apply when building new facilities. However, any amount of renovation should incorporate the requirements and recommendations because they are based on research that shows that well-constructed facilities are critical to providing a safe and effective science learning environment for students.

PREPARATION AND STORAGE AREAS

The total preparation and storage area should be 15 square feet per student, or 360 square feet to support instruction for 24 students. Of the 15 square feet, approximately one square foot should be dedicated to separate, secure storage. However, to meet Texas Accessibility Standards requirements, a room of approximately 6 x 8 feet is needed to provide the five-foot wheelchair turn radius.
The preparation and storage room requires

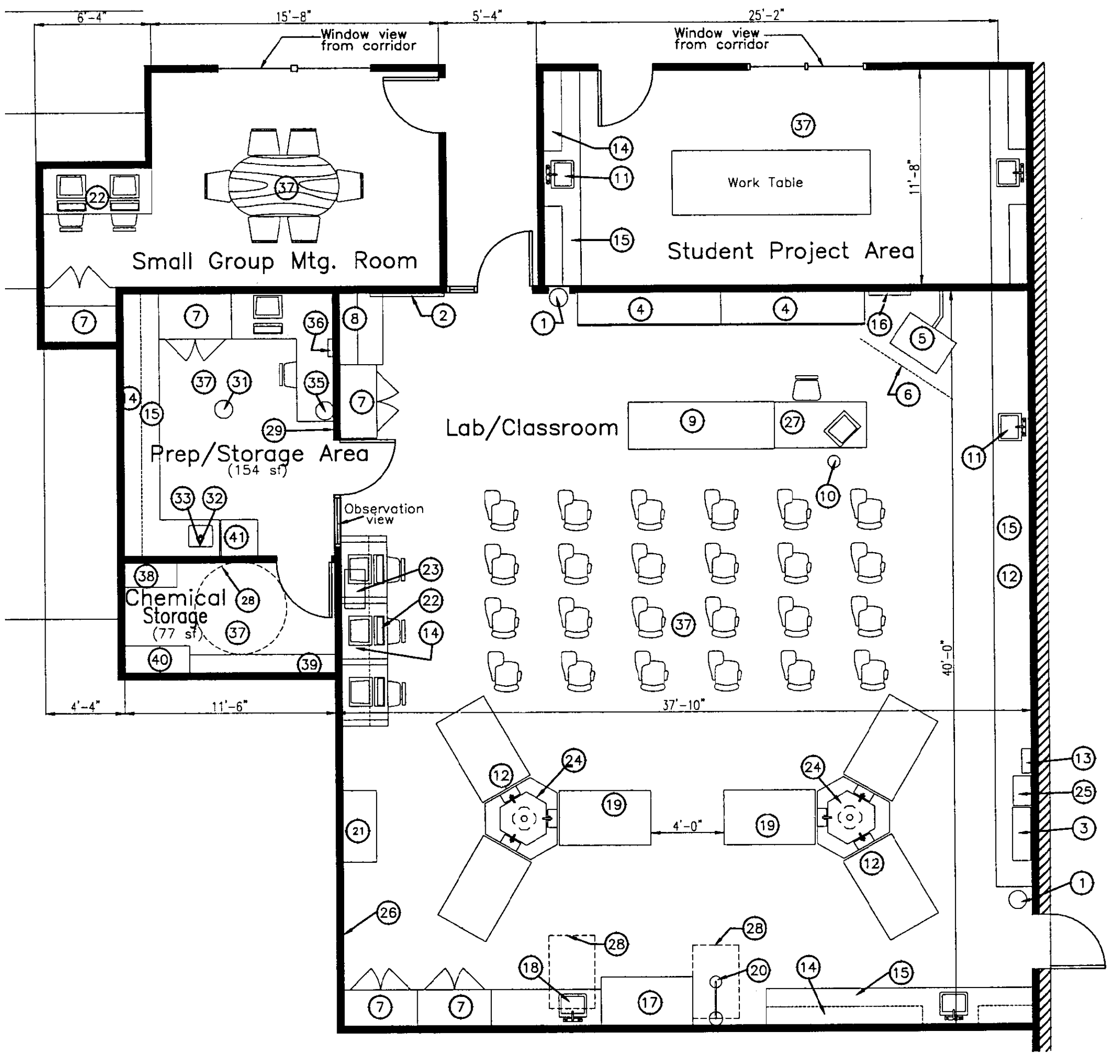
- an ADA eye / face wash & drench station
- a large, deep sink with hot water
- a fume hood for grades 6–12
- a BC type fire extinguisher
- a labeled master utility cutoff
- storage for utility carts
- adequate space for equipment and materials to be safelay stored out of the aisles
- a refrigerator (spark-proof) for chemicals and lab specimens
- an MSDS book

FACILITIES CHECKLIST

A convenient checklist has been prepared for teachers and administrators to use to determine whether their science facilities are providing safe learning environments for students and safe working conditions for the faculty. The checklist, which is included in Appendix E, is based on laws, rules, and regulations established through state and federal legislation and by regulatory agencies. Use the checklist to determine whether your school's science facilities are safe.

AN EXAMPLE OF A COMBINATION LABORATORY/CLASSROOM

1440 square feet (36 x 60 sq. ft. per student)



Design layout
by
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and
Martha Pena Weiss
Pfluger Associates P.L.L.C.
Architects/Planning Consultants

LEGEND:
COMBINATION LABORATORY/CLASSROOM

CLASSROOM LEGEND

1. ABC fire extinguisher (recessed in wall)
2. Tack board (4')
3. Fire blanket storage
4. Sliding marker board assembly (with storage accommodations)
5. T.V. monitor
6. Projection screen
7. Tall storage cabinet
8. Open adjustable shelves (12" deep)
9. Mobile demonstration center
10. LCD projector (mounted from ceiling)
11. Moveable demonstration table (24" x 54")
12. Utility connections (electricity, gas, data) Note: GFCI in all electrical outlets
13. First-aid cabinet
14. Upper cabinets
15. Base cabinets
16. Emergency utility cutoff panel
17. Demonstration fume hood
18. Sink (ADA compliant)
19. Moveable tables (36" x 54")
20. Shower and eye/face wash station
21. Tote Cabinet
22. Computer station (moveable cart)
23. Computer printer
24. Tri-facial utility center with sinks
25. Safety goggle cabinet
26. Lab apron storage
27. Teacher's desk
28. ADA clear floor space

PREPARATION STORAGE LEGEND

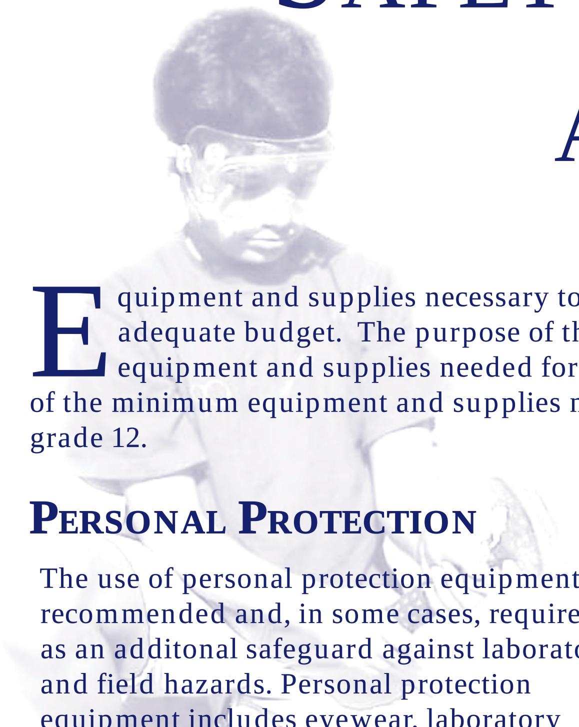
29. Mater utility cutoff switch
30. Not used
31. Emergency lighting
32. Eye/face wash and drench station
33. Large sink (hot and cold water)
34. Not used
35. BC fire extinguisher (recessed in wall)
36. Phone
37. Smoke detector
38. Flammables storage cabinet
39. Nonmetal adjustable shelves
40. Vented acid cabinet
41. Portable skeleton cabinet

CHEMICAL STORAGE AREA LEGEND

(Note: Ventilation system should be isolated from the rest of the building.)

38. Flammables storage cabinet (43" wide x 18" deep)
39. Open adjustable shelves (nonmetal)
40. Acid cabinet (43" wide x 18" deep) vented, nonmetal (separate compartment for nitric acid)

Safety Equipment and Supplies



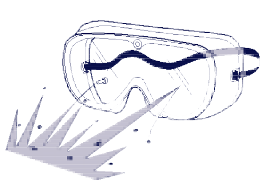
Equipment and supplies necessary to teach inquiry science must be supported by an adequate budget. The purpose of this chapter is to provide information on the safety equipment and supplies needed for science instruction. Refer to Appendix H for a list of the minimum equipment and supplies needed to teach science in kindergarten through grade 12.

Personal Protection

The use of personal protection equipment is recommended and, in some cases, required, as an additonal safeguard against laboratory and field hazards. Personal protection equipment includes eyewear, laboratory aprons, laboratory coats and protective gloves. Eyewear should meet the ANSI Standard Z87.1: Practice for Occupational and Educational Eye and Face Protection. Eyewear meeting this standard will bear markings such as "Z87.1" on the frames, and the lenses will be marked with the manufacturer's trademark.

Eye Protection Devices

Safety goggles are required for science laboratory and field activities involving ANY hazardous chemical that could damage a person's eyes if it were to come into contact with them. Goggles provide eye protection from fine dusts, liquids, splashes, mists, and sprays. They also prevent splashes and sprays from body fluids and dangerous chemicals. Reusable goggles should always be disinfected before being used by another student.



Safety goggles should be large enough to protect and form a seal around the eyes. If not able to form a seal, goggles should contain side shields to prevent contamination to the eyes.

Sanitization is required for any piece of safety equipment that is shared with another person. There are several ways to sanitize goggles, including placing them under ultraviolet lamps in goggle cabinets for an appropriate amount of time. Other methods of sanitizing may be found in Appendix A.

Eye protection may also be provided by safety glasses with shatterproof lenses. However, safety glasses with sideshields will NOT provide adequate protection for chemical splashes; they are designed primarily to protect the eyes from flying objects.

Face shields can provide additional facial protection, especially if coupled with safety goggles. However, plastic–type lenses or devices may be severely affected by certain chemicals and, in some cases, easily scratched.

Protective Gloves

Gloves protect hands from heat, absorb perspiration, and provide a shield from corrosive chemicals and body fluids. They also prevent the transmission of microorganisms from one person to another.

Certain gloves can dissolve when they come into contact with solvent. The correct glove should match the nature of the job. Always check your gloves to be sure that there are no tears, punctures, and holes, especially if the gloves are made of latex.

To remove gloves, peel them off your hands starting at the wrists and working toward the fingers. Keep the working surface of the gloves from making contact with the skin during removal.

Protective Gloves and Their Function

GLOVE TYPE	FUNCTION
Plastic	Protects against light corrosives and irritants.
Latex	• Provides protection against biological materials. • Should be changed as soon as they become soiled. • Note: Some people may have an allergic reaction to latex, which can lead to a serious medical condition.
Natural Rubber	Protects against electric shock and light corrosive material.
Neoprene	Great when working with solvents, oils, or light corrosive material.
Cotton	• Absorbs perspiration. • Great for wearing under latex gloves.
Asbestos	• Insulates against heat. • Note: Asbestos gloves are labeled with a warning sign about the danger of cancer. Asbestos is a known carcinogen.

Laboratory Aprons and Coats

Laboratory aprons and coats are designed to protect clothing and skin from splashed and spilled chemicals and biological materials. They should fit the wearer properly to provide maximum protection. A laboratory coat or an apron should be worn at all times in the laboratory.

There are no ANSI standards for the manufacture of laboratory aprons. Therefore, selection of the appropriate apron must be based on the hazards with which it is likely to come into contact. Apron materials vary widely and may be used in single or multiple layers. Multiple-layered aprons decrease the rate of permeation. They are usually made of plastic or rubber to protect against corrosive materials and irritating chemicals.

Aprons are usually listed as “bib type,” which are suitable for laboratory use. Aprons should be worn over clothing that covers the arms and body.

Laboratory coats are usually fire retardant and made of cotton or paper. They provide protection against flying objects, sharp or rough edges, splashes and spills, and fire.

Fire Prevention and Control

Fire is one of the most frequent mishaps in the science laboratory. Fire prevention, therefore, is essential. Effective fire prevention centers on the understanding that as long as air is present, oxygen will be available for combustion to take place. The best areas to exercise preventive measures are at the fuel and ignition sources.

Fires are classified by the chemical properties of the fuel. The basic fire classifications are as follows:

- Class A – Ordinary combustible (paper, wood, etc.)
- Class B – Organic solvents (acetone, alcohols, ethers)
- Class C – Electrical wiring or static charges
- Class D – Active metals (sodium, potassium, magnesium)

The symbols A, B, C, and D are accepted for the different classifications of fire. They are applied to fire extinguishers and extinguisher locations to indicate their suitability in extinguishing the different types of fires (see Appendix G).

FIRE PREVENTION

The following precautions should be taken to prevent fires from occurring in the science classroom, laboratory, storage room, and preparation area.

- Be aware of ignition sources in your laboratory area (open flames, heat, and electrical equipment).
- Purchase and store flammable reagents in the smallest quantities possible.
- Do not store flammable liquids in standard refrigerators (use only spark-proof refrigerators).
- Store flammable liquids in appropriate safety cabinets and / or safety cans.
- Do not store incompatible reagents together (e.g., acids with flammables). A list of incompatible reagents can be found in Appendix F.
- Do not store ethers for extended periods of time, as explosive peroxides could form.
- Make sure that all electrical cords are in good condition. All electrical outlets should be grounded and should accommodate a three-pronged plug.

Each science classroom, laboratory, storage room, and preparation area should be equipped with a fire blanket and fire extinguisher.

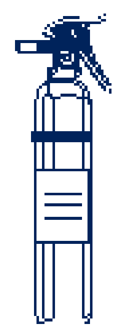
Remember . . .

R	**R**escue anyone in immediate danger.
A	Turn in an **A**larm by calling 911.
C	**C**lose the doors and windows.
E	**E**xtinguish the fire.

Even after practicing fire safety and prevention, a fire may still occur in a science classroom laboratory, storage room or preparation area. Actual fire control requires the proper use and types of control devices, such as fire extinguishers and blankets.

FIRE EXTINGUISHERS

In most school environments hand-held, portable fire extinguishers are the first fire-extinguishing agent that people use. Therefore, a multipurpose ABC fire extinguisher must be located in each science classroom, laboratory, storage room, and preparation area.



Extinguishers must be . . .

- located in a clear area where they can be easily seen,
- inspected on a regular basis, and
- handled by teachers and students who have been trained in their use.

Fire extinguishers are labeled in accordance with NFPA standards (see Appendix G).

FIRE BLANKETS

Fire blankets are made of specially treated fabric and should be located in accessible areas in all science laboratories where hazardous chemicals are stored and used. Fire blankets should be used if one is unable to reach the safety shower.

To use a fire blanket, follow the recommended technique of wrapping the victim in it to extinguish the fire.

PROTECTION FROM CHEMICALS

FUME HOODS

Develop procedures for the proper use of laboratory fume hoods for students taking chemistry, physical science, or any course in which chemicals are used.

Post written instructions on the use of fume hoods, and include in these instructions the laboratory safety training that each student is to receive.

> *"A fume hood is required for every chemistry, physical science, or other science laboratory where hazardous or vaporous chemicals are used. Most middle schools need a fume hood in the preparatory rooms."*
>
> NSTA, *Guide to School Science Facilities*, 1999

GENERAL USE OF FUME HOODS

Each laboratory facility where chemicals are used in experiments, as well as each preparation room, should be equipped with a fume hood. However, even an open-face fume hood with a low-face velocity can not provide complete safety against events that take place in the hood. However, a well-designed hood in a properly ventilated room can provide adequate protection against fumes. To ensure proper protection, follow these recommended guidelines.

- Keep the interior light on so that the working area is properly illuminated.
- Check the exhaust system—air movement should be inward and upward in the hood.
- The exhaust should be vented to the outside above the roof and away from air vents.
- Conduct inside the hood all portions of the experiment that cause contaminates to form.
- Do not place large objects directly on the hood's working surface. Place blocks under the large object to allow proper airflow under the object.
- Locate the fume hood in an area of low traffic.
- Move the vertical sash to the lowest position that allows access so that manipulation is possible. The sash should protect the head and upper body in case of an explosion. (Safety goggles are required.)
- Do not place your head in the hood when contaminants are being generated.
- Do not use the fume hood as a waste disposal unit except to dispose of small amounts of volatile chemicals.
- Do not store chemicals or apparatuses in the working area of the hood.
- Keep the slots in the hood baffle (air intake) free from obstructions.

- Keep the laboratory door closed unless the manufacturer indicates otherwise.
- Do not place electrical receptacles, or other sources that may produce a spark, in the fume hood while using flammable chemicals or when gases may be present.
- The hood's sash should be marked for the appropriate closure point when it is necessary to partially close the sash during an operation.
- The sash should be closed when the hood's exhaust system is not operating.
- Provide regular maintenance on the hood's exhaust system. Use static pressure gauges on the hood throat and across filters in the exhaust system to ensure proper exhaust flow.

Texas Education Agency, *Science Laboratory and Chemical Waste Disposal for Texas Teachers*, 1990

EYE/FACE WASH STATIONS

The first response (prior to medical treatment) for a student or teacher who has hazardous material in their eyes or on their face should be to flush the affected area with water to dilute chemicals, wash off debris, and irrigate the eyes. It is very important to hold the eyelids open and roll the eyeballs so that water can flow over all surfaces of the eyeballs and in the folds surrounding them.

An eye / face wash station that can wash both eyes simultaneously is required in every science laboratory, classroom, and preparation room where hazardous materials are used.

Squeeze-bottle eyewashes are NOT sufficient and should NOT be used as eye/face washes in any science laboratory.

There are several different designs for eye / face washes. To ensure that the eye / face wash stations in your science facilities meet safety requirements, they should . . .

- be located no more than 10 seconds or 25 feet from any student workstation;
- comply (one eye / face wash) with ADA regulations on accessibility;
- be provided with sufficient water pressure to operate correctly (0.4 gpm);
- wash both eyes simultaneously and the face with tepid water (60–90°F);
- supply an instantaneous flow of tempered (recirculated) water for at least 15 minutes;
- have a water control valve that remains on, allowing the user to use both hands;
- be clearly marked and unobstructed for immediate use;
- be flushed for five minutes once a week to remove any harmful contaminant that may form or grow in the eyewash.

"For the first time ever, a student had to use one of our eye washes. The eye washes, as in many schools, only have cold water going to them. As a result, the 15 minutes of eye irrigation became quite painful to the student. Fortunately, the student suffered no eye damage from either the material that got into her eye or from the cold water. The cold water diminished the student's willingness to continually irrigate her eyes. I wonder how many schools have thought to ensure that the water is at an appropriate (60–90°F) temperature?"

David Hoyler, Director
Middle and Upper Schools
Locust Valley, NY

The hand-held drench hoses are listed in the American National Standards Institute's (ANSI) Standards for Showers and Eyewash Equipment (ANSI Z358.1), but carry instructions that they are ***not intended to replace emergency shower or eyewash units***.

For more information, see the American National Standards Institute's standards for eyewash equipment.

SAFETY SHOWERS

A safety shower is required in chemistry and integrated physics and chemistry, as well as in any laboratory where hazardous chemicals are used. Safety showers . . .

- must meet the standards for height, spray pattern, tepid water temperature (60–90°F), and water flow of 20 gallons per minutes at 30 PSI.
- must have a control valve that can remain on (15 minutes) without requiring the use of the operator's hands.
- should be located no more than 25 feet from any student workstation or no more than 10 seconds away.
- should each be marked with a highly visible sign.
- should be large enough to accommodate the injured person and a teacher assisting with the emergency.
- should have a fixed valve handle or a chain with a large ring that can be pulled to start the flow of water.
- must have sufficient water flow and pressure to function properly for immediate use.
- should be ADA compliant.
- must be flushed once a week to eliminate contamination and be checked for proper working conditions.

VENTILATION

A well-maintained ventilation system contributes to a healthy environment in science classrooms and laboratories. The following recommendations appear in the NSTA's *Guide to School Science Facilities.*

"Forced ventilation at a minimum rate of four changes of air per hour should be provided for science laboratories, and continuous ventilation at six changes per hour for chemical storage rooms. Assuming that there is a fume hood in each preparation room, four air changes per hour is adequate. All exhausts should be vented to the outside of the building, not recirculated in the building's ventilation system.

Chemical storage rooms need systems that vent directly outside, usually to the roof, and away from fresh-air intake pipes. Stage cabinets for flammables should not be ventilated to the outside.

Every science room should be equipped with exhaust fans designed for the rapid venting of smoke or bad odors created by an investigation."

Additional information on ventilation can be found in the American National Standards Institute's standards for laboratory ventilation (ANSI Z9.5-1992).

UTILITY CARTS

Chemicals should be transported from the preparatory room to the classroom or laboratory via heavy-duty utility carts with raised sides to contain spills. Carts composed of noncorrosive materials (plastic or stainless steel) are recommended to reduce rusting and deterioration. Heavy-duty wheels or casters approximately five inches in diameter are recommended to ensure the smooth transportation of chemicals.

Each laboratory and preparatory room should have at least one utility cart for transporting chemicals and other materials.

ELECTRICAL EQUIPMENT SAFETY

Electrical safety needs must be considered for all new, old, and renovated science classrooms, laboratories, storage rooms, and preparation areas. The focus of electrical safety should be on prevention.

The minimum considerations for electrical safety include the following.

- Ground-fault circuit interrupters (GFCI's) should be installed to protect against major shock and electrical fires by preventing short circuits.
- All outlets must be grounded to prevent electrical accidents. A sufficient number of outlets should be provided to eliminate the need for extension cords. If floor boxes are used, they should not be located near water sources or areas where water is used.
- Use surge protectors to protect computers and other electronic devices from power surges.
- Locate emergency shut-off controls (for electricity, gas and water) in an area that is not easily accessible to students.
- Do not overload electrical circuits.
- Use only spark-free refrigeration in laboratories, storage rooms, and preparation areas when storing flammable chemicals.
- Avoid using extension cords.

In developing the school's safety program, include provisions for handling electrical emergencies. All science teachers should know where the master electrical cutoff switch and the control box are located, and how to operate both of these.

Before conducting an activity that requires the use of an electrical device, the teacher and students should familiarize themselves with the device's operation and safety features.

As a safety precaution, examine the wiring for frayed or bare wires, and examine the electrical plugs to make sure the wiring is secure. If a problem occurs . . .

1. **Remember to remain calm and consider the evidence.**
   - Was a pop or a spark made when you attempted to operate the equipment?
   - Were you able to see where it happened?
   - Is there an explanation for the situation?
2. **Consider whether any action is warranted.**
   - Will this action be safe?
   - Could there be too many electrical devices on one circuit?
   - Use the master electrical utility cutoff and check the devices. Are the devices still warm?
   - Is there an odor that smells like burning electrical insulation?
   - Are the wires to the equipment warm or hot?
3. **Direct students not to touch anything.**
   - All electrical hazards are not directly due to an electrical situation.
   - Special attention must also be given to the proper use and handling of laboratory equipment.

Texas Education Agency, *Manual of Safety and Health Hazards in the School Science Laboratory*, 1984

Chemical Safety

The Hazard Communication Act requires employers to maintain a legible copy of a current Material Safety Data Sheet (MSDS) for each hazardous chemical they purchase. Material Safety Data Sheets are required to be readily available, on request, to employees at each workplace.

Every chemical manufacturer is required to supply a recent MSDS with each chemical it produces. These should be sent with each chemical that is purchased by a school or school district. If MSDS forms are not available, request them from the chemical manufacturer. Every teacher needs to know and understand the information on an MSDS.

Material Safety Data Sheets

Each manufacturer may develop a unique format and style for listing the information required by the Hazard Communication Act. The areas outlined below identify the information that should be listed on MSDS forms for science teachers.

Product Identification

This section provides the name, address, and telephone number of the manufacturer in case additional information about a chemical is needed. This section also lists an emergency phone number where the manufacturer can be reached in case of an emergency.

Hazardous Chemicals

Information about the hazardous chemical is listed in this section. It is important that the user know the exact ingredients of the substance, whether it is an element or a compound, whether the substance is pure, and what percentage of the substance is hazardous. Pure substances will have a Chemical Abstract Service (CAS) number that identifies the substance. The American Chemical Society assigns a different CAS number to each compound and element.

The common name of the chemical is given and other common names, such as a trade name, may appear also. Specific hazardous information such as a chemical's Threshold Limit Value (TLV) and the Time Weighted Average (TWA) is also provided.

The TWA indicates how much a person can be exposed safely to a given chemical, assuming that the person works an eight-hour day, five days a week. The more toxic the compound, the lower the exposure limit.

Physical Data

This section provides information about the physical characteristics of a hazardous substance, including the boiling point and specific gravity.

The section may also provide the vapor pressure and vapor density if the chemical is a liquid. When the vapor pressure and vapor density are high and the substance is combustible, a flammability hazard will be indicated. Other physical properties that may be listed in this section include the substance's evaporation rate, solubility in water, its appearance, color, and odor. Some compounds have distinctive odors, such as ammonia or hydrogen sulfide.

Fire and Explosion Hazards

This section provides information about the flash point of the chemical. The flash point is the minimum temperature at which there are sufficient vapors present to support combustion. Liquids with flash points below 20^{o}C are very hazardous and flammable. Liquids that have low flash points and wide flammability limits are very dangerous.

Many liquids react so rapidly that an explosion occurs along the burning process. Most of these liquids, including gasoline, diethyl ether, and carbon disulfide, will rate "4" (i.e., most flammable) on the National Fire Protection Standards scale.

This section may also provide information about the type of fire extinguisher to use when a particular substance is burning, as well as information about precautions to follow when handling these dangerous materials. Flammables have specific storage requirements and transportation precautions.

Health Hazards

This section discusses the several ways a chemical can create health problems. Generally, the first concern a person will have about a hazardous substance is whether it is poisonous. Therefore, it is important to know what concentrations of a given chemical will cause injury to a person.

Almost every chemical will be toxic to humans at some concentration level. In a medical sense, a lethal dose (LD) indicates the percentage of people who have died when exposed to that concentration level of the chemical. For example, LD_{50} means that 50% of the population receiving that concentration level will likely die.

A second health concern is the corrosiveness of a chemical when it comes into contact with skin. Strong alkaline substances, such as calcium oxide, potassium hydroxide, and sodium phosphate, can cause chemical burns. Some corrosive chemicals can cause rapid dehydration of the body tissues, such as glacial acetic acid and anhydrous aluminum chloride. Others, such as hydrofluoric acid, cause rapid decomposition of skin, bones, and other body tissues.

A third health hazard that may be listed in this section are carcinogens—i.e., chemicals that cause cancer. Some known carcinogens include organic compounds such as benzene and carbon tetrachloride. Chemicals suspected of being carcinogens include formaldehyde and polychlorinated biphenyls.

Fire and Explosion Data

This section indicates the stability of the substance. High reactivity is commonly associated with unstable compounds. Many highly reactive compounds are explosives, such as picric acid and ammonium perchlorate. Strong oxidants are color-coded yellow.

Compounds that are highly reactive with water will appear in this section, even though they occupy a different quadrant on the National Fire Prevention Standard diamond. Compounds such as sodium hydride react with water to release hydrogen gas. An important feature of this section is the listing of the incompatibility of certain chemicals with other chemicals. This information assists with the storage of chemicals in compatible families.

Spill and Disposal Procedures

This section provides valuable information that is difficult to find in other resources—how to handle a chemical spill and how to dispose of chemicals properly. Many MSDS forms will list the Environmental Protection Agency's hazardous waste number for disposal purposes. Or they may simply state that the chemical must be disposed of in accordance with local, state, and federal environmental regulations.

PROTECTIVE EQUIPMENT

This section lists personal protective equipment that must be used or worn by the teacher and students using the chemical in an experiment.

STORAGE AND HANDLING PROCEDURES

This section provides the user with information about the proper storage and handling of a particular chemical. For example, statements such as "Storage Code: RED—flammable substance; store in cool, well-ventilated areas," will be found in this section or combined with other sections of the MSDS.

TRANSPORTATION DATA

This is optional information on MSDS forms that lists the Department of Transportation (DOT) class required if the material is to be shipped.

CHEMICAL LABELING

There are no regulations on what a chemical label must look like. However, the Hazard Communication Act does require that all manufacturer's labels must include

- the name of the chemical;
- physical and health hazards associated with the chemical, including the organs it would affect; and
- the manufacturer's name and address.

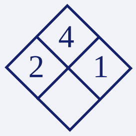
The sample label of Ethyl Ether included in this chapter lists the information required in addition to the NFTA Hazard Code, the chemical formula, and the CAS number. Other items that may be identified on the chemical label include the

- CAS number that was assigned by the Chemical Abstract Service;
- chemical formula;
- molecular weight (for compounds) or atomic weight (for elements);
- common name of the chemical;
- purity of the substance;
- lot number; and
- supplier's name and address.

If the chemical is removed and placed in a new container, or if the original label is destroyed, the label of the new container must include

- the chemical name and its formula, and
- the physical and health hazards associated with the chemical.

ETHYL ETHER
$C_2H_5OC_2H_5$
Education Grade
1000mL



CAS 60-29-7

GENERIC CHEMICALS
1717 Toxic Row
Ether, USA 10059

HIGHLY VOLATILE
EXTREMELY FLAMMABLE
MAY FORM EXPLOSIVE PEROXIDES
HARMFUL IF SWALLOWED OR INHALED
MAY CAUSE INJURY TO EYES
EFFECTS MAY BE DELAYED
STORE AT 77°F (SAMPLE LABEL)

CHEMICAL STORAGE

Safe chemical storage is based on the chemical properties and hazards of the substances that are to be stored. To store chemicals properly, follow these guidelines.

1. Label the container with the name of the chemical, the hazards associated with the chemical, and the manufacturer's name and address.

2. Store chemicals in compatible families.

3. Locate the chemical storage room in such a way as to minimize injuries to people and damage to the building if an explosion or fire should occur.

4. Ensure that the storage room has two exits and doors that lock.

5. Label the storage room doors "Authorized Personnel Only" or "Hazardous Materials."

6. Provide the storage room with continuous forced-air ventilation that is vented to the outside and away from air intakes.

7. Ensure that storage cabinets and shelves are resistant to corrosion.

8. Store chemicals in an upright position and no more than two containers deep.

9. Equip shelves with a lip to prevent chemicals from being jarred off the shelf.

10. Store corrosives (acids and bases) in an approved corrosives cabinet.

11. Store flammables in a flammable-approved cabinet.

12. Do not store chemicals above eye-level or on the floor.

13. Store water-reactive chemicals (metals) where they will remain dry.

14. Label safety equipment clearly inside the storeroom.

    - ABC fire extinguisher
    - Safety goggles
    - Fire blanket
    - Spill kit
    - First-aid kit

15. Provide the room with adequate lighting.

16. Install smoke detectors.

17. Maintain a chemical inventory.

Chemical Disposal

There are two important steps to take before proceeding with chemical disposal. First, determine how many chemicals are designated for disposal.

Second, remove

- out-of-date or contaminated chemicals;
- chemicals without legible labels; and
- chemicals that are too hazardous for student use.

Options for Chemical Disposal

Contact commercial chemical disposal companies in your area. Many waste disposal companies recycle chemicals and resell them. Other options may be available by contacting

- other schools in your area, possibly to combine quantities for disposal;
- industries in the area for assistance with disposal; or
- institutions of higher education, which might allow you to use their system of disposal.

Chemical disposal companies can properly disposed of chemicals by using one or more of the following methods.

1. Incineration
2. Detonation
3. Open burning
4. Neutralization of acids and bases (final pH range of 5–9)
5. Carbon absorption
6. Oxidation / reduction
7. Precipitation and clarification
8. Biological treatment
9. Land disposal

Do not flush chemicals down sinks. This may adversely affect the water treatment plants in your area by destroying microorganisms essential to the process of water purification.

Texas Education Agency, *Science Laboratory Safety and Chemical Waste Disposal for Texas Science Teachers*, 1985

MICROSCALE CHEMISTRY

Discussing microscale science techniques may appear out of place in a laboratory safety manual. To the contrary, however, microscale techniques offer a pedagogically sound approach to science laboratory investigations and provide simple solutions to many safety issues.

The primary construct put forth by advocates of microscale chemistry is to instill in educators and students the idea, "If you don't need that much, then don't use it." The purpose is to move away from a "throwaway" mentality. One aspect of microscale chemistry is that it reduces the amount of materials being wasted.

Educators and administrators find microscale chemistry appealing because hazardous waste management is a problem confronting all education institutions. Schools are finding it increasingly difficult to fund the disposal of hazardous waste while attempting to maintain a safe hands-on chemical learning environment. Microscale experiments make it possible to promote critical thinking skills while addressing major safety issues. The advantages of incorporating microscale / small-scale chemistry into the learning environment include

- a reduction in the cost of chemicals;
- a reduction of possible fire and explosion danger;
- a reduction of chemical waste disposal costs;
- the introduction of experiments in which chemicals once thought to be too expensive or hazardous can be made available with the reduced amounts;
- the recycling of products for future experiments (plan ahead and use it again);
- the introduction of smaller, less expensive glassware; and
- reduced exposure to toxic materials.

SAFETY ADVANTAGES

Using microscale chemistry techniques means that

- spills are reduced becasue liquids are dispensed from plastic dropper bottles;
- accidental glass container breakage is eliminated;
- air quality is improved because smaller amounts of vapor escape; and
- fire hazards are virtually eliminated.

Although some of the liquid is lost due to vaporization during both processes, the microscale technique reduces the amount of hazardous organic chemicals that must be recovered and disposed of properly. In addition, this technique represents a responsible step in reducing environmental pollutants.

In the science storeroom, keeping chemicals in smaller containers (approximately 10% of the size used in macroscale) reduces the need for storage space. Packaging and handling represent the greatest costs in purchasing chemicals.

Consider health and fire hazards, storage cost, and disposal cost when buying more chemicals than are needed simply because the cost per milliliter or gram appears to be less in larger quantities.

Byron E. Howell, *Microscale Chemistry Center*, 1999

CHEMICAL SPILLS

If a chemical spill should occur in the laboratory, preparatory room, or classroom, the teacher should take the following actions as quickly as possible to reduce the possibility of injury to a student.

- Immediately evacuate all students through the exits farthest from the spill. Fumes from a chemical spill can cause severe damage to the body.

- Immediately help any person to the safety shower who has been splashed with the chemical.
- Turn on the emergency exhaust fan.
- Contain the spill, wearing proper protective clothing. Do not allow the spill to trap you.
- Call for help. The school safety plan include information about agencies or departments in your community that will assist with containment and removal of the chemical.

SPILL CONTROL MATERIALS

There are many types of commercial materials that have been developed for the containment and removal of chemical spills. These range from absorbent pads that quickly absorb chemicals in a liquid state, to porous bags filled with an inert amorphous silicate that absorbs the chemical, to materials that neutralize an acid or a caustic spill.

Spill control materials typically found in public schools include a plastic five-gallon bucket filled with dry sand, vermiculite, or dry clay materials. These do nothing to neutralize a chemical, but they absorb the liquid or contain it in a smaller area. The disadvantage of using sand is that it is heavy and difficult to transport.

Once the chemical has been contained and neutralized, use clean-up equipment made of plastic or polypropylene so that the equipment doesn't react with any of the chemical that remains. Place the contaminated material in plastic bags or containers and mark them appropriately. Inform the custodial staff of the material so that they can dispose of it properly.

HEALTH CONCERNS

Dangerous situations can arise very quickly, and a teacher must know what to do when they occur. There is no time to form a plan of action in an emergency. The plan must be worked out in advance and quickly recalled when an emergency arises. *Most laboratory accidents can be prevented if practioners use approved activities, good laboratory management techniques, and safe practices during the investigation.*

HEALTH CONCERNS

ALLERGIES

An allergy is a hypersensitivity to a foreign substance that is harmless to most people but produces a violent reaction in an allergy sufferer. Allergic reactions are the body's efforts to eliminate something it considers harmful. In some people the histamine that the body produces in response to an allergen can cause muscle cramps, disorientation, unconsciousness, and death from shock or suffocation.

Teachers should be aware of their students' allergies of their students as well as their own. These should always be reviewed before beginning an experiment, whether it is performed indoors or outdoors.

It is a good practice to inform the student's parents about the live and preserved plants, animals, chemicals, outdoor activities, and foods that may be tasted or used in your classroom. Express any concern about students' possible allergic reactions to the materials. Parents should respond by listing allergic reactions that their children may have if exposed to the materials listed. This sharing of information may prevent a student from having a severe allergic reaction in your classroom.

LATEX ALLERGIES

Some laboratory investigations, such as a dissection, may require students and teachers to wear gloves during the procedure. Latex gloves may pose a hazard to the person wearing them, as about one percent of the general population is allergic to latex. Research indicates that high-latex, protein- content powdered gloves are the most dangerous and should be avoided in schools. Students known to have latex allergies, spina bifida, and other myelodysplasias are at the highest risk.

Latex gloves are the most common cause of allergic reactions to latex. Proper glove-wearing behaviors, including the removal of all jewelry and the avoidance of hand lotions that might react with the latex, are important factors in ensuring glove integrity. Substituting vinyl gloves may prevent many of the allergic reactions caused by latex.

Latex allergy can often be determined by a skin test or a blood test, but neither method has proved to be very reliable.

SYMPTOMS OF LATEX ALLERGIES

Individuals who are allergic to latex will often develop "contact dermatitis"—a rash—when they come into contact with latex. Other symptoms might include itching, watery eyes, and sneezing. With continued exposure, chronic lesions could develop, and these could cause anaphylaxis or suffocation.

The rising incidence in the natural rubber latex sensitivity / allergy is associated with the increased glove use recommended by the U. S. Department of Health's list of standard precautions.

GLOVE TYPES

Three types of gloves are recommended for use by teachers and students.

1. Polyethylene gloves are thin, flat, loose, transparent gloves usually worn by persons handling food. These are suitable for dissections and the cleaning of bodily fluids that may be introduced into the classroom or laboratory.
2. Vinyl gloves are shaped to fit the hand, and they come in various sizes. They conform to the hand better than do the polyethylene type, but not as well as latex gloves.
3. Latex gloves come in many varieties—powdered or dry, hypoallergenic or regular. They conform well to the hand and are suitable for tasks that require fine finger dexterity.

Most literature is in agreement that latex gloves offer the best protection against HIV and hepatitis B viruses.

BURN HAZARDS

Burns from heat or chemicals are among the common accidents that can occur in the science laboratory or classroom.

Careful planning, classroom management techniques, and safety training for students can prevent burns from occurring.

Accidents may still happen, however, so ensuring that only first-degree burns occur is a desirable secondary goal in laboratory safety.

The following information is adapted from the U.S. Department of Health and Human Services' *Manual of Safety and Health Hazards in the School Science Laboratory*.

DEGREE OF BURN	INJURY TO BODY	FIRST-AID PROCEDURE
First-degree burns	• Affect the outer layer of the epidermis • Characterized by redness and heat • Itching, burning, and pain common	• Hold burn under cool water for 5 minutes. • Cover with clean dressing.
Second-degree burns	• Affect deeper layers of the epidermis • Characterized by mottled red skin and blisters • Considerable pain and body fluid loss through blisters • Possible infection and hospitalization	• Call 91 1. • Call the school nurse. • DO NOT remove burnt clothing. • DO NOT cover burns with dressing.
Third-degree burns	• Affect skin and deeper tissue • Are white or charred in appearance • Little pain because nerve endings are burned • Internal loss of body fluids • High risk of infection • Extensive hospitalization required	• Call 911. • Call the school nurse. • DO NOT r emove baurnt clothing. • DO NOT cover burns with dr essing.

Chemical Burns

Handle hazardous chemicals with extreme care to prevent chemical burns. Hold the chemical at arm's length toward the back of the working area on the laboratory table. Do not place hazardous chemicals in unstable containers or in an apparatus that is not properly secured.

If a student receives a chemical burn, remove his or her clothing and place the student in the safety shower for at least 15 minutes. Call the school nurse, and call 911. Cover burns with clean dressing.

A chemical burn to the eyes should be continuously washed for at least 15 minutes at the eyewash station. Call the school nurse, and call 911. Remove contact lenses. Cover both eyes with clean dressing.

Use gloves and wash your hands before and after giving first aid, to prevent the spread of pathogens! Gloves do not provide 100% protection from infection.

Prevention

Most chemical burns result from accidental contact with heated objects or liquids. Heated objects should be constantly attended by the student conducting the investigation or placed where students will not make accidental contact with them.

Hot plates are one of the more dangerous pieces of equipment because they retain heat for a long period of time after they have been switched off. A hot plate sitting on the edge of a laboratory table appears harmless—until a student leans an elbow on it while conducting an investigation. Hot plates should always be placed out of reach to prevent students from accidentally touching or leaning on them while they are hot.

Students should never have to reach across a hot apparatus to perform an experiment. The apparatus should be placed so that if hot liquids are spilled, they will land on the laboratory table, not the student.

Remember . . .

- Open ends of glassware used for heating should be pointed away from all other students.
- Use a hot plate rather than a Bunsen burner when evaporating liquids.
- Set hot-plate thermostats at the correct temperature for the experiment, not at the maximum temperature.
- Operate Bunsen burners at the lowest level possible.
- Do not hold objects in a Bunsen burner flame for an excessive period of time.
- Do not boil hot-water baths unless absolutely necessary.
- Light bulbs used in experiments should be the lowest wattage possible.
- Mix heat-generating chemicals slowly.
- Use diluted solutions of chemicals when possible.

If a student should ingest or inhale a chemical, call the school nurse, 911, and the poison control center in your area. If you need to perform CPR, use a mouth-to-mask resuscitator so that you do not succumb to the chemical as well.

GLASSWARE HAZARDS

Most injury-related laboratory accidents involve glassware failure that is caused by improper use. Because it is fragile, glassware used in science laboratories should be made of Pyrex or Kimax. This type of durable glassware offers the best resistance to chemicals, heat, and accidental breakage. Remember . . .

- Never use glassware that is scratched or chipped, or else breakage and injury may result. Dispose of glassware in an appropriate container.
- Always lubricate glass tubing, thermometers, and rods when inserting them in rubber stoppers.
- Always protect the hands with several layers of cloth when inserting glass in rubber stoppers.
- Do not try to cut through glass with a file. To properly cut glass, make a scratch on the glass tubing or rod with a sharp triangular file using a quick motion. Snap the tubing or rod at the scratch, and fire polish the cut ends.
- Wrap or strip glassware with masking tape if it is to be used under a vacuum or under pressure. This will prevent flying pieces of glass in the event of an implosion or explosion.
- Never heat pipettes, volumetric flasks, or burets as they can expand and the liquids inside can increase in volume when heated.
- Do not heat bottles, graduated cylinders, volumetric glassware, funnels, jars, droppers, watchglasses, desiccators, or glass plates.
- Manipulate heated glass with caution to avoid burns. Remember that glass cools slowly.
- When bending glass tubing or fire polishing cut glass tubing, never hand the tubing to anyone until it has cooled.
- If a student receives a minor cut or scratch, wash your hands, put on protective gloves, and clean the area with soap and water. Place a clean dressing over the wound and send the student to the school nurse.
- If a student receives a wound that causes severe bleeding, send for the nurse and call 911. Put on protective gloves and apply pressure to the wound until help arrives. If the student has been impaled by an object that is still in the wound, DO NOT remove the object or severe bleeding could result.

Many injuries occur during the cleaning of glassware. In addition to the possibility of injury from broken glass, there is the threat of injury from the cleaning solutions used.

Most glassware can be cleaned with detergents and brushes. When stronger cleaning solutions are needed, trisodium phosphate, dichromate-acid, and alcoholic potassium hydroxide are used. All of these cleaning solutions are hazardous chemicals

BIOHAZARDS

A biohazard is defined as any biological material (living or dead) that is a pathogen (disease-carrying organism).

The biohazard symbol is universal and should be used on all potentially pathogenic materials.

BIOLOGICAL SPILLS

Biological spills that occur in a science laboratory or classroom can generate aerosols that can be dispersed in the air throughout the room. These spills can be very dangerous if they involve infectious microorganisms.

If a spill occurs, follow these steps.

- Remove any contaminated clothing.
- Vigorously wash the exposed area with soap and water for one minute.
- Wearing disposable gloves, soak up the contents of the spill with paper towels.
- Place contaminated paper towels in a plastic bag for disposal.
- Apply disenfectant to the spill area.
- Consult the MSDS, and call a physician if necessary.

BLOOD SPILLS

The cleaning of blood spills should be limited to persons who are trained for the task. If an untrained person encounters a blood spill, they should limit access to the area and call for assistance immediately. Follow these steps for the proper removal of blood spills.

- Wear disposable gloves.
- If the gloves develop holes, remove them and wash hands immediately; then use new gloves.
- Remove contaminated gloves by grasping a glove at the wrist and pulling it off, turning the glove inside out.
- Double-bag gloves and contaminated materials.
- Use disposable towels only.
- If the spill involved broken glassware, NEVER pick up the glass directly with the hands.
- Use a brush and dustpan to collect broken glassware.
- Clean up biological spills of ANY type with a 1:10 solution of bleach (one part bleach to ten parts water). Leave the solution on the contaminated area for 15 minutes. This solution will destroy most viruses and bacteria.

STANDARD PRECAUTIONS

Standard precautions have been created by the U.S. Department of Health to minimize the risk of infection form all types of sources; these apply to everyone. All blood, bodily fluids, and bodily substances should be considered potentially infectious. Use the steps below to prevent infection and to develop a procedure for infection control.

- Wash hands with soap.
- Wear disposable gloves and wash hands after removing the gloves.
- Wear mask and eye protection or a face shield.
- Wear lab aprons or coats.
- Place contaminated waste (gloves, paper towels, bandages, etc.) in a plastic bag.
- Notify custodial staff for proper disposal of waste.
- Custodial staff should place the material in a red plastic biohazard bag and follow proper disposal procedures.

Lifting Heavy Objects

Teachers and students must know how to use their bodies properly when lifting or moving heavy objects. Observe the following guidelines to avoid possible injury.

Think Before Lifting

- Assess the size of the object and get help if necessary.
- When possible, use an assistive device or try pushing or pulling the object first.
- When lifting an injured student, explain the process so that, if possible, the student can help.
- Make sure your path is clear and unobstructed before lifting the object.

While Lifting

- Bend your knees, keep your back straight, and hold the object close to your body.
- Spread your feet about one foot apart and use your leg muscles.
- Never twist your body. Move your feet first, then allow the leg muscles to turn the body.
- Never jerk the load. Lift in a smooth motion, and don't twist your body.
- If the object is too heavy to lift alone, GET HELP!
- Use the same technique to set down the object that you used to pick it up.

First-Aid Kits

Keep first-aid kits in a conspicuous place in science laboratories and preparation rooms—preferably next to a sink. Mark the kits' location clearly, and make students aware of the location and procedures for using the kits.

Items Recommended for First-Aid Kits

- box of disposable gloves (latex or plastic)
- antiseptic and disinfectant
- bottle of bleach—prepare solution at the time it is needed (dilute 1 part bleach to 10 parts water)
- disposable towels
- sterile gauze for covering large wounds
- medical tape
- scissors
- bandage strips for covering small wounds
- plastic bags for holding contaminated waste

Items Not Recommended for First-Aid Kits

- iodine (can cause tissue damage)
- ice pack compress (swelling of soft tissue should be examined by a physician)
- ammonia inhalants (if student is unconscious, get help)
- tourniquet (use pressure until medical assistance is available)

In addition to keeping first-aid kits in the laboratory and preparatory rooms, teachers should have a transportable first-aid kit for use during a field investigation. Several types of transportable kits are available that can be worn around the teacher's waist.

LIVE ANIMALS IN THE CLASSROOM

Occasionally, live animals may be brought into the classroom to facilitate student observations of, and respect for, living organisms and the conditions under which they thrive. The National Association of Biology Teachers (NABT) supports these experiences as long as participants observe the guidelines developed by the scientific and educational communities for the proper care of and respect for all living animals.

> *"Studying animals in the classroom enables students to develop skills of observation and comparison, a sense of stewardship, and an appreciation for the unity, interrelationships, and complexity of life. This study, however, requires appropriate, humane care of the organism. Teachers are expected to be knowledgeable about the proper care of organisms under study and the safety of their students."*
>
> NSTA, *Guidelines for Responsible Use of Animals in the Classroom*, 1991

GUIDELINES FOR THE STUDY OF LIVE ANIMALS

Teachers and students must be aware of the responsibilities involved with the study of live animals. The guidelines below were developed to assist with the introduction of live animals into the classroom or laboratory (see Appendix B).

- Do not perform investigations on any animal that might cause suffering or pain, or that might pose a health hazard to the teacher or students.
- Animals brought to the classroom should be observed carefully by a science instructor. The health and safety of the animal and the students should be a priority during classroom activities.
- Animals that "live" in the classroom should be treated with care and respect while sharing the living space with students.
- Be aware of any allergies students may have toward animals.
- Wear personal protective equipment when caring for animals, especially animals that are not domesticated. Some wild (non-domesticated) animals may carry infectious diseases or organisms that can be transmited to humans.
- Students should notify the teacher prior to bringing an animal to the classroom. This way, potentially dangerous situations can be prevented.

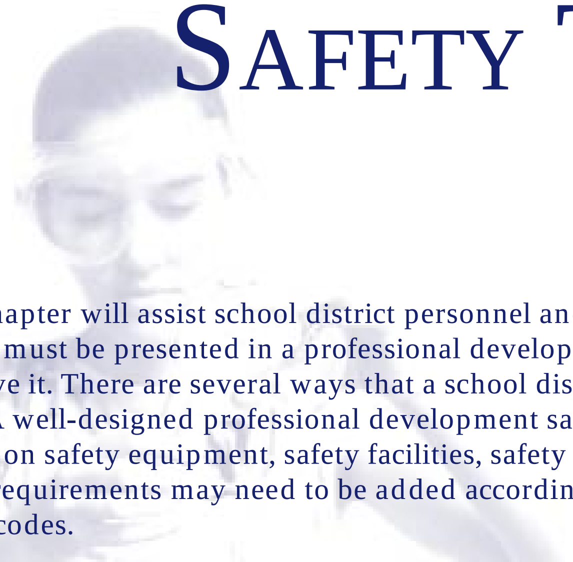
HANDLING LIVE ANIMALS

Use precautions when keeping live animals in the classroom. Teachers should be aware that diseases such as salmonellosis can be transmitted to students who handle classroom animals. The small painted turtle that frequents elementary school classrooms has been found to carry salmonella.

Keeping the cages clean of fecal remains will reduce the presence of bacteria that may cause an illness.

Always insist that students ***wash their hands*** before feeding the animals, as well as after they have handled the animals or touched materials from the animal's cage.

SAFETY TRAINING



This chapter will assist school district personnel and administrators with guidelines on what must be presented in a professional development program and who should receive it. There are several ways that a school district's safety program can be presented. A well-designed professional development safety program should include information on safety equipment, safety facilities, safety procedures, and first aid. Additional requirements may need to be added according to local school district policy and local safety codes.

In addition to professional development on general safety components, teachers and other district employees must receive instruction on the Texas Hazard Communications Act.

TEXAS HAZARD COMMUNICATIONS ACT (HAZCOM)

The Hazard Communications Act of 1985 was passed during the 69th Legislative Session and became law effective January 1, 1986. The law was later revised during the 73rd Legislative Session and became law effective September 1, 1993. Under section 502.009(b) of the Texas Hazard Communications Act, public schools are to develop, implement, and maintain a written hazard communication program.

WHO SHOULD RECEIVE PROFESSIONAL DEVELOPMENT?

Section 502.004 of the Hazard Communications Act defines an "employee" as a person who may be or may have been exposed to hazardous chemicals in the person's workplace under normal operating conditions or foreseeable emergencies. This includes persons working for this state (school district personnel).

The law requires that all teachers of Prekindergarten through high school and other district personnel must receive training on the Hazards Communications Act prior to working in the area or with the hazardous materials. Teachers new to the profession must receive safety training before they work with or in the area containing the hazardous chemicals however, district personnel changing assignments only require training on hazardous materials not covered in their initial training and updates. For example, a teacher changing assignments from earth science to chemistry and previously trained on the Hazard Communications Act will require additional training on the hazardous chemicals related to the new teaching assignment.

> "Students are not 'employees' for the purpose of the Texas Hazard Communications Act, Texas Health and Safety "Code, Sections 502.001-016. Therefore, the Texas Hazard Communications Act is not applicable to students in their capacity as students except for the requirements of Section 502.004(e)(5)(B) that requires that materials safety data sheets must be maintained by the laboratory and made accessible to students."
>
> *July 21, 1993 Texas Attorney General ruling, Opinion Number DM-239*

1. A professional development program must include, as appropriate:

   a. understanding and interpreting labels on hazardous chemicals and Material Safety Data Sheets (MSDS) and the relationship between those two methods of hazard communications;

   b. safe handling of hazardous chemicals known to be present in the school district personnel's work area and to which the employee may be exposed;

   c. the proper use of protective equipment and first aid treatment to be used with respect to the hazardous chemicals to which teacher may be exposed;

   d. general safety instructions on the handling, cleanup procedures, and disposal of hazardous chemicals.

2. Training on hazardous chemicals may be conducted by the categories of the chemicals. The protective equipment and first aid treatment may be accomplished by categories of hazardous chemicals as well.

3. Teachers and other school district personnel must receive additional training when the potential for exposure to hazardous chemicals in the work area increases significantly or when the school district receives new and significant information concerning the hazards of a chemical in the employee's work area.

4. The school district shall provide training to a new or newly assigned teacher, administrator, or other school district personnel before the individual works with or in an area containing a hazardous chemical.

5. The school district shall keep a written hazard communications program and a record of each training session given to school district personnel, including the date, a roster of the employees who attended, the subjects covered in the training session, and the names of the instructors. Those records shall be maintained for at least 5 years by the school district. The Texas Department of Health will have access to those records and may interview teachers during compliance inspections.

HAZCOM Guidelines for School Districts

The Texas Department of Health recommends the following steps as a guide for the development of a district-wide safety-training program.

1. Create a list of all district personnel that require safety training.

2. Determine the appropriate level of training for different job classifications based on the number and type of chemicals, chemical categories used, and the duration and frequency of use.

3. Designate a person(s) responsible for conducting the safety training.

4. Determine the format of the safety program to include visuals, classroom instruction, hands-on instruction, materials required.

5. Elements of the training program should include but should not be limited to:

- Texas Hazard Communications Act—purpose and application,
- use, location, and interpretation of Materials Safety Data Sheets (MSDS),
- location, health effects, and safe handling of hazardous chemicals present in the work area,
- proper use of protective equipment—safety goggles, lab aprons, safety gloves, etc.,
- first aid treatment with respect to hazardous chemical exposure,

- safety instructions on the labeling, handling, cleanup , and disposal of hazardous chemicals,
- the employee rights under the Texas Hazard Communications Act.

6. Describe the procedures for training new or newly assigned employees where hazardous chemicals may be found.

7. Describe the procedures for providing periodic update safety training.

8. Describe the school district's procedures for responding to responding to an emergency situation involving hazardous chemicals.

9. Establish a procedure for maintaining records of training sessions that include:

- dates of the training sessions
- a list of district personnel trained
- topics covered in the safety session
- name of the instructor(s)
- retention of this information for at least 5 years

The school district has the responsibility to obtain an MSDS for each hazardous chemical used in the schools. Copies of the MSDS are to be maintained on each campus readily available to teachers and other district personnel upon request. Generic MSDS that comply with OSHA standards are acceptable in lieu of the manufacturer's MSDS.

For further information on the requirements of a HAZCOM training program, contact:

Texas Department of Health
Hazard Communications Branch
1100 West 49th Street
Austin, Texas 78756
(512) 834-6603

SAFETY TRAINING FOR STUDENTS

The science laboratory is a place of discovery and investigation. One of the first things students discover is that learning in a laboratory is an exciting experience. The laboratory can also be a dangerous place to work if proper safety rules are not established and followed. To prepare students for a successful year in science, the teachers should develop safety rules that incorporate the following safety information.

PERSONAL PROTECTIVE EQUIPMENT

1. Many materials in the laboratory cause eye injury. Protect yourself from possible injury by wearing the splash-proof safety goggles provided in the laboratory. In Texas schools, state law requires that safety goggles be worn in all situations where the possibility of injury to the eye is present. This includes working with chemicals, heating materials, and using certain kinds of equipment.

2. Wear laboratory aprons or coats when working with chemicals or heated substances.

3. Wear protective gloves when handling hazardous chemicals and materials.

PROPER DRESS

1. Wear long-sleeved blouses and shirts. Regular length slacks or denim jeans provide good protection for your legs. Shorts will not protect the legs and are not appropriate when working in a laboratory.

2. Tie back long hair to prevent it from coming into contact with chemicals or an open flame.

3. Wear shoes without open ends. Sandals will not protect the feet from spills or other injuries and should never be worn in a laboratory.

4. Remove or tie back any article of clothing or jewelry that hangs down from the body and might come into contact with chemicals or open flames.

GENERAL LABORATORY RULES

1. Read all directions for doing a laboratory investigation before beginning. Be alert in the laboratory and listen for the teacher's directions. Ask questions if you do not understand any part of the investigation.

2. Never perform activities that are not authorized by the teacher.

3. Do not handle equipment without specific permission.
4. Take extra precautions when handling chemicals. Never pour chemicals or other substances into the sink or trash container. If a chemical spill occurs, notify the teacher immediately.

5. Never eat or drink in the laboratory. Never drink from a beaker or other container used in the laboratory.

6. There should never be loud talking or playing in the laboratory.

7. Handle cutting instruments carefully. Never cut materials toward you—use a cutting motion away from yourself.

8. When you have completed the investigation, clean up your work area and return equipment and supplies to their proper place.

9. Wash your hands with soap and warm water after every investigation.

10. Turn off all burners before leaving the laboratory.

11. Know the location and use of all safety equipment (fire extinguishers, eye/fash wash station, safety shower, fire blankets, chemical spill kits)

12. Never work in the laboratory alone or without permission.

13. Do not enter supply or storage rooms without a teacher present or without the teacher's permission.

FIRST-AID PROCEDURES

1. Report all accidents to your teacher immediately.

2. Learn what to do in case of an accident (such as an acid spilling on the body, materials entering the eye, and cuts or burns).

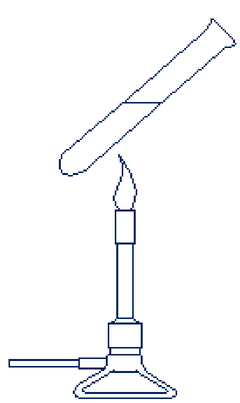
   - When chemicals splash onto the body, rush to the safety shower, pull the handle, and remain in the shower for at least 15 minutes.

- If materials enter your eye, rush to the eye/face wash station and flush the eyes with a continuous steam of water for at least 15 minutes. Hold your eyelids open with your fingers, or get assistance from your teacher.
- Report minor cuts or burns to the teacher, so that he or she can administer first aid in the laboratory.

3. Be aware of the location of the first-aid kit, but allow the teacher to administer first aid to an injured student.

USE FIRE SAFELY

1. Do not use an open flame without first putting on safety goggles.
2. Know how to light and regulate the flame on a burner.
3. Never leave an open flame unattended. When the burner is not being used, turn it off.
4. Keep your area clean and free from clutter.
5. Do not reach across an open flame.
6. Always point the open end of a test tube away from others when heating liquids. Some chemicals can boil out of the test tube violently and unexpectedly when being heated.



7. Never heat chemicals in a closed container such as a corked test tube. The expanding gas inside will cause the test tube to explode or turn the stopper into a projectile with considerable force.
8. Do not pick up a container that has been heated or hand a heated container to someone. Hold the back of your hand near the container and check for heat. If you can feel heat, use a mitten or tongs to pick up the container.

USE CHEMICALS SAFELY

1. Never touch, taste, or smell any chemical that you do not know is harmless. Many chemicals are toxic. If you are instructed to smell fumes during an investigation, do so by gently waving your hand over the container so that the fumes are brought to you. Do not bring the container to your nose. Do not inhale the fumes directly from the container, as they may be concentrated and cause you injury.
2. Use only chemicals that are listed in the investigation, and do not substitute other chemicals for the ones listed.
3. Notify the teacher immediately if chemicals have been spilled.
4. Dispose of the chemicals properly as directed by the teacher. Do not pour them into the sink or trash container.
5. Use extra precautions with acids and bases. Always pour acid into water. Do not pour water into acids.
6. Remember to wash any acid or base from your skin immediately and notify the teacher.
7. Use a pipette bulb. Never pipette liquids using your mouth.
8. Read the labels twice before using a chemical.

9. Do not pour extra chemicals back into the original container. This causes contamination of the chemical and may cause incorrect results to occur in future investigations.

10. Never use the same spatula to remove chemicals from two different containers. Each container should have its own spatula.

11. When removing a stopper from a bottle, do not lay it on the lab table, but place the stopper between two fingers and hold the bottle so that the label is in the palm of your hand. Both the bottle and the stopper should be held in one hand.

12. Replace all stoppers and caps on the correct bottles after you have finished using them.

USE GLASSWARE SAFELY

1. Never force glass tubing into a rubber stopper. Use a lubricant and a turning motion on the glass tubing when inserting it into a rubber stopper or rubber tubing.

2. When heating glassware, use a wire or ceramic screen to protect the glassware from the flame.

3. After cutting glass tubing, always fire polish the ends to remove any sharp edges.

4. Never use broken or chipped glassware. If glassware breaks, notify your teacher and properly dispose of it in a broken glassware container.

5. Never eat or drink from laboratory glassware.

6. Clean glassware thoroughly before returning it to storage.

USE ELECTRICAL EQUIPMENT SAFELY

1. Be careful not to shock yourself or another person.

2. Turn off all power sources when setting up circuits or repairing equipment.

3. Do not use metal articles such as rulers, metal pencils or writing pens; do not wear rings, metal watchbands, or bracelets when working with electrical equipment.

4. When disconnecting electrical equipment, pull from the plug and not the wire.

5. Use caution when handling electrical equipment that has been in use. The equipment may be warm or hot from being used.

6. Never connect, disconnect, or operate a piece of electrical equipment with wet hands or while standing on a wet floor.

OTHER PRECAUTIONS

1. Do not use hair spray, hair mousse, or other flammable hair products during or just before laboratory work where an open flame is used. These products may contain highly flammable chemicals and ignite easily.

2. Synthetic fingernails are also highly flammable and should not be worn in the laboratory.

PROFESSIONAL DEVELOPMENT

Teachers should maintain a record of professional development they have received on safety. Using the Professional Development Profile and working with district administrators, teachers can identify the areas of safety they need to learn more about to provide a safe learning environment for their students. Science coordinators and supervisors can collect this information to provide districtwide staff development for their teachers.

PROFESSIONAL DEVELOPMENT PROFILE

Equipment

Telephone
- ☐ emergency numbers
- ☐ locations
- ☐ portable communications

Fire Extinguishers
- ☐ types and uses
- ☐ location

Public Address System
- ☐ location
- ☐ emergency use

Eye Protection Devices
- ☐ law requirements
- ☐ types of protection
- ☐ purpose
- ☐ sanitation and storage

Fire Blankets
- ☐ purpose
- ☐ location

Spill Control Kit
- ☐ types
- ☐ purpose
- ☐ proper use
- ☐ location
- ☐ disposal

Facilities

Corrosive Materials Cabinet
- ☐ purpose
- ☐ location
- ☐ chemical storage
- ☐ ventilation

Broken Glass Containers
- ☐ purpose
- ☐ location
- ☐ proper disposal

Electrical Safety
- ☐ circuit breaker box
- ☐ electrical outlets
- ☐ extension cords
- ☐ location of outlets
- ☐ hazards

Emergency Showers
- ☐ law r equirements
- ☐ location
- ☐ proper use
- ☐ purpose
- ☐ routine tests

Eye / Face Wash Stations
- ☐ law requirements
- ☐ water temperature
- ☐ water pressure
- ☐ types and purpose

Flammable Materials Cabinet
- ☐ purpose
- ☐ location
- ☐ chemical storage

Master Utility Controls
- ☐ purpose
- ☐ types of controls
- ☐ location
- ☐ maintenance
- ☐ security

Chemical Safety (HAZCOM)
- ☐ types of chemicals
- ☐ ventilation
- ☐ shelving
- ☐ chemical storage
- ☐ MSDS

Emergency Exits
- ☐ law requirements

Forced Air Ventilation
- ☐ law requirements
- ☐ purpose
- ☐ uses
- ☐ locations

Safety Signs
- ☐ types
- ☐ purpose
- ☐ locations

Compressed Gas Cylinders
- ☐ types
- ☐ pressure hazards
- ☐ transporting
- ☐ security

Fume Hoods
- ☐ requirements
- ☐ location
- ☐ purpose and use

Emergency Exhaust Fan
- ☐ purpose and use

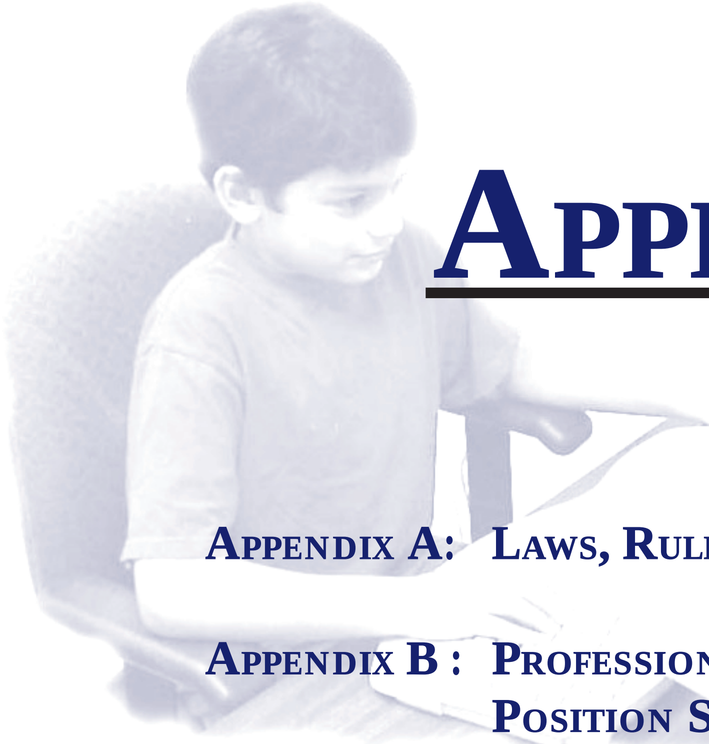
Procedures

Fire Drill Procedures
- ☐ fire drill rules
- ☐ posting evacuation routes

Safety Contract
- ☐ student contract
- ☐ purpose and use

Emergency Procedures
- ☐ developing procedures
- ☐ what to do in an emergency
- ☐ when and how to call for assistance
- ☐ field investigations

First-Aid Procedures
- ☐ handling cuts, burns, and minor injuries
- ☐ reporting and keeping records
- ☐ when to call for assistance
- ☐ who to call for assistance
- ☐ CPR training
- ☐ abdominal thrust
- ☐ field investigations



APPENDICES

Appendix A

Laws, Rules, and Regulations

Federal Law

Public Law 105-17	Least Restrictive Environment

Texas Education Code (State Law)

Chapter 1	Equal Educational Services or Opportunities
Chapter 21	Code of Ethics
Chapter 28	Required Curriculum
Chapter 37	Safe Schools
Chapter 38	Protective Eye Devices in Public Schools
Chapter 46	Instructional Facilities Allotment

Texas Administrative Code, Title 19, Part II (Texas Education Agency Rules)

Chapter 61	School Facilities Standards
Chapter 74	Required Curriculum (40% Laboratory Instruction)
Chapter 247	Educators' Code of Ethics

Texas Administrative Code, Title 25 (Texas Department of Health Rules)

Chapter 295	Standards for Face and Eye Protection in Public Schools
Chapter 501	Hazardous Substances
Chapter 502	Hazard Communication Act

Civil Practice and Remedies Code, Title 5 (State Law)

Chapter 101	Tort Claims

Federal Law
Public Law 105-17
Least Restrictive Environment

Title I—Individuals with Disabilities Education Act
Sec. 101. AMENDMENTS TO THE INVIDUALS WITH DISABILITIES EDUCATION ACT.
Part A—GENERAL PROVISIONS

Section 612(a)(5). Least Restrictive Environment.
IN GENERAL—To the maximum extent appropriate, children with disabilities, including children in public or private institutions or other care facilities, are educated with children who are not disabled, and special education classes, separate schooling, or other removal of children with disabilities from the regular educational environment occurs only when the nature or severity of the disability of a child is such that education in regular classes with the use of supplementary aids and services cannot be achieved satisfactorily.

Texas Education Code
Equal Educational Services or Opportunities

TITLE 1. GENERAL PROVISIONS
CHAPTER 1. GENERAL PROVISIONS

Sec. 1.001. Applicability.

Sec. 1.002. Equal Educational Services or Opportunities.

(b) An educational institution may not deny services to any individual eligible to participate in a school district's special education program as provided by Section 29.003, but the educational institution shall provide individuals with disabilities special educational services as authorized by law or, where expressly authorized, assist in and contribute toward the provision of appropriate special educational services in cooperation with other educational institutions and other appropriate agencies, institutions, or departments.

Added by Acts 1995, 74th Legislature, chapter 260, Sec. 1, effective. May 30, 1995.

Texas Education Code
Code of Ethics

SUBTITLE D. EDUCATORS AND SCHOOL DISTRICT EMPLOYEES AND VOLUNTEERS
CHAPTER 21. EDUCATORS
SUBCHAPTER A. GENERAL PROVISIONS

Sec. 21.041. Rules; Fees.

(b) The board shall propose rules that:

(8) provide for the adoption, amendment, and enforcement of an educator's code of ethics.

Added by Acts 1995, 74th Legislature, chapter 260, Sec. 1, effective. May 30, 1995.

Texas Education Code
Required Curriculum

SUBTITLE F. CURRICULUM, PROGRAMS, AND SERVICES
CHAPTER 28. COURSES OF STUDY; ADVANCEMENT
SUBCHAPTER A. ESSENTIAL KNOWLEDGE AND SKILLS; CURRICULUM

Sec. 28.001. Purpose.

It is the intent of the legislature that the essential knowledge and skills developed by the State Board of Education under this subchapter shall require all students to demonstrate the knowledge and skills necessary to read, write, compute, problem solve, think critically, apply technology, and communicate across all subject areas. The essential knowledge and skills shall also prepare and enable all students to continue to learn in postsecondary educational, training, or employment settings.

Added by Acts 1995, 74th Legislature, chapter 260, Sec. 1, effective May 30, 1995.

Sec. 28.002. Required Curriculum.

(a) Each school district that offers kindergarten through grade 12 shall offer, as a required curriculum:

(1) a foundation curriculum that includes:
(A) English language arts;
(B) mathematics;
(C) science; and
(D) social studies, consisting of Texas, United States, and world history, government, and geography; and

(2) an enrichment curriculum that includes:
(A) to the extent possible, languages other than English;
(B) health;
(C) physical education;
(D) fine arts;
(E) economics, with emphasis on the free enterprise system and its benefits;
(F) career and technology education; and
(G) technology applications.

(j) The State Board of Education by rule may require laboratory instruction in secondary science courses and may require a specific amount or percentage of time in a secondary science course that must be laboratory instruction.

Texas Education Code
Removal of Disruptive Student

SUBTITLE G. SAFE SCHOOLS
CHAPTER 37. DISCIPLINE; LAW AND ORDER
SUBCHAPTER A. ALTERNATIVE SETTINGS FOR BEHAVIOR MANAGEMENT

Sec. 37.002. Removal by Teacher.

(a) A teacher may send a student to the principal's office to maintain effective discipline in the classroom. The principal shall respond by employing appropriate discipline management techniques consistent with the student code of conduct adopted under Section 37.001.

(b) A teacher may remove from class a student:

(1) who has been documented by the teacher to repeatedly interfere with the teacher's ability to communicate effectively with the students in the class or with the ability of the student's classmates to learn; or

(2) whose behavior the teacher determines is so unruly, disruptive, or abusive that it seriously interferes with the teacher's ability to communicate effectively with the students in the class or with the ability of the student's classmates to learn.

Sec. 37.006. Removal for Certain Conduct.

(d) In addition to Subsection (a), a student may be removed from class and placed in an alternative education program under Section 37.008 based on conduct occurring off campus and while the student is not in attendance at a school-sponsored or school-related activity if:

(1) the superintendent or the superintendent's designee has a reasonable belief that the student has engaged in conduct defined as a felony offense other than those defined in Title 5, Penal Code; and

(2) the continued presence of the student in the regular classroom threatens the safety of other students or teachers or will be detrimental to the educational process.

Texas Education Code
Protective Eye Devices in Public Schools

CHAPTER 38. HEALTH AND SAFETY

Sec. 38.005. Protective Eye Devices in Public Schools.

Each teacher and student must wear industrial-quality eye-protective devices in appropriate situations as determined by school district policy.

Added by Acts 1995, 74th Legislature, chapter 260, Section 1, effective May 30, 1995.

Texas Education Code
Standards for School Facilities

CHAPTER 46. INSTRUCTIONAL FACILITIES ALLOTMENT

Sec. 46.008. Standards.

The commissioner shall establish standards for adequacy of school facilities. The standards must include requirements related to space, educational adequacy, and construction quality. All new facilities constructed after September 1, 1998, must meet the standards to be eligible to be financed with state or local tax funds.

Added by Acts 1997, 75th Legislature, chapter 592, Sec. 1.04, effective September 1, 1997.

Texas Administrative Code
School Facilities Standards

The State Board of Education (SBOE) is assigned specific rulemaking authority under the Texas Education Code. SBOE rules are codified under the Texas Administrative Code (TAC). The TAC is the official compilation of all final state agency rules published in the Texas Register. Following its effective date, a SBOE rule is entered into the TAC under Title 19, Part II. Title 19 is Education, and Part II is the Texas Education Agency.

Texas Administrative Code, Title 19, Part II
Chapter 61. School Districts
Subchapter CC. Commissioner's Rules Concerning School Facilities

Statutory Authority: The provisions of this Subchapter CC issued under the Texas Education Code, §42.004, unless otherwise noted.

§61.1033. School Facilities Standards.

(a) Definitions and procedures. The following words, terms, and procedures, when used in this section, shall have the following meanings, unless the context clearly indicates otherwise.

(5) Major space renovations - At least 50% of the gross area of the facility's instructional space is within the limits of the work. Other renovations associated with repair or replacement of architectural interior or exterior finishes; fixtures; equipment; and electrical, plumbing, and mechanical systems are not subject to the requirements of subsections (d) and (e) of this section, but shall comply with applicable building codes as required by subsection (f) of this section.

(6) Square feet per pupil - The net interior space of a room divided by the maximum number of pupils to be housed in that room during a single class period.

(7) Square feet per room measurements - The net square footage of a room that will house 22 students at the elementary level and 25 students at the middle or high school level. The net square footage of a room includes exposed storage space, such as cabinets or shelving, but does not include hallway space or storage space, such as closets or preparation offices.

(b) Effective date. The requirements for school facility standards shall apply to projects for new construction or major space renovations approved by a school district board of trustees after September 1, 1998.

(c) Certification of design and construction.

(1) In this section, the word “certify” indicates that the architect or engineer has reviewed the standards contained in this chapter and used the best professional judgment and reasonable care consistent with the practice of architecture or engineering in the State of Texas in executing the construction documents. The architect or engineer also certifies that these documents conform to the provisions of this section, except as indicated on the certification.

(2) The school district shall notify and obligate the architect or engineer to provide the required certification. The architect’s or engineer’s signature and seal on the construction documents shall certify compliance.

(3) To ensure that facilities have been designed and constructed according to the provisions of this section, each of the involved parties shall execute responsibilities as follows.

(A) The school district shall provide the architect or engineer the long-range school facility plan and / or educational specifications approved by the board of trustees as required by this subchapter, and building code specifications for the facility.

(B) The architect or engineer shall perform a building code search under applicable regulations that may influence the project, and shall certify that the design has been researched before it is final.

(C) The architect or engineer shall also certify that the facility has been designed according to the provisions of this section, based on the long-range school facility plan and / or educational specifications, building code specifications, and all documented changes to the construction documents provided by the district.

(D) The building contractor or construction manager shall certify that the facility has been constructed in general accordance with the construction documents specified in subparagraph of this paragraph.

(E) When construction is completed, the school district shall certify that the facility conforms to the design requirements specified in subparagraph (A) of this paragraph.

(d) Space, minimum square foot requirements.

(1) A school district shall provide instructional space if required by the district educational specifications described in subsection (e) of this section.

(2) For each type of instructional space, a district may satisfy the requirements of this section by using, as appropriate, either the standard for the minimum square feet per pupil or for square feet per room specified in paragraphs (1)-(3) of this subsection. Room size requirements are based on rooms that will house 22 students at the elementary level and 25 students at the middle or high school level.

(A) General classrooms.

(i) Classrooms for prekindergarten - Grade 1 shall have a minimum of 36 square feet per pupil or 800 square feet per room.

(ii) Classrooms at the elementary school level shall have a minimum of 30 square feet per pupil or 700 square feet per room.

(iii) Classrooms at the secondary school level shall have a minimum of 28 square feet per pupil or 700 square feet per room.

(B) Specialized classrooms.

(i) Computer laboratories shall have a minimum of 41 square feet per pupil or 900 square feet per room at the elementary school level; and 36 square feet per pupil or 900 square feet per room at the secondary school level.

(ii) Science lecture/lab shall have a minimum of 41 square feet per pupil or 900 square feet per room at the elementary school level; 50 square feet per pupil or 1,000 square feet per room at the middle school level; and 50 square feet per pupil or 1,200 square feet per room at the high school level.

(e) Educational adequacy. A proposed new school facility or major space renovation of an existing school facility meets the conditions of educational adequacy if the design of the proposed project is based on the requirements of the school district's educational program and the student population that it serves.

(f) Construction quality.

(1) Districts with existing building codes. A school district located in an area that has adopted local building codes shall comply with those codes (including fire and mechanical, electrical, and plumbing codes). The school district is not required to seek additional plan review of school facilities projects other than what is required by the local building authority.

(2) Districts without existing building codes. A school district located in an area that has not adopted local building codes shall adopt and use the latest edition of either the Uniform Building Code or Standard (Southern) Building Code (and related fire, mechanical, and plumbing codes); and the National Electric Code. A qualified, independent third party, not employed by the design architect or engineer, shall review the plans and specifications for compliance with the requirements of the adopted building code. The plan review shall examine compliance conditions for emergency egress, fire protection, structural integrity, life safety, plumbing, and mechanical and electrical design. The review shall be conducted before bidding and must be conducted by a certified building code consultant. Associated fees shall be the responsibility of the school district. The reviewer shall prepare a summary list of any conditions not in conformance with the provisions of the adopted building code and is required to send a copy to the school district, design architect, or engineer. The design architect or engineer shall revise the plans and specifications as necessary and certify code compliance to the district. Any disputes shall be a matter for contract resolution.

(3) Other provisions. School districts shall comply with the provisions of the Americans with Disabilities Act of 1990 (Title I and Title II) and other local, state, and federal requirements as applicable.

Statutory Authority: The provisions of this §61.1033 issued under the Texas Education Code, §46.008, as added by House Bill 4, 75th Texas Legislature, 1997.

Source: The provisions of this §61.1033 adopted to be effective September 1, 1998, 23 TexReg 7221.

Texas Administrative Code
Required Curriculum

Texas Administrative Code, Title 19, Part II
Chapter 74. Curriculum Requirements
Subchapter A. Required Curriculum

Statutory Authority: The provisions of this Subchapter A issued under the Texas Education Code, §§7.102, 28.002, 28.023, 28.025, 28.054, and 38.003, unless otherwise noted.

§74.1. Essential Knowledge and Skills.

(a) A school district that offers Kindergarten through Grade 12 must offer the following as a required curriculum:

(1) a foundation curriculum that includes:
- (A) English language arts;
- (B) mathematics;
- (C) science; and
- (D) social studies, consisting of Texas, United States and world history, government, and geography; and

(2) an enrichment curriculum that includes:
- (A) to the extent possible, languages other than English;
- (B) health;
- (C) physical education;
- (D) fine arts;
- (E) economics, with emphasis on the free enterprise system and its benefits;
- (F) career and technology education; and
- (G) technology applications.

(b) A school district must provide instruction in the essential knowledge and skills of the appropriate grade levels in the foundation curriculum as specified in Chapter 110 of this title (relating to Texas Essential Knowledge and Skills for English Language Arts and Reading); Chapter 111 of this title (relating to Texas Essential Knowledge and Skills for Mathematics); Chapter 112 of this title (relating to Texas Essential Knowledge and Skills for Science); Chapter 113 of this title (relating to Texas Essential Knowledge and Skills for Social Studies); and Chapter 128 of this title (relating to Texas Essential Knowledge and Skills for Spanish Language Arts and English as a Second Language). A school district may add elements at its discretion but must not delete or omit instruction in the foundation curriculum specified in subsection (a) of this section.

Source: The provisions of this §74.1 adopted to be effective September 1, 1996, 21 TexReg 4311; amended to be effective September 1, 1998, 23 TexReg 5675.

*§74.2. Description of a Required Elementary Curriculum***.**

A school district that offers kindergarten through Grade 5 must provide instruction in the required curriculum as specified in §74.1 of this title (relating to Essential Knowledge and Skills). The district must ensure that sufficient time is provided for teachers to teach and for students to learn English language arts, mathematics, science, social studies, fine arts, health, physical education, technology applications, and to the extent possible, languages other than English. The school district may provide instruction in a variety of arrangements and settings, including mixed-age programs designed to permit flexible learning arrangements for developmentally appropriate instruction for all student populations to support student attainment of course and grade level standards.

Source: The provisions of this §74.2 adopted to be effective September 1, 1996, 21 TexReg 4311; amended to be effective September 1, 1998, 23 TexReg 5675.

§74.3. Description of a Required Secondary Curriculum.

(a) Middle Grades 6-8. A school district that offers Grades 6-8 must provide instruction in the required curriculum as specified in §74.1 of this title (relating to Essential Knowledge and Skills). The district must ensure that sufficient time is provided for teachers to teach and for students to learn English language arts, mathematics, science, social studies, fine arts, health, physical education, technology applications, and to the extent possible, languages other than English. The school district may provide instruction in a variety of arrangements and settings, including mixed-age programs designed to permit flexible learning arrangements for developmentally appropriate instruction for all student populations to support student attainment of course and grade level standards.

(b) Secondary Grades 9–12.

(1) A school district that offers Grades 9–12 must provide instruction in the required curriculum as specified in §74.1 of this title (relating to Essential Knowledge and Skills). The district must ensure that sufficient time is provided for teachers to teach and for students to learn the subjects in the required curriculum. The school district may provide instruction in a variety of arrangements and settings, including mixed-age programs designed to permit flexible learning arrangements for developmentally appropriate instruction for all student populations to support student attainment of course and grade level standards.

(2) The school district must offer the courses listed in this paragraph and maintain evidence that students have the opportunity to take these courses:

(C) Science - Integrated Physics and Chemistry, Biology, Chemistry, and Physics. Science courses shall include at least 40% hands-on laboratory investigations and field work using appropriate scientific inquiry;

Source: The provisions of this §74.3 adopted to be effective September 1, 1996, 21 TexReg 4311; amended to be effective October 13, 1997, 22 TexReg 10129; amended to be effective September 1, 1998, 23 TexReg 5675.

Texas Administrative Code
Educators' Code of Ethics

Texas Administrative Code, Title 19, EDUCATION
Part 7, State Board for Educator Certification
Chapter 247. Educators' Code of Ethics

Statutory Authority: The provisions of this Chapter 247 are authorized under Texas Education Code, §21.041(b)(8), which requires the State Board for Educator Certification (SBEC) to propose rules providing for the adoption, enforcement, and amendment of an educators' code of ethics, and Section 63(i) of the conforming amendments to Senate Bill 1 (74th Legislature, 1995), which provides for a code of ethics proposed by the SBEC and adopted by the State Board of Education.

§247.1. Purpose and Scope.

In compliance with the Texas Education Code, § 21.041(b)(8), the State Board for Educator Certification (the board) adopts an educators' code of ethics as set forth in §247.2 of this title (relating to Code of Ethics and Standards Practices for Texas Educators). The board may amend the ethics code in the same manner as any other formal rule. The board is solely responsible for enforcing the ethics code for purposes related to certification disciplinary proceedings.

§247.2. Code of Ethics and Standard Practices for Texas Educators.

(a) Professional responsibility. The Texas educator should strive to create an atmosphere that will nurture to fulfillment the potential of each student. The educator shall comply with standard practices and ethical conduct toward students, professional colleagues, school officials, parents, and members of the community. In conscientiously conducting his or her affairs, the educator shall exemplify the highest standards of professional commitment.

(c) Principle II: Professional practices and performance. The Texas educator, after qualifying in a manner established by law or regulation, shall assume responsibilities for professional administrative or teaching practices and professional performance and shall demonstrate competence.

(5) Standard 5. The educator shall comply with written local school board policies, state regulations, and other applicable state and federal laws.

(e) Principle IV: Ethical conduct toward students. The Texas educator, in accepting a position of public trust, should measure success by progress of each student toward realization of his or her potential as an effective citizen.

(1) Standard 1. The educator shall deal considerately and justly with each student and shall seek to resolve problems including discipline according to law and school board policy.

(2) Standard 2. The educator shall not intentionally expose the student to disparagement.

(3) Standard 3. The educator shall not reveal confidential information concerning students unless disclosure serves lawful professional purposes or is required by law.

(4) Standard 4. The educator shall make reasonable effort to protect the student from conditions detrimental to learning, physical health, mental health, or safety.

(5) Standard 5. The educator shall not deliberately distort facts.

(6) Standard 6. The educator shall not unfairly exclude a student from participation in a program, deny benefits to a student, or grant an advantage to a student on the basis of race, color, sex, disability, national origin, religion, or family status.

(7) Standard 7. The educator shall not unreasonably restrain the student from independent action in the pursuit of learning or deny the student access to varying points of view.

(f) Principle V: Ethical conduct toward parents and community. The Texas educator, in fulfilling citizenship responsibilities in the community, should cooperate with parents and others to improve the public schools of the community.

(1) Standard 1. The educator shall make reasonable effort to communicate to parents information that lawfully should be revealed in the interest of the student.

Source: The provisions of this Chapter adopted to be effective March 1, 1998, 23 TexReg 1023.

Texas Administrative Code
Standards for Face and Eye Protection in Public Schools

Title 25. HEALTH SERVICES
Part I. TEXAS DEPARTMENT OF HEALTH
Chapter 295. OCCUPATIONAL HEALTH
Subchapter F. STANDARDS FOR FACE AND EYE PROTECTION IN PUBLIC SCHOOLS

§295.141 Purpose and Scope.

(a) Purpose. The purpose of these sections of this undesignated head is to provide governing boards and administrators of Texas school districts reasonable and adequate means, ways, and methods for the proper selection and safe use of eye protective equipment.

(b) Scope. These sections shall apply to all teachers and pupils within Texas public schools participating in certain vocational, industrial arts, and chemical-physical courses or laboratories where potentially hazardous operations exist. These sections were extracted from American Standards Association Bulletin Z2.1-1959, which is to be used as a further reference for material not contained within these sections.

Source: The provisions of this §295.141 adopted to be effective February 22, 1993, 18 TexReg 848.

§295.143 Definitions.

(a) General information.

(1) The word “approved” refers to approval by the Texas Department of Health, i.e., the agency having jurisdiction over the specific requirement.

(2) The use of the word “shall” indicates a mandatory requirement. The word “should” indicates a recommendation.

(b) Specific definitions.

(1) Bridge size—The distance between lenses on the nose side of each eye, expressed in millimeters.

(2) Contaminant—A harmful material that is foreign to the normal atmosphere.

(4) Dust—Finely divided solid particles generated by processing (including handling, crushing, grinding, or pulverizing) materials such as rock, metal, wood, and grain.

(6) Eye size—A measurement expressed in millimeters and denoting the size of the lens-holding section of an eye frame.

(10) Goggles—A device, with contour-shaped eyecups or facial contact with glass or plastic lenses, worn over the eyes and held in place by a headband for the protection of the eyes and eye sockets.

(11) Hand shield—A device, usually held in the hand or supported on the wearer’s chest, designed to protect the eyes and face during welding operations.

(13) Lens—The transparent glass or plastic device through which the wearer of the protective goggles or spectacles sees, and which provides protection to the eyes against flying objects, glare, or injurious radiation, or a combination of these hazards.

(14) Lens, corrective—A lens ground to the wearer's individual corrective prescription.

(15) Mist—Suspended liquid droplets generated by breaking up a liquid into a dispersed state.

(16) Particulate matter—Matter occurring in the form of minute separate particles, such as dust, fume, mist, and fog; a dispersoid.

(19) Spectacle—A device patterned after conventional-type spectacle eyewear but of more substantial construction, either with or without side shields, and with clear, impact-resistant filter or corrective lenses of glass or plastic.

Source: The provisions of this §295.143 adopted to be effective February 22, 1993, 18 TexReg 848.

§295.144 General Requirements.

(a) Eye protection shall be required where there is a reasonable probability of injury to the body that can be prevented by such protection.

(b) In such cases, governing boards and administrators of Texas school districts shall furnish protectors of a type suitable for the work to be performed, and participating teachers and pupils shall use such protectors.

(c) No person shall be subjected, without protection, to a hazardous environmental condition.

(d) Protectors shall meet the following minimum requirements. Protectors shall:

(1) provide adequate protection against the particular hazards for which they are designed;

(2) be reasonably comfortable when worn under the designated conditions;

(3) fit snugly and shall not unduly interfere with the movements of the wearer;

(4) be durable;

(5) be capable of being disinfected; and

(6) be easily cleanable.

(e) Protectors should be kept clean and in good repair.

(f) Eye protector shall be provided where machines or operations present the hazard of flying particles, pieces, or substances.

(g) Workers whose vision requires the use of corrective lenses in spectacles and who are required by this standard to wear protective goggles shall be provided with goggles of one of the following types:

(2) goggles that can be worn over corrective spectacles without disturbing the adjustment of the spectacles; and

(h) Only protectors which bear the label of or meet the standards set forth in American Standards Association Bulletin Z2.1-1959 shall be used.

Source: The provisions of this § 295.144 adopted to be effective February 22, 1993, 18 TexReg 848.

§295.145 Eye Protectors.

(a) Face shields.

(1) Function. The devices described in this subsection are designed to provide protection to the face (i.e., the front part of the head including forehead, eyes, cheeks, nose, mouth, chin) and neck, where required, from flying particles and sprays of hazardous liquids and, in addition, to provide antiglare protection where required.

(2) Intended uses. Some typical uses for face shields include the following:

(C) buffing, polishing, wire brushing, and grinding operations where flying particles or objects may strike the face;

(E) handling hot or corrosive materials.

(c) Goggles, eyecup models. The three basic types of eyecup goggles shall be subdivided into the following classes.

(1) Chippers' models providing protection against flying objects. Eyecups shall be ventilated in a manner to permit circulation of air. Ventilation openings shall be such as to exclude a spherical particle 0.04 inch in diameter.

(2) Dust and splash models providing protection against relatively fine dust particles or liquid splashes. Eyecups shall be ventilated in a manner to permit circulation of air. The ventilation openings shall be baffled or screened to prevent the direct passage of dust or liquids into the interior of the eyecups.

(3) Welders' and cutters' models providing protection against glare and injurious radiations. The basic designs may be modified to provide more protection against special hazards, but the modified equipment shall meet the same requirements as the basic design. Eyecups shall be ventilated in a manner to permit circulation of air. The ventilation openings shall be baffled to prevent the passage of light rays into the interior of the eyecups.

(d) Spectacles, metal or plastic frame.

(1) Protection. Spectacles shall provide protection to the eye from flying objects and, where required, from glare and injurious radiations. Spectacles without side shields are intended to provide frontal eye protection only. Where side as well as frontal eye protection is required, the spectacles shall be provided with side shields. The edge of the side shield shall have a smooth finish or shall be padded.

(2) Materials and methods of test. General materials used shall be capable of withstanding the disinfection, corrosion resistance, water absorption, and inflammability tests outlined in §295.146 of this title (relating to Materials and Methods of Test of Protections).

(e) Goggles, flexible fitting.

(1) Description. Goggles shall consist of a frame (composed of a flexible, chemical-resistant, nontoxic, nonirritating, and slow-burning material, forming a lens holder), lenses, and a positive means of support on the face such as an adjustable headband of suitable material to retain the frame comfortably and snugly in place in front of the eyes. The lens holder shall be such that the lenses are held firmly and tightly and may be removed or replaced without the use of tools. The goggles may be ventilated or not, as required by their intended use. Where chemical goggles are ventilated, the openings shall be such as to render the goggles splashproof.

(2) Protection. Goggles shall provide eye protection from fine dusts, fumes, liquids, splashes, mists, and spray.

(3) Application. Specific application for use of flexible fitting goggles will be found in Table 1 of §295.147 of this title (relating to Selection of Eye and Face Protective Devices).

(4) Materials and methods of test. Plastic lenses used in flexible fitting goggles shall be not less than 0.050 inch in thickness. Materials used shall be capable of withstanding the disinfection, corrosion resistance, water absorption, and flammability tests outlined in §95.146 of this title (relating to Materials and Methods of Test of Protections).

(f) Goggles, plastic eyeshield.

(1) Description. The goggles shall consist of a frame of plastic material, lens or lenses, and a means of support such as an adjustable headband to retain the goggles in front of the eyes. The frame and lens need not be of the same material. The lens need not be an integral part of the goggles. The frame may be translucent, clear, or opaque, and may be ventilated or not, as required by its intended use. The edge of the frame which bears against the face shall have a smooth surface free from roughness or irregularities which might cause discomfort to the wearer.

(2) Protection. The goggles shall provide protection against flying objects and, where required, from glare and injurious radiations. Where the goggles are used for protection against injurious light radiation, the lenses and frames shall meet the requirements of §295.148(b) of this title (relating to Appendix for §295.146) and the frames shall prevent the passage of injurious light rays.

(3) Application. Specific application for use of plastic eyeshield goggles will be found in Table of §295.147 of this title (relating to Selection of Eye and Face Protective Devices).

(4) Materials and methods of test. Where plastic lenses are used in plastic eyeshield goggles, they shall be not less that 0.050 inch in thickness. If glass lenses are used, they shall be not less than 3.0 millimeters nor more than 3.8 millimeters in thickness. Materials used shall be capable of withstanding the disinfection, corrosion, resistance, water absorption, and flammability tests outlined in §295.146 of this title (relating to Materials and Methods of Test of Protections).

(g) Spectacles, plastic eyeshield.

(1) Description. Spectacles shall consist of a frame of metal, fiber, or plastic material, plastic lens or lenses, and temples or other suitable means of support to retain the frame before the eyes. The lens or lenses need not be an integral part of the frame. The spectacles shall have side shields, if required by their intended use.

(2) Protection. Spectacles shall provide protection to the eye from flying objects and, where required, from glare and injurious radiation. Spectacles without side shields provide frontal eye protection only. Where side as well as frontal eye protection is required, the spectacles shall be provided with side shields.

(3) Application. Specific application for use of plastic eyeshield spectacles will be found in Table 1 of §295.147 of this title (relating to Selection of Eye and Face Protective Devices).

(4) Materials and methods of test. Plastic lenses used in plastic eyeshield spectacles shall not be less that 0. 050 inch in thickness. Materials used shall be capable of meeting the applicable requirements and withstanding the tests outlined in §295.146

of this title (relating to Materials and Methods of Test of Protections).

§295.146 Materials and Methods of Test of Protections.

(a) Materials. Materials used in the manufacture of eye protectors shall combine mechanical strength and lightness of weight to a high degree, shall be nonirritating to the skin when subjected to perspiration, and shall withstand frequent disinfection by the methods prescribed in this section. Where metals are used, they shall be inherently corrosion resistant.

(b) Disinfection. All materials shall be such as to withstand, without visible deterioration or discoloration, washing in detergents and warm water, rinsing to remove all traces of detergent, and disinfection by the following methods:

(1) immersion for 10 minutes in a solution of formalin made by placing one part of 40% formaldehyde solution in nine parts of water at a room temperature of 68 degrees Fahrenheit;

(2) subjection to a moist atmosphere of formaldehyde for a period of 10 minutes at a room temperature of 68 degrees Fahrenheit; or

(3) immersion for 10 minutes in a solution of modified phenolics, hypochlorite, or quaternary ammonium compounds in strength specified by the manufacturer at a room temperature of 68 degrees Fahrenheit.

(c) Corrosion resistance. Metal parts shall be tested for corrosion resistance by placing them in a boiling aqueous 10% (by weight) solution of sodium chloride for a period of 15 minutes. The parts upon being removed from this solution shall be immediately immersed in a 10% (by weight) aqueous solution of sodium chloride at a room temperature of 68 degrees Fahrenheit. They shall then be removed from this solution and, without wiping off the adhering liquid, allowed to dry for 24 hours at room temperature. The metal parts shall then be rinsed in lukewarm water and allowed to dry. On visual inspection, the metal parts shall show no signs of roughening of the surface resulting from corrosion.

(d) Water absorption. Plastic parts shall be tested for water absorption and the results calculated in accordance with Test Method Number 7031 of Federal Specification L-P-406 (see §295.148(a) of this title (relating to Appendix for §295.146)). The amount of the water absorbed shall not exceed 5.0%.

(e) Flammability.

(1) Eyecup goggles. Eyecup goggles shall be tested for flammability by use of a 5/8-inch high diameter Bunsen burner, adjusted for a 3/4-inch high non-luminous flame of commercial natural gas (1,000-1,200 British thermal units). The temple side of the specimen shall be held at the tip of this flame in a draft-free room and the time (in seconds) required to ignite the material so that it will remain burning after the flame is removed shall be determined. The time required to ignite the specimen in the manner described shall be not less than four seconds.

(2) All other types. Where plastic materials are used, such materials shall be slow burning. Cellulose nitrate, or materials having flammability characteristics approximating those of cellulose nitrate, shall not be used. Flammability of the materials shall be no greater than that exhibited by cellulose acetate or acetate butyrate.

Source: The provisions of this §295.146 adopted to be effective February 22, 1993, 18 TexReg 848.

§295.147 Selection of Eye and Face Protective Devices.

Source: The provisions of this §295.147 adopted to be effective February 22, 1993, 18 TexReg 848.

§295.148 Appendix for §295.146.

(c) Maintenance and disinfection of eye protectors.

(1) Maintenance.

(A) It is essential that the lenses of eye protectors be kept clean. Continuous vision through dirty lenses can cause eye strain, which could possibly result in substandard production by the operator. Daily cleaning of the eye protector with soap and hot water is recommended.

(C) Replace headbands. Slack, worn-out, sweat-soaked, or twisted headbands do not hold the eye protector in proper position. Visual inspection can determine when the elasticity is reduced to a point beyond proper function.

(D) Keep goggles in case when not in use. Spectacles, in particular, should be given the same care as one's own glasses, since the frame, nose pads, and temples can be damaged by rough usage.

(2) Disinfection. Personal protective equipment which has been previously used shall be disinfected before being issued to another employee. Even when each employee is assigned protective equipment for extended periods, it is recommended that this equipment be cleaned and disinfected regularly. Several methods for disinfecting eye-protective equipment are acceptable. The most effective method is to disassemble the goggles or spectacles and thoroughly clean all parts with soap and hot water. Carefully rinse all traces of soap and replace defective parts with new ones. Swab thoroughly or completely immerse all parts for 10 minutes in a solution of germicidal deodorant fungicide. Remove parts from solution and suspend in a clean place for air drying at room temperature or with heated air. Do not rinse after removing parts from solution because this will remove the germicidal residue, which retains its effectiveness indefinitely. The dry parts or items should be placed in clean, dust-proof containers, such as a box, bag, or plastic envelope, to protect them until reissue.

(d) Fitting of goggles and spectacles.

(1) Cup goggles.

(A) The first step in fitting cup goggles is to adjust the nose bridge. Both the ball and link-chain bridges of goggles are adjustable to accommodate the individual wearer. Both types of bridges usually have some means for shortening or lengthening. In either case, to shorten or lengthen the bridge, the instructions of the manufacturer should be followed. Chain not needed after adjustment should be cut off. The chain should be insulated to protect the nose of the wearer.

(B) The proper procedure for adjusting headbands is to keep the band loose enough to slip two fingers under it, palm side down, without stretching. Headbands should be worn low and flat and approximately at the base of the skull in order to hold goggles in a comfortable position. Most cup goggles are thinner and slanted away at the lower nasal sides, which makes for comfort as well as easy identification in getting them right side up.

(2) Spectacles.

(A) The first step in fitting spectacles is to determine the proper eye and bridge sizes. This is done best by using fitting samples and placing the sample spectacles on the nose to arrive at the proper size. The adjustable rocker pads should fit flush against the sides of the nose without allowing the metal bridge of the spectacle to rest on the nose bridge of the wearer. The small metal arms, to which the pearloids pads are attached, can be readily adjusted by round nose pliers which are especially designed for this purpose.

(B) To fit the temples comfortably over the ears, hold the spectacle firmly in one hand and shape the bow of the temple gradually by drawing it slowly between thumb and forefinger of other hand. Temples should be angled down from frame to ear so that lenses will be perpendicular to the line of vision. Prescription safety spectacles should be fitted only by qualified optical personnel.

Source: The provisions of this §295.148 adopted to be effective February 22, 1993, 18 TexReg 848.

Texas Administrative Code
Hazardous Substances

Health and Safety Code

TITLE 5. SANITATION AND ENVIRONMENTAL QUALITY
SUBTITLE D. HAZARDOUS SUBSTANCES
CHAPTER 501. HAZARDOUS SUBSTANCES
SUBCHAPTER A. GENERAL PROVISIONS

Sec.502.002. Hazardous Substance Described.

(A) A hazardous substance is:

(1) a substance or mixture of substances that is toxic, corrosive, flammable, an irritant, or a strong sensitizer, or that generates pressure through decomposition, heat, or other means, if the substance or mixture of substances may cause substantial personal injury or substantial illness during or as a proximate result of any customary or reasonably foreseeable handling or use, including reasonably foreseeable ingestion by children;

(2) a toy or other article, other than clothing, that is intended for use by a child and that presents an electrical, mechanical, or thermal hazard; or

(3) a radioactive substance designated as a hazardous substance under Section 501.003.

(B) A substance is corrosive if, when in contact with living tissue, it causes destruction of that tissue by chemical action. A chemical action on an inanimate surface is not corrosive for the purpose of this section.

(C) An article is an electrical hazard if, in normal use or when subjected to reasonably foreseeable damage or abuse, it may cause, because of its design or manufacture, personal injury or illness by electric shock.

(D) A substance is flammable if it has a flash point of 80 degrees Fahrenheit or less, as determined by the Tagliabue Open Cup Tester or other method as provided by Section 501.021.

(E) A substance is an irritant if it is noncorrosive and if, on immediate, prolonged, or repeated contact with normal living tissue, it induces a local inflammatory reaction.

(F) An article is a mechanical hazard if, in normal use or when subjected to reasonably foreseeable damage or abuse, it presents, because of its design or manufacture, an unreasonable risk of personal injury or illness:

(1) from fracture, fragmentation, or disassembly of the article;
(2) from propulsion of the article or a part or accessory of the article;
(3) from points or other protrusions, surfaces, edges, openings, or closures;
(4) from moving parts;
(5) from lack or insufficiency of controls to reduce or stop motion;

(6) as a result of self-adhering characteristics of the article;
(7) because the article or a part or accessory of the article my be aspirated or ingested;
(8) because of instability; or
(9) because of any other aspect of the article's design or manufacture

(G) A substance is radioactive if it emits ionizing radiation.

(H) A substance is a strong sensitizer if, when on normal living tissue, it causes, through an allergic or photodynamic process, a hypersensitivity that becomes evident on reapplication of the same substance.

(I) An article is a thermal hazard if, in normal use or when subject to reasonable foreseeable damage or abuse, it present, because of its design or manufacture, an unreasonable risk of personal injury or illness because of heat, including heat from heated parts, substances, or surfaces.

(J) A substance is toxic if it is capable of producing personal injury or illness to any person through ingestion, inhalation, or absorption through any body surface, and it is not radioactive.

Texas Administrative Code
Hazard Communication Act

Health and Safety Code

TITLE 5. SANITATION AND ENVIRONMENTAL QUALITY
SUBTITLE D. HAZARDOUS SUBSTANCES
CHAPTER 502. HAZARD COMMUNICATIONS ACT
SUBCHAPTER A. GENERAL PROVISIONS

Sec. 502.001. Short Title.

This chapter may be cited as the Hazard Communications Act.

Sec. 502.003 Definitions.

(1)–(3) Intentionally omitted.

(4) "Chemical name" means:

(A) the scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstracts Service (CAS) rules of nomenclature;

(B) A name that clearly identifies the chemical for the purpose of conducting a hazard evaluation.

(5) "Common name" means a designation of identification, such as a code name, code number, trade name, brand name, or generic name, used to identify a chemical other than by its chemical name.

(6)–(9) Intentionally omitted.

(10) "Employee" means a person who may be or may have been exposed to hazardous chemicals in the person's workplace under normal operating conditions or foreseeable emergencies, and includes a person working for this state, a person working for a political subdivision of this state, or member of a volunteer emergency service organization or, it the applicable OSHA standard or MSHA standard is not in effect, a person working for a private employer. Workers such as office workers or accountants who encounter hazardous chemicals only in nonroutine, isolated instances are not employees for purposes of this chapter.

(11) "Employer" means a person engaged in private business who is regulated by the federal Occupational Safety and Health Act of 1970 (Pub. L. No. 91-596), the Federal Coal Mine Health and Safety Act of 1969 (Pub. L. No. 91-173), or the Federal Mine Safety and Health Amendments Act of 1977 (Pub. L. No. 95-164) on the effective date of this Act, or the state or a political subdivision of the state, including a state, county, or municipal agency, a public school, a college or university, a river authority or publicly owned utility, a volunteer emergency service organization, and other similar employers. The term does not include any person to whom the federal Occupational Safety and Health Act of 1970 (Pub. L. No. 91-596), the Federal Coal Mine Health and Safety Act of 1969 (Pub. L. No. 91-173), or the Federal Mine Safety and Health Amendments Act of 1977 (Pub. L. No. 95-164) is applicable if that employer is covered by the OSHA standard or the other two federal laws.

(12) "Expose" or "exposure" means that an employee is subjected to a hazardous chemical in the course of employment through any route of entry, including inhalation, ingestion, skin contact, or absorption. The term includes potential, possible, or accidental exposure under normal conditions of use or in a reasonably foreseeable emergency.

(13) "Hazardous chemical" or "chemical" means an element, compound, or mixture of elements or compounds that is a physical hazard or health hazard as defined by the OSHA standard in 29 CFR Section 1910 (c), or a hazardous substance as defined by the OSHA standard in 29 CFR Section 1910.1200 (d)(3), or by OSHA's written interpretations. A hazard determination may be made by employers who choose not to rely on the evaluations made by their suppliers if there are relevant qualitative or quantitative differences. A hazard determination shall involve the pest professional judgement.

(14)–(16) Intentionally omitted

(17) "Material Safety Data Sheet" ("MSDS") means a document containing chemical hazard and safe handling information that is prepared in accordance with the requirements of the OSHA standard for that document.

(18)–(19) Intentionally omitted

(20) "Physical hazard" means 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 in terms defined in the OSHA standard.

(21) Intentionally omitted

(22) “Work area” means a room, a defined space, a utility structure, or an emergency response site in a workplace where hazardous chemicals are present, produced, or used and where employees are present.

(23) “Workplace” means an establishment, job site, or project, at one geographical location containing one or more work areas, with or without buildings, that is staffed 20 or more hours a week.

Sec. 502.004. Applicability of Chapter.

(a) Except as provided by Subsection (b), this chapter applies to only employers who are not required to comply with the OSHA standard, the Federal Coal Mine Health and Safety Act of 1969 (Pub. L. No. 91-173), or the Federal Mine Safety and Health Amendments Act of 1977 (Pub. L. No. 95-164).

Sec. 502.006. Material Safety Data Sheet.

(a) A chemical manufacturer or distributor shall provide appropriate material safety data sheets to employers who acquire hazardous chemicals in this state with each initial shipment and with the first shipment after an MSDS is updated. The MSDSs must conform to the most current requirements of the OSHA standard.

(b) An employer shall maintain a legible copy of a current MSDS for each hazardous chemical purchased. If the employer does not have a current MSDS for a hazardous chemical when the chemical is received at the workplace, the employer shall request an MSDS in writing from the manufacturer or distributor in a timely manner or shall otherwise obtain a current MSDS. The manufacturer or distributor shall respond with an appropriate MSDS in a timely manner.

(c) Material safety data sheets shall be readily available, on request, or review by employees or designated representatives at each workplace.

Sec. 502.007. Label.

(a) A label on an existing container of a hazardous chemical may not be removed or defaced unless it is illegible, inaccurate, or does not conform to the OSHA standard to other applicable labeling requirement. Primary containers must be relabeled with at least the identity appearing on the MSDS, the pertinent physical and health hazards, including the organs that would be affected, and the manufacturer’s name and address. Except as provided by Subsection (b), secondary containers must be relabeled with at least the identity appearing on the MSDS and appropriate hazard warnings.

(b) An employee may not be required to work with a hazardous chemical from an unlabeled container except for a portable container intended for the immediate use of the employee who performs the transfer.

Sec. 502.009. Employee Education Program.

(a) An employer shall provide an education and training program for employees who use or handle hazardous chemicals.

(b) An employer shall develop, implement, and maintain at the workplace a written hazard communication program for the workplace that describes how the criteria specified in this chapter will be met.

(c) An education and training program must include, as appropriate:

(1) information on interpreting labels and MSDSs and the relationship between those two methods of hazard communications;

(2) the location by work area, acute and chronic effects, and safe handling of hazardous chemicals known to be present in the employee's work area and to which the employees may be exposed;

(3) the proper use of protective equipment and first aid treatment to be used with respect to the hazardous chemicals to which employees may be exposed; and

(4) general safety instructions on the handling, cleanup procedures, and disposal of hazardous chemicals.

(d) Training may be conducted by categories of chemicals. An employer must advise employees that information is available on the specific hazards of individual chemicals through the MSDSs. Protective equipment and first aid treatment may be by categories of hazardous chemicals.

(e) An employer shall provide additional instruction to an employee when the potential for exposure to hazardous chemicals in the employee's work area increases significantly or when the employer receives new and significant information concerning the hazards of a chemical in the employee's work area. The addition of new chemicals alone does not necessarily require additional training.

(f) An employer shall provide training to a new or newly assigned employee before the employee works with or in a work area containing a hazardous chemical.

(g) An employer shall keep the written hazard communication program and a record of each training session given to employees, including the date, a roster of the employees who attended, the subjects covered in the training session, and the names of the instructors. Those records shall be maintained for at least five years by the employer. The department shall have access to those records and may interview employees during inspections.

Sec. 502.017. Employee Notice; Rights of Employees.

(a) An employer shall post and maintain adequate notice, at locations where notices are normally posted, informing employees of their rights under this chapter. If the director does not prepare the notice under Section 502.008, the employer shall prepare the notice.

(b) Employees who may be exposed to hazardous chemicals shall be informed of the exposure and shall have access to the workplace chemical list and MSDSs for the hazardous chemicals. Employees, on request, shall be provided a copy of a specific MSDS with any trade secret information deleted. In addition, employees shall receive training concerning the hazards of the chemicals and measures they can take to protect themselves from those hazards. Employees shall be provided with appropriate personal protective equipment. These rights are guaranteed.

Civil Practice and Remedies Code
Tort Law

TITLE 5. GOVERNMENTAL LIABILITY
CHAPTER 101. TORT CLAIMS
SUBCHAPTER A. GENERAL PROVISIONS

Sec. 101.001. Definitions

In this chapter:

(2) "Employee" means a person, including an officer or agent, who is in the paid service of a governmental unit by competent authority, but does not include an independent contractor, or a person who performs tasks the detail of which the government unit does not have the legal right to control.

(3) "Governmental Unit" means:

(B) a political subdivision of this state, including any city, county, school district, junior college district, levee improvement district, drainage district, irrigation district, water improvement district, water control and improvement district, water control and preservation district, freshwater supply district, navigation district, conservation and reclamation district, soil communication district, public health district, and river authority.

Sec. 101.021. Governmental Liability.

A governmental unit in the state is liable for:

(1) property damage, personal injury, and death proximately caused by the wrongful act or omission or the negligence of an employee acting within his scope of employment if:

(A) the property damage, personal injury, or death arises from the operation or use of a motor-driven vehicle or motor-driven equipment; and
(B) the employee would be personally liable to the claimant according to Texas law; and
(C) personal injury and death so caused by a condition or use of tangible personal or real property if the governmental unit would, were it a private person, be liable to the claimant according to Texas law.

Acts 1985, 69th Legislature, chapter. 959, Sec. 1, effective September 1, 1985

NOTICE TO EMPLOYEES

The Texas Hazard Communication Act of 1985 (revised 1993), codified as Chapter 502 of the Texas Health and Safety Code

Requires Public Employers to provide employees with specific information on the hazards of chemicals to which employees may be exposed in the workplace. As required by law, your employer must provide you with certain information and training. A summary of the law follows.

Workplace Chemical List. Employers must develop a list of hazardous chemicals used in the workplace in excess of 55 gallons or 500 pounds. This list shall be updated by the employer at least annually and made available for employees and their representatives on request.

Materials Safety Data Sheets. Employees who may be exposed to hazardous chemicals shall be informed of the exposure by the employer and shall have ready access to the most current material safety data sheets, which detail physical and health hazards and other pertinent information on those chemicals.

Labels. Employees shall not be required to work with hazardous chemicals from unlabeled containers, except portable containers for immediate use and the contentsof which are known to the user.

E***mployee Education***. Program Employees shall receive training by the employer on the hazards of the chemicals and on measures they can take to protect themselves from those hazards, and shall be provided with appropriate personal protective equipment. Training shall be provided to new employees prior to working in the area with hazardous chemicals.

Reporting Injuries or Fatalities. Employers must report to the Texas Department of Health within 48 hours of the occurrence of a chemical accident that results in one or more employee fatalities or results in the hospitalization of five or more employees.

Employee Rights. Employees may file complaints with the Texas Department of Health at the address or telephone number below and may not be discharged or discriminated against in any manner for the exercise of any rights provided by this act.

EMPLOYERS MAY BE SUBJECT TO ADMINISTRATIVE PENALTIES AND CIVIL OR CRIMINAL FINES RANGING FROM $50 TO $100,000 FOR EACH VIOLATION OF THIS ACT.

Further information may be obtained from:
Texas Department of Health
Hazard Communications Branch
1100 West 49th Street
Austin, Texas 78756
(512) 834-6603

Appendix B

Professional Organization Position Statements

The American College of Occupational and Environmental Medicine and the American Academy of Ophthalmology
- The Use of Contact Lenses in an Industrial Environment

Council of State Science Supervisors
- Laboratory Safety
- Science Education Safety: Key Issues in School Laboratory Safety

National Association of Biology Teachers
- The Role of Laboratory and Field Instruction in Biology Education
- The Use of Human Body Fluids and Tissue Products in Biology Teaching
- The Use of Animals in Biology Education

National Science Teachers Association
- Guidelines for Responsible Use of Animals in the Classroom
- Elementary School Science
- Laboratory Science
- Liability of Teachers for Laboratory Safety and Field Trips

These are position statements of national and state professional organizations. Local school districts should use the information based on evaluations of what is appropriate for their curriculum.

A JOINT STATEMENT OF THE AMERICAN COLLEGE OF OCCUPATIONAL AND ENVIRONMENTAL MEDICINE AND THE AMERICAN ACADEMY OF OPHTHALMOLOGY POLICY STATEMENT

THE USE OF CONTACT LENSES IN AN INDUSTRIAL ENVIRONMENT

Policy:
Under the Americans with Disabilities Act of 1990, individuals cannot be disqualified from performing their essential functions in an industrial environment because they wear contact lenses unless it can be proven that they pose a direct threat to the health or safety of themselves or others in the work place. However, contact lenses do not fulfill the personal protective equipment requirements for ocular safety when worn by individuals performing certain tasks (e.g. welding and grinding) identified in the Code of FederLaboratory Investigations and ActivitiesLaboratory Investigations and Activitiesal Regulations. As required by the Occupational Safety and Health Administration (OSHA), individuals who wear contact lenses in the work place must combine them with appropriate industrial safety eyewear.

Background:
Individuals who wear contact lenses (either for cosmetic or medical reasons) have sometimes been disqualified from industrial employment. However, some individuals must wear contact lenses for medical reasons to obtain their best visual performance or efficiency. Under 1990 ADA, the use of contact lenses may be considered an accommodation for the ocular disabled in cases such as monocular aphakia and keratoconus, and would therefore be permitted. Other individuals simply prefer to wear contact lenses instead of spectacles for correcting refractive errors.

Evaluation:
OSHA has codified the voluntary ANSI Z87.1 consensus standard, which makes compliance mandatory. The OSHA rule states, "The required industrial-safety eyewear for the specific hazard identified in ANSI Z87.1 must be worn over the contact lenses." Therefore, individuals who wear contact lenses are required to combine them with appropriate industrial safety eyewear (ANSI Z87.1) since contact lenses do not provide ocular protection from hazards such as particles, chemicals, and radiant energy. For example, medical personnel must wear eye-and-face-safety devices to protect themselves from HIV or laser radiation, and cosmetologists should wear such devices to protect themselves from aerosol spray.

Additionally, when a full-face respirator is used, both spectacles and contact lenses can pose safety problems in the industrial work place. Zelnick et al showed that when a respirator was worn even without spectacles there was a loss of visual field, which varied depending on the type of full-face respirator. Since the frames of the spectacles have been shown to be an obstruction of the full field of vision, the use of a respirator compounds the loss of visual field. Individuals who wear soft contact lenses in air-fed respirators have been shown to present with symptoms of "dry-eyes" due to dehydration of the contact lenses. Increasing the blinking rate and sometimes using artificial tears is necessary to minimize these symptoms.

Challenges to federal regulations and voluntary ANSI standards, which disallowed the use of contact lenses with a respirator, resulted in an OSHA-funded research project conducted by Lawrence Livermore National Laboratories (LLNL). The research concluded that the "prohibition against wearing contacts while using a full-facepiece respirator should be revoked or withdrawn. Wearers of corrective lenses should have the option of wearing either contacts or eyeglasses with their full-facepiece respirators." In consideration of LLNL's research and other articles that support contact lens use, the prohibition was considered unwarranted by OSHA. OSHA published an enforcement procedure authorizing the use of rigid gas-permeable and soft contact lenses in all workplaces and with all types of respirators.

Recommendations:
Medical personnel should determine, on an individual basis, the advisability of wearing contact lenses in the industrial work environment. Individuals should be instructed in the principles of contact lens wear, and the symptoms of problems, and they should be urged to seek immediate help if an injury occurs.

COUNCIL OF STATE SCIENCE SUPERVISORS (CSSS) POSITION PAPERS

LABORATORY SAFETY

The Council supports the premise that science should be taught in a space specifically dedicated to science classes with provisions for laboratory activities. A safe and well-equipped preparation and workspace for students and teacher must be provided. Adequate storage space for equipment and supplies, including a separate storage area for potentially dangerous materials, must be provided. An adequate budget for facilities, equipment, supplies, and proper waste management must be provided to support the laboratory experiences. They must be maintained and updated on a regular basis. Unique science supplies must be provided in sufficient quantity that students have a direct, hands-on experience.

The number of students assigned to each laboratory class should not exceed 24. Students must have immediate access to the teacher in order to provide a safe and effective learning environment.

Training in laboratory safety must be provided to the teacher. Necessary safety equipment, such as safety goggles, fire extinguishers, fire blankets, fume hoods, and eye washes, must be provided and maintained.

SCIENCE EDUCATION SAFETY: KEY ISSUES IN SCHOOL LABORATORY SAFETY

Students and teachers must be aware of the potential for safety problems in the science classrooms and laboratories. Schools should review available safety resources and develop safety training for their teachers and students as well as safety rules for the classroom.

Teachers must choose safe labs that cover important concepts. Thought must be given to the chemicals purchased by schools. Which chemicals are the safest for the proposed labs, how much is needed, where will the chemicals be stored and in what arrangement? Are the storage areas locked and well ventilated?

Schools needing to dispose of unwanted or unknown (no label) chemicals should contact their state science education supervisor, state ecology agency or regional EPA office. Teachers or school officials should be prepared to give the name or description of the chemical, amount, type of container, nearest landfill and local sewage system.

Some state education agencies have worked with their state pollution control agencies and have used polluter fines to conduct statewide school chemical clean-ups in their states. Where this can not be done, local schools should band together to engage in regional chemical clean-ups to conserve costs.

Scientific equipment must be maintained. Written lab instructions must be clear and safety rules emphasized in these instructions.

Most states have regulations on fume hoods, whole-room ventilation, chemical storage, eyewash, safety showers, eyewear, aprons, gloves, fire blankets, first aid kits, and fire extinguishers in science classrooms. Schools should check with their state science supervisor for regulations, laws, and liabilities.

General Science Safety Checklist

The following is a suggested checklist of safety concerns in K–12 science laboratories.

1. Appropriate protective equipment for the science laboratory
2. Enforcement of safety procedures
3. All students and teachers know the local policies on all protective equipment
4. All students read and sign a lab safety contract
5. Sufficient, accessible lab stations per number of students in each laboratory
6. All students must wear proper safety goggles whenever chemicals, glassware, or heat is used
7. Equipment and chemical inventory maintained
8. Chemicals properly arranged by compatibility and securely stored
9. Restricted amounts of chemicals
10. Adequate labeling on equipment, chemicals and hazards
11. Material Safety Data Sheets
12. Unobstructed exits from laboratory
13. Uncluttered laboratories
14. Master shut-off switches for gas, water and electricity
15. Safety Rules and charts posted
16. Records kept on safety training and lab incidents
17. Emergency exit / escape plan posted
18. Live animals and students are protected from one another

General Lab Safety Recommendations

1. Always perform an experiment or demonstration prior to allowing students to replicate the activity. Look for possible hazards. Alert students to potential dangers.
2. Safety instructions should be given orally and be posted each time an experiment is begun.
3. Constant surveillance and supervision of student activities are essential.
4. Never eat or drink in the laboratory or from laboratory equipment. Keep personal items off the lab tables.
5. Never use mouth suction in filling pipettes with chemical reagents. Use a suction bulb.
6. Never force glass tubing into rubber stoppers.
7. A bucket of 90% sand and 10% vermiculite, or kitty litter (dried bentonite particles) should be kept in all rooms in which chemicals are either handled or stored. The bucket must be properly labeled and have a lid that prevents other debris from contaminating the contents.
8. Smoke, carbon monoxide, and heat detectors are recommended in every laboratory. Units should be placed in the laboratory and related areas (storerooms, preparation rooms, closets, and offices).
9. Use heat-safety items such as safety tongs, mittens, aprons, and rubber gloves for both cryogenic and very hot materials.
10. A positive student attitude toward safety is imperative. Students should not fear doing experiments, using reagents, or equipment, but should respect them for potential hazards. Students should read the lab materials in advance, noting all cautions (written and oral).
11. Teachers must set good safety examples when conducting demonstrations and experiments. They should model good lab safety techniques such as wearing aprons and goggles.
12. Rough play or mischief should not be permitted in science classrooms or labs.
13. Never assume that an experiment is free from safety hazards just because it is in print.
14. Closed-toed shoes are required for labs involving liquids, heated or heavy items that may injure the feet.
15. Confine long hair and loose clothing. Laboratory aprons should be worn.
16. Students should avoid transferring chemicals they have handled to their faces.
17. Never conduct experiments in the laboratory alone or perform unauthorized experiments.
18. Use safety shields or screens whenever there is potential danger that an explosion or implosion of an apparatus might occur.
19. All persons engaged in supervising, or observing science activities involving potential hazards to the eye must wear proper eye protection devices.

20. Make certain all hot plates and burners are turned off when leaving the laboratory.
21. School staff should conduct frequent inspection of the laboratory's electrical, gas, and water systems.
22. Install ground fault circuit interrupters at all electrical outlets in science laboratories.
23. A single shut-off for gas, electricity, and water should be installed in the science laboratory. It is especially important that schools in the earthquake zones have such a switch.
24. MSDS sheets must be maintained on all school chemicals. Schools should maintain an inventory of all science equipment.
25. Laboratories should contain safety equipment appropriate to their use, such as emergency shower, eye-wash station (15 minutes of potable water that operates hands free), fume hood, protective aprons, fire blankets, fire extinguisher, and safety goggles for all students and teacher(s).
26. Protective (rubber or latex) gloves should be provided when students dissect laboratory specimens.
27. New laboratories should have two unobstructed exits. Consider adding another to old labs if only one exit exists.
28. There should be frequent laboratory inspections, and school staff should conduct an annual, verified safety check of each laboratory.
29. Give consideration to the National Science Teachers Association's recommendation to limit science classes to 24 students or less for safety.
30. All work surfaces and equipment in the chemical or biological laboratory should be thoroughly cleaned after each use.
31. Students should properly note odors or fumes with a wafting motion of the hand.
32. Chemistry laboratories should be equipped with functional fume hoods. Fume hoods should be available for activities involving flammable and / or toxic substances.
33. The several chemical authorities believe that contact lenses do not pose additional hazards to the wearer and that contact lenses are allowed when appropriate eye and face protection are used. The wearing of contact lenses in the science laboratory has been a concern because of the possibility of chemicals becoming trapped between the lenses and the eye in the event of a chemical splash. Check with your state science supervisor for your state's recommendation.
34. All laboratory animals should be protected and treated humanely.
35. Students should understand that many plants, both domestic and wild, have poisonous parts and should be handled with care.

Criteria for scheduling special needs students into laboratory classes should be established by a team of counselors, science teachers, special education teachers and school administrators. Aides or special equipment should be made available to the science teacher.

Source: The Council of State Science Supervisors.

NATIONAL ASSOCIATION OF BIOLOGY TEACHERS POSITION STATEMENTS

THE ROLE OF LABORATORY AND FIELD INSTRUCTION IN BIOLOGY EDUCATION

Philosophy

The study of biology provides students with opportunities to develop an understanding of our living world. Biology is the study of life and its evolution; of organisms and their structures, functions, processes, and interactions with each other and with their environments.

Scientific inquiry is the primary process by which scientific knowledge is gained. It involves the basic skills of questioning, prediction, qualitative and quantitative observation, classification, inference, communication and, additionally, integrated skills such as identifying and controlling for variables, generating procedures, planning strategies for testing hypotheses and answering questions, and for collecting and interpreting appropriate data. The knowledge of biology includes scientific data, concepts, hypotheses, theories, methodology, use of instruments, and conceptual themes.

Biologists recognize that knowledge based upon experimental results and accurate observations is gained through a variety of experiences, including the pursuit of cause and effect relationships. Thus, the role of the laboratory and field learning becomes a key component in understanding biology. Laboratory activities and inquiry provide students with opportunities to observe, sample, experience, and experiment with scientific phenomena in their quest for knowledge of living things.

The most effective vehicle by which the process of inquiry can be learned appears to be a laboratory or field setting where the student experiences, firsthand, the inquiry process. Laboratory and field studies have also been demonstrated to be effective means for comprehension, understanding and application of biological knowledge. Thus, study in a laboratory and / or field setting is an integral and essential part of a biology course. The following are recommendations regarding teaching strategies, physical resources, and curriculum development that will enhance the study of biology and improve the quality of biology instruction in our schools.

A Definition of a Laboratory Environment

In a laboratory or field learning environment, students work individually or in small groups on a question, problem or hypothesis; they use the processes and materials of science to construct their own explanation of biological phenomena. They will often observe, collect data and interpret data of life processes, living organisms, and / or simulations of living phenomena. The distinction between laboratory or field learning and traditional classroom learning is that activities are student-centered, with students actively engaged in hands-on, minds-on activities using laboratory or field materials and techniques.

Teaching Strategies

1. Direct experience. The laboratory and field components of biology instruction should provide experiences for direct student involvement which emphasize the above process skills and the tentative nature of science; knowledge is gained by observing cause and effect relationships among variables. It is essential for students to be provided opportunities for questioning, hypothesis formulation, experimental design, and data analysis. Also, students must be given opportunities to pursue procedural options rather than simply follow recipes. They must be provided opportunities to design and carry out their own experiments. While computer-assisted instruction and video materials contribute to biology learning, they should not be used to substitute for direct observation of living organisms or for experiments in which students learn cause and effect relationships between and among biological phenomena. School administrators need to recognize the expenses related to offering experiential, hands-on laboratory courses and provide adequate funding.

2. Instructional time. Biology courses need to have an integrated laboratory and field experience component in which students spend at least one-half of their total instructional time. Provisions for this amount of laboratory and fieldwork should be made in the curriculum of a biology course.

3. Instruction. While we respect the professional teacher's expertise in determining appropriate lessons and sequence of instruction, most of the student's biology education should begin with experiences in a laboratory or field setting. These experiences allow students to construct new knowledge for themselves and can provide the basis for the introduction of more abstract concepts presented in lectures, discussions or reading assignments.

4. Quality of instruction. Biology laboratory instruction should provide students with frequent opportunities to observe and experiment with living materials, as opposed to nonliving specimens or artifacts. Every student should have direct, hands-on experiences with the laboratory materials.

5. Teacher education. Teachers of secondary biology laboratory instruction are expected to have a major in the biological sciences and should have formal training in laboratory and field teaching strategies (see NABT Biology Teaching Standards). Instruction in biology laboratory and field study should be an integral part of pre-service and in-service teacher training. Ideally, pre-service teachers should do "lab and/or field science" under the guidance of a research scientist. One cannot truly teach or truly understand process science until he/she has science research experience. Educational institutions should encourage their life science teachers to grow professionally by attending summer institutes and professional meetings, as well as taking graduate courses in biology and biology education. Administrators should seek educational funding from available sources to support and compensate teachers in their efforts to update their current knowledge and to network with colleagues from different schools.

Facilities, Classroom Environment, and Teacher Load

1. Laboratory space. Adequate and appropriate facilities, materials and equipment need to be provided for students to learn biology in a laboratory and field setting. This is essential at all levels of biology instruction, including elementary school, middle school, high school, college and university. The laboratory space should be (a) available to the teacher during the planning and preparation period and (b) available to students for special projects, makeup laboratories, etc. outside their regular class hours. Each student should have his/her own laboratory work space.

2. Facility. The laboratory classroom should be equipped with work areas that have sinks, a water supply, and natural gas and electrical outlets available in sufficient quantity to support a laboratory/field-oriented biology course. Adequate ventilation, fume hoods, and reference materials are also necessary, and the laboratory size must allow all students to participate in real hands-on activities. There should be adequate space for storage of materials and secure areas for storage of solvents, reactants, or potentially hazardous or dangerous chemicals as per guidelines set by the American Chemical Society. Facilities structure and configuration should be inspected for updating every 10 years. There should also be a space (living materials center) dedicated to growing living specimens for study in biology classes.

3. Materials budget. The National Science Education Standards address the need for making resources available; allocation of funds must provide opportunities to learn in an inquiry-based curriculum. To that end, biology teachers must be provided with an annual budget sufficient to purchase both expendable material and equipment necessary to conduct inquiry-based learning.

4. Safety. Approved guidelines for the safe use, maintenance and storage of laboratory materials must be followed. This includes classroom instruction on safety and emergency procedures. NABT Guidelines for the Use of Live Animals, Working with DNA & Bacteria in Precollege Science Classrooms (or safety guidelines from organizations such as NIH, the American Chemical Society, etc.) and appropriate safety procedures for using plants and microorganisms should be followed. Each laboratory room must be equipped with safety goggles and laboratory aprons for all students, a first-aid kit, a fire blanket, and an all-purpose fire extinguisher. A safety shower and eyewash station should be available within a 20-second walk. Safety goggles, if used by different students, must be

disinfected with an alcohol swab wipe before being assigned to another user. The state Texas Education Agency guidelines for safety procedures should be rigorously followed.

5. Class size and supervision. A student-to-instructor ratio in the biology laboratory classroom must permit safe and effective instruction. Class size should be determined by the physical design of the classroom and should not exceed 24 students in a laboratory setting for any reason when students are assigned to a single teacher.

6. Teaching load. Due to the extra time and preparation that laboratory courses require, life science teachers should not be assigned more than five classes per semester. Since each laboratory requires a different repertoire of organisms, equipment, materials, supplies, solutions and planning, and also demands lessons plans and grading time, teaching load should not be more than two process-oriented science course preparations and have no more than 24 students assigned to each class. Teachers should have their own science classrooms and have access to those classrooms during their preparation times. Time must also be allowed within the teaching day for the setup and dismantling of laboratory preparations. Where possible, student or adult laboratory assistance should be provided, and in high school, we strongly recommend that a laboratory manager (or instructional aid) be hired to assist in preparation, setup, and dismantling of laboratory materials for experiential learning lessons.

Curriculum Development

Most laboratory and field activities used in the schools are prepared commercially; NABT urges these other developers to provide instructional activities that meet the above guidelines. The most productive curricula will be those with an abundance of active learning, such as laboratory and field investigations, upon which the teacher can base further indirect learning experiences, such as lectures, discussions and assignments.

Adopted by the Board of Directors, September 1990. Revised 1994. National Association of Biology Teachers.

THE USE OF HUMAN BODY FLUIDS AND TISSUE PRODUCTS IN BIOLOGY TEACHING

Laboratory activities using human body samples can be important components of biology teaching. The chance that human body samples may transmit serious diseases raises concerns about their use in biology teaching. The National Association of Biology Teachers supports the use of human body samples for teaching biology only if teachers ensure safe conditions that prevent the spread of disease. Teachers should use substitute activities or materials if they cannot guarantee the safe handling, storage, cleanup and disposal of human body samples. Teachers wishing to use human body samples should weigh the potential risks of using these materials against the educational outcomes gained. In addition, teachers should remain sensitive to students desiring not to handle certain body samples.

Human body samples used in high school and college biology pedagogy include blood, cheek cells, feces, mucus, saliva, semen, and urine. All of these should be treated as biological hazards having the potential to spread communicable disease. These samples are generally used in the following acceptable capacities:

Blood

Blood is used for blood typing studies in general biology and anatomy and physiology class activities. It is also used for microscopic and physiological analysis in anatomy and physiology class activities and immunology laboratory sessions.

Cheek Cells

Cheek cells are regularly used in introductory biology classes for microscopic analysis.

Feces

Feces are rarely used in biology instruction. Materials containing feces are sometimes used in microbiology and parasitology class activities.

Mucus

Cultures obtained from respiratory mucus are used in microbiology classes.

Saliva

The enzymes present in saliva are used in general biology class activities. Cells collected with saliva are used for microscopic analysis in general biology and anatomy and physiology class activities. Microbiology class activities use saliva for obtaining oral microorganisms from tooth tartar.

Semen

Samples of semen are used for microscopic analysis in general biology and anatomy and physiology activities.

Urine

Urinalysis in anatomy and physiology classes requires freshly collected urine. Some microbiology laboratory activities entail culturing microorganisms from urine.

Recommendations

NABT offers the following recommendations for teachers wishing to conduct activities requiring the use of human body samples:

Use human body samples only if you know the samples are free of disease. Do not use any samples of unknown origin. It is best to avoid using student samples collected at home or off campus.

Human body samples should only be used if all students, teachers, and other people coming in contact with the samples are following the Universal Precautions for handling human body samples. Proper collection, storage, and disposal methods must be followed. Guidelines for handling human body samples are available from hospitals, clinical laboratories, and public health agencies. They are published in the Code of Federal Register available through government documents libraries.

Whenever possible, try to substitute comparable but safer alternatives for human body samples. Many materials available for purchase mimic the properties of blood, saliva, and urine. In addition, The American Biology Teacher and other journals provide information about do-it-yourself fluid substitutes. Disease-free animal samples of blood, feces, and semen can be purchased for microscopic analysis from biological and chemical supply companies. Pure cultures of microorganisms resembling those found in human body samples can also be purchased.

Suggested Safety Precautions to Follow with Human Body Fluids and Tissue Products

Teachers wishing to use human body samples should consider the following minimum precautions before conducting laboratory activities:

Handling

Students should not be allowed to collect samples without supervision or advice of the teacher. Samples should be collected, handled, and transferred using proper safety apparel:

- Plastic or latex gloves
- Safety glasses or goggles
- A lab coat or an apron.

Students should always wash their hands after any laboratory activity using any type of human body sample.

Storage

All samples must be used and temporarily stored in labeled, leakproof containers during classroom use. Labeling should include the type of sample, the source of the sample, and the current date. Samples kept for long-term storage must be kept refrigerated in clearly labeled leakproof containers. Again, labeling should include sample type, sample source, and collection date. Samples must never be stored near food or in refrigerators and freezers being used for food storage. Refrigerators used to store human body samples must be labeled with signs that indicate the presence of biohazardous materials or human body samples.

Cleanup and Disposal

In most areas, human body samples may be disposed of in public sewers as long as the samples are free of parasites and highly contagious pathogens. Check with city or other local agencies before doing so. Samples having parasites and highly contagious pathogens must be sterilized, as described below, before disposal. Laboratory materials contaminated with human body samples must be sterilized before reuse or disposal. Reusable materials, like glassware and microscope slides, can be sterilized using an autoclave (pressurized steam heat at 121° C for 20 minutes) or by soaking in a 10% solution (10 mL of bleach added to 90 mL of tap water) of household strength bleach (household bleach is 5% hypochlorite) for 30 minutes. Bleaching should be followed by a warm soap water wash.

Contaminated lancets, needles, or broken glass must be sterilized using an autoclave or bleach treatment before disposal. They must then be discarded in a red "Sharps Container" marked biohazardous materials. Sharps Containers are available from biological and medical supply companies. Lancets and needles must never be reused. Spills must be decontaminated immediately using bleach that has soaked the area for at least 10 minutes. Contaminated broken glass must be handled with cut-proof gloves or a hand broom. All work surfaces should be wiped down with the 10% bleach solution after completion of the activity.

THE USE OF ANIMALS IN BIOLOGY EDUCATION

The National Association of Biology Teachers (NABT) believes that the study of organisms, including non-human animals, is essential to the understanding of life on Earth. NABT recommends the prudent and responsible use of animals in the life science classroom. NABT believes that biology teachers should foster a respect for life. Biology teachers also should teach about the interrelationship and interdependency of all things.

Classroom experiences that involve non-human animals range from observation to dissection. NABT supports these experiences so long as they are conducted within the long established guidelines of proper care and use of animals, as developed by the scientific and educational community.

As with any instructional activity, the use of non-human animals in the biology classroom must have sound educational objectives. Any use of animals, whether for observation or dissection, must convey substantive knowledge of biology. NABT believes that biology teachers are in the best position to make this determination for their students.

NABT acknowledges that no alternative can substitute for the actual experience of dissection or other use of animals and urges teachers to be aware of the limitations of alternatives. When the teacher determines that the most effective means to meet the objectives of the class do not require dissection, NABT accepts the use of alternatives to dissection including models and the various forms of multi-media. The Association encourages teachers to be sensitive to substantive student objections to dissection and to consider providing appropriate lessons for those students where necessary.

Adopted by the Board of Directors in October 1995.
This policy supersedes and replaces all previous NABT statements regarding animals in biology education.

NATIONAL SCIENCE TEACHERS ASSOCIATION
POSITION STATEMENTS

GUIDELINES FOR RESPONSIBLE USE OF ANIMALS IN THE CLASSROOM

These guidelines are recommended by the National Science Teachers Association for use by science educators and students. They apply, in particular, to the use of non-human animals in instructional activities planned and / or supervised by teachers who teach science at the pre-college level.

Observation and experimentation with living organisms give students unique perspectives of life processes that are not provided by other modes of instruction. Studying animals in the classroom enables students to develop skills of observation and comparison, a sense of stewardship, and an appreciation for the unity, interrelationships, and complexity of life. This study, however, requires appropriate, humane care of the organism. Teachers are expected to be knowledgeable about the proper care of organisms under study and the safety of their students. These are the guidelines recommended by NSTA concerning the responsible use of animals in a school classroom laboratory:

- Acquisition and care of animals must be appropriate to the species.
- Student classwork and science projects involving animals must be under the supervision of a science teacher or other trained professional.
- Teachers sponsoring or supervising the use of animals in instructional activities—including acquisition, care, and disposition—will adhere to local, state, and national laws, policies, and regulations regarding the organisms.
- Teachers must instruct students on safety precautions for handling live animals or animal specimens.
- Plans for the future care or disposition of animals at the conclusion of the study must be developed and implemented.
- Laboratory and dissection activities must be conducted with consideration and appreciation for the organism.
- Laboratory and dissection activities must be conducted in a clean and organized workspace with care and laboratory precision.
- Laboratory and dissection activities must be based on carefully planned objectives.
- Laboratory and dissection objectives must be appropriate to the maturity level of the student.
- Student views or beliefs sensitive to dissection must be considered; the teacher will respond appropriately.

Adopted by the NSTA Board of Directors in July 1991. © 1991 National Science Teachers Association.

ELEMENTARY SCHOOL SCIENCE

The National Science Teachers Association supports the notion that investigative science must be a basic in the daily curriculum of every elementary school child at every grade level.

In the last decade, numerous reports have been published calling for reform in education. Each report has highlighted the importance of early experiences in science so that children develop problem-solving skills that empower them to participate in an increasingly scientific and technological world.

1. The elementary science program must provide opportunities for children to develop understandings and skills necessary to function productively as problem-solvers in a scientific and technological world.
2. Elementary school children learn science best when:
    - they are involved in first-hand exploration and investigation and inquiry / process skills are nurtured.
    - instruction builds directly on the child's conceptual framework.

- content is organized on the basis of broad conceptual themes common to all science disciplines.
- mathematics and communication skills are an integral part of science instruction.

3. The learning environment for elementary science must foster positive attitudes towards self and society, as well as science.
4. Elementary school children value science best when
   - a variety of presentation modes are used to accommodate different learning styles, and students are given opportunities to interact and share ideas with their peers;
   - the scientific contributions of individuals from all ethnic origins are recognized and valued;
   - other subject areas are infused into science; and
   - inquiry skills and positive attitudes are modeled by the teacher and others involved in the education process.
5. Teacher preparation and professional development must enable the teacher to implement science as a basic component of the elementary school curriculum.
6. Teacher preparation and professional development must provide for:
   - experiences that will enable teachers to use hands-on activities to promote skill development, selecting content and methods appropriate for their students, and for design of classroom environments that promote positive attitudes toward science and technology.
   - continuing science inservice programs based on current educational research that encompass content, skills, techniques, and useful materials.
   - participation in workshops, conferences, and meetings sponsored by local, state, and national agencies.
7. The school administrators must be advocates for elementary science.
8. Administrators must provide instructional leadership by:
   - building consensus for an elementary science program that reflects these standards.
   - implementing and monitoring the progress of the science program.
9. Administrators must provide support systems by:
   - supplying appropriate materials, equipment, and space.
   - recognizing exemplary elementary science teaching.
   - encouraging special science events.
10. The instructional implementation and support system for elementary school science must include the combined efforts of all aspects of the community: parents, educators, businesses, and other organizations.
11. The community must be advocates for elementary school science by:
    - participating in ongoing planning, assessment, and funding of elementary science programs.
    - promoting informal science learning experiences.
12. Assessment must be an essential component of an elementary science program.
13. Assessment must be aligned with:
    - what is of value, i.e., the problem-solving model of instruction: concept application, inquiry, and process skills.
    - the curricular objectives and instructional mode.
    - the purpose for which it was intended: grading, diagnosis, student and / or parent feedback, or program evaluation.
14. Elementary school science instruction must reflect the application and implementation of educational research.
15. Elementary school science programs are improved when:
    - teachers keep abreast of appropriate science education research.
    - educational research becomes the premise for change or innovation in elementary school science, and teachers participate in action research in elementary science.

Adopted by the NSTA Board of Directors in January 1990. Modified by the NSTA Task Force on Elementary School Science Scope and Sequence, in March 1991. 1991 National Science Teachers Association.

LABORATORY SCIENCE

The inquisitive spirit of science is assimilated by students who participate in meaningful laboratory activities. The laboratory is a vital environment in which science is experienced. It may be a specially equipped room, a self-contained classroom, a field site, or a larger place, such as the community in which science experiments are conducted. Laboratory experience is so integral to the nature of science that it must be included in every science program for every student. Hands-on science activities can include individual, small, and large group experiences.

Problem-solving abilities are refined in the context of laboratory inquiry. Laboratory activities develop a wide variety of investigative, organizational, creative, and communicative skills. The laboratory provides an optimal setting for motivating students while they experience what science is.

Laboratory activities enhance student performance in the following domains:

- process skills: observing, measuring, manipulating physical objects
- analytical skills: reasoning, deduction, critical thinking
- communication skills: organizing information, writing
- conceptualization of scientific phenomena.

Since the laboratory experience is of critical importance in the process of enhancing students' cognitive and affective understanding of science, the National Science Teachers Association makes the following recommendations.

Preschool/Elementary School Level

- Preschool/Elementary science classes must include activity-based, hands-on experiences for all children. Activities should be selected that allow students to discover and construct science concepts; and, after the concept is labeled and developed, activities should allow for application of the concept to the real lives of students. Provisions also need to be included for inquiry activities in which students manipulate one variable while holding others constant and establish experimental and control groups.
- Children at all developmental levels benefit from science experiences. Appropriate hands-on experiences must be provided for children with special needs who are unable to participate in classroom activities. A minimum of 60 percent of the science instruction time should be devoted to hands-on activities, the type of activities where children are manipulating, observing, exploring, and thinking about science using concrete materials. Reading about science, computer programs, and teacher demonstrations are valuable, but should not be substituted for hands-on experiences.
- Evaluation and assessment of student performance must reflect hands-on experience. The full range of student experience in science should be measured by the testing program.
- Hands-on activities should be revised and adapted to meet student needs and to enhance curricular goals and objectives. There should be ongoing dissemination of elementary science education research results and information about supplementary science curricula.
- Hands-on activities must be supported with a yearly building science budget, including a petty cash fund for immediate materials purchase. Enough supplies, e.g. magnets, cells, hand lenses, etc., should be purchased, permitting each child to have hands-on experiences. Many science activities can also be taught using easily accessible, free and inexpensive materials.
- Reasonable and prudent safety precautions should always be taken when teachers and students are interacting with manipulative materials. (See NSTA publication: Safety in the Elementary Science Classroom)
- Preschool/Elementary science should be taught in a classroom with sufficient workspace to include flat moveable desks or tables/chairs, equipment, and hands-on materials. Consideration should be made for purchase and storage of materials with convenient accessibility to water and electricity. Computers, software, and other electronic tools should be available for children's use as an integral part of science activities.
- Parents, community resource people, and members of parent/teacher organizations should be enlisted to assist preschool/elementary teachers with science activities and experiences. For

example, these individuals could act in the role of field trip chaperones, science fair assistants, material collectors, or science classroom aides.
- The number of children assigned to each class should not exceed 24. Teachers and children must have immediate access to each other in order to provide a safe and effective learning environment.

Middle School Level

- All middle level science courses must offer laboratory experiences for all students. Students at all developmental levels benefit from the laboratory experience.
- A minimum of 80 percent of the science instruction time should be spent on laboratory-related experience. This time includes pre-lab instruction in concepts relevant to the laboratory, hands-on activities by the students, and a post-lab period involving communication and analysis.

Computer simulations and teacher demonstrations are valuable but should not be substitutions for laboratory activities.

Investigations should be relevant to contemporary social issues in science and technology. (Note the NSTA Position Paper on Science-Technology-Society.) In those schools where team teaching is practiced, science topics should be integrated with the other academic areas.

- Evaluation and assessment of student achievement in science should reflect the full range of student experiences, especially laboratory activities.
- Laboratory activities in science need to be subjected to continual professional review. A need exists for ongoing research to evaluate the merit of certain laboratory activities, especially some traditional verification labs. Laboratory activities should be screened for safety and new activities need to be developed. An emphasis must be placed on disseminating new information to teachers.
- An adequate budget for facilities, equipment, and supplies must be provided to support the laboratory activities. The budget needs to provide funds for the purchase of locally available materials, as needed, during the course of the school year.

Training in laboratory safety must be provided to the teacher. Necessary safety equipment, such as safety goggles, fire extinguishers, and eye washes, must be provided and maintained.

- Due to the nature of middle level science activities, teachers should not have to share a laboratory with other teachers. A combination science-laboratory room should be used by only one teacher. This room should have at least one resident computer.

In schools where students are grouped together in interdisciplinary teams, it is more important for science to be taught in a well-equipped science laboratory than to have all students in a team in close proximity to one another learning science in a regular classroom.

- A competent student laboratory assistant should be provided to assist with laboratory preparation. It is a valuable experience for the student and helps alleviate some of the teacher’s time spent setting up and cleaning up activities.
- The number of students assigned to each class should not exceed 24. The students and teacher must have immediate access to each other for there to be a safe and effective learning environment.

High School Level

- All high school science courses must offer laboratory experiences for all students. Experiences must be provided for students who are unable to participate in specific laboratory activities.
- A minimum of 40 percent of the science instruction time should be spent on laboratory-related activities. This time includes pre-lab instruction in concepts relevant to the laboratory, hands-on activities by the students, and a post-lab period involving communication and analysis. Computer simulations and teacher demonstrations are valuable but should not be substitutions for laboratory activities.

Investigations relevant to contemporary social issues in science and technology should be encouraged. (Note the NSTA Position Paper of Science-Technology-Society.)

- Evaluation and assessment of student performance must reflect the laboratory experience. The full range of student experience in science should be measured by the testing program.
- Laboratory activities in science need to be subjected to continual professional review. A need exists for ongoing research support for evaluating laboratory activities and their appropriate use at particular grade levels, for screening activities to ensure safety, and for developing new laboratory activities. Special emphasis must be placed on disseminating the results of this research to teachers.
- An adequate budget for facilities, equipment, supplies, and proper waste management must be provided to support the laboratory experiences. Equipment and facilities must be maintained and updated on a regular basis. Unique instructional supplies must be provided in sufficient quantity that students have a direct, hands-on experience. For some activities, funds for field experiences must also be included in the budget.
- Science should be taught in a space specifically dedicated to science classes with provisions for laboratory activities. A safe and well-equipped preparation and workspace for students and teacher must be provided. Adequate storage space for equipment and supplies, including a separate storage area for potentially dangerous materials, must be provided. Special considerations should be given to ensure laboratory safety for the teacher and the students. Accommodation must also be made for computers and other electronic equipment in order to provide easy access for students to use these devices as laboratory tools.
- A competent paraprofessional should be provided to assist with preparation for laboratory experiences, including set-up and clean up, maintaining community contacts, resources searching, and other supportive services.
- No more than two different preparations should be assigned to the teacher for any academic term. The development, implementation, and evaluation of effective laboratory activities require extensive time by the teacher.
- The number of students assigned to each laboratory class should not exceed 24. The student must have immediate access to the teacher in order to provide a safe and effective learning environment.

Adopted by the NSTA Board of Directors in January 1990.

LIABILITY OF TEACHERS FOR LABORATORY SAFETY AND FIELD TRIPS

Laboratory investigations and field trips are essential to effective science instruction. Teachers should be encouraged to use these instructional techniques as physical on-site activity important to the development of knowledge, concepts, processes, skills, and scientific attitudes. Inherent in such physical activities is the potential for injury and possible resulting litigation. All such liability must be shared by both school districts and teachers, utilizing clearly defined safety procedures and a prudent insurance plan. The National Science Teachers Association recommends that school districts and teacher adhere to the following guidelines:

1. School districts should develop and implement safety procedures for laboratory investigations and field trips.
2. School districts should be responsible for the actions of their teachers and be supportive of the use of laboratory activities and field trips as teaching techniques.
3. School districts should look to NSTA for help in informing teachers about safety procedures and encouraging them to act responsibly in matters of safety and related liability.
4. School districts should provide liability and tort insurance for their teachers.
5. Teachers, acting as agents of the school districts, should utilize laboratory investigations and field trips as instructional techniques.
6. Teachers should learn safe procedures for laboratory activities and field trips and follow them as a matter of policy.
7. Teachers should exercise reasonable judgement and supervision during laboratory activities and field trips.
8. Teachers should expect to be held liable if they fail to follow district policy and litigation ensues.
9. School districts and teachers should share the responsibility of establishing safety standards and seeing that they are adhered to.

Adopted by the NSTA Board of Directors in July 1985.

Appendix C

Agencies and Associations

State Agencies and Associations

Alternative Fuels Council
1700 North Congress Avenue
P.O. Box 13047
Austin, Texas 78711

Animal Health Commission
2105 Kramer Lane
P.O. Box 12966
Austin, Texas 78711-2966

Environmental Protection Agency
Region VI
1201 Elm Street
Dallas, Texas 75270

General Land Office
1700 North Congress Avenue
Austin, Texas 78701

Hazard Communication Branch
Texas Department of Health
1100 West 49th Street
Austin, Texas 78756-7111

Health and Human Services
4900 North Lamar
Austin, Texas 78711-3247

National Institute of Occupational Safety
and Health
1200 Main Tower Building
Dallas, Texas 75202

Occupational Safety and Health Administration
Region VI
525 Griffin Square Building
Dallas, Texas 75202

Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Railroad Commission of Texas
1701 North Congress Avenue
Austin, Texas 78711

State Fire Marshall's Office
P.O. Box 149221
Austin, Texas 78714-9221

State Law Library
205 West 14th Street
Austin, Texas 78711-2367

Texas Cancer Council
211 East 7th Street
Suite 710
P.O. Box 12097
Austin, Texas 78711-2097

Texas Commission on Alcohol and Drug Abuse
9001 North Interstate 35
Suite 105
Austin, Texas 78753-5233

Texas Commission for the Blind
4800 North Lamar
Austin, Texas 78756

Texas Commission for the Deaf
and Hard of Hearing
4800 North Lamar
Suite 300
P.O. Box 12904
Austin, Texas 78711

Texas Commission on Fire Protection
12675 Research Boulevard
P.O. Box 2286
Austin, Texas 78768-2286

Texas Department of Licensing & Regulations
920 Colorado
Austin, Texas 78701

Texas Education Agency
1701 North Congress Avenue
Austin, Texas 78701

Texas Ethics Commission
201 East 14th Street
P.O. Box 12070
Austin, Texas 78711-2070

Texas Department of Health
1100 West 49th Street
Austin, Texas 78756-7111

Texas Natural Resource Conservation
Commission
12100 Park 35 Circle
Austin, Texas 78711-3087

Texas Structural Pest Control Board
1106 Clayton Lane
Suite 201
Austin, Texas 78766

Texas Water Development Board
1700 North Congress Avenue
Austin, Texas 78711-3231

Appendix D

Safety Forms

Accident Report
(Sample)

School______________________________Date_____________Time_______

Student's Full Name____

Student's Address____

Phone___________________Age_________Sex_________Grade__________

- ☐ Abrasion
- ☐ Burn
- ☐ Puncture or Cut
- ☐ Ingested Material
- ☐ Sprain
- ☐ Chemical Contact

- ☐ Eye
- ☐ Arm
- ☐ Leg
- ☐ Torso
- ☐ Internal

Description of the Accident:

- Location where the accident occurred___________________________
- List of tools, equipment, or chemicals involved:_____________________
- First aid treatment administered_______________________________
- Who administered the first aid?________________________________
- Time Parent Notified ___________
- Student sent: Home _____ Doctor _____ Hospital _________________________

Name of Hospital

______________________ ______________________ ______________________

Principal **Teacher** **Nurse**

EMERGENCY MEDICAL INFORMATION FORM
(SAMPLE)

Name of student ______________________________________ Date ____________

Date of birth ____________________ Age _____________

Home address ____

____

Name of parents or guardian ____

Home phone _____________________ Business phone ______________________

Alternate emergency contact ____

Phone number _____________________

Family doctor ____

Office phone _____________________ Office address _______________________

Please describe any health related problems, allergies, or other physical conditions that may limit full participation in the field trip activities.

Please list any medications that the student is required to take during the field trip.

Name: (1)__________________ (2)__________________ (3)__________________

Dosage: (1)__________________ (2)__________________ (3)__________________

In case of an emergency, I hereby authorize the physician selected by school personnel to provide the necessary medical treatment for my child.

Signature __________________________________ Date _____________________

Print Name _________________________________

THIS FORM MUST BE RETURNED BY ______________________

MATERIAL SAFETY DATA SHEET

(SAMPLE)

MATERIAL IDENTITY: ETHYL ALCOHOL

- CAS Number: 64-17-5
- Date Prepared: October 28, 2000
- Manufacturer: Jane & John Doe Chemical Company
- Address: Hazardland, Texas 77777
- Information on Chemical: 1-800-111-0000
- Emergency Line: 1-800-111-0001

SECTION I: MATERIAL IDENTIFICATION AND INFORMATION

COMPONENTS	PERCENTAGE	TLV
Ethyl Alcohol (ethanol)	92.4-100	1000 ppm
Water	0-7.6	N / A

SECTION II: PHYSICAL AND CHEMICAL CHARACTERISTICS

- Boiling point: 172°F (78°C)
- Vapor Pressure (mm Hg & temperature): 100 mm at 27°C
- Vapor Density (Air = 1): 1.59
- Solubility in water (Completely miscible appearance and odor): Alcohol is clear and has an alcohol odor. Appearance and odor can be modified by non-hazardous components of the mixture.
- Specific Gravity (Water = 1): 0.785 (60°F)
- Melting Point: -130°C
- Evaporation Rate (n-Butyl Acetate = 1): 2.7
- Water Reactive: None

SECTION III: FIRE AND EXPLOSION HAZARD DATA

- Flash Point and Method Used: 55°F c.c.
- Auto-Ignition Temperature: 793°F
- Flammability Limits in Air (% by Volume)
    - ◊ LEL: 3.28%
    - ◊ UEL: 19.00%
- Extinguisher Media (carbon dioxide); alcohol foam Special Fire Fighting Procedures: Use ABC chemical fire extinguisher.
- Unusual Fire & Explosion Hazards: Explosion hazard is moderate when exposed to flame.

SECTION IV: REACTIVITY HAZARD DATA

- Stability: Stable
    - ◊ Conditions to Avoid: Keep away from heat or ignition sources.
- Incompatibility (Materials to avoid): Oxidizing agents such as acetyl chloride, nitric acid & hydrogen peroxide.
- Hazardous Decomposition Products: Carbon dioxide during combustion.
- Hazardous Polymerization: Does not occur.

SECTION V: HEALTH HAZARD INFORMATION

- Primary Route of Entry:
  - ◊ Inhalation
  - ◊ Ingestion
- Carcinogen Listed: No carcinogens present
- Health Hazards
  - ◊ Acute: Irritation of eyes, nose and throat; headache
  - ◊ Chronic: Drowsiness and lassitude; loss of appetite and inability to concentrate
  - ◊ Medical Conditions Generally Aggravated by Exposure: Unknown
- Emergency First Aid Procedures: Seek medical assistance for further treatment
  - ◊ Eye Contact: Irrigate eyes with water for 15 minutes
  - ◊ Skin Contact: Wash with water
  - ◊ Inhalation: If excessive, notify authorities and seek medical assistance
  - ◊ Ingestion: Gastric lavage, followed by saline catharsis, seek medical care

SECTION VI: CONTROL AND PROTECTIVE MEASURES

- Respiratory Protection: Activated Carbon Respirator
- Protective Gloves: Not required unless in contact with skin
- Eye Protection: Chemical Splash Goggles
- Ventilation to be Used: Local exhaust sufficient
- Other Protective Clothing or Equipment: If exposure limit is exceeded, use NIOSH approved respirator

SECTION VII: HANDLING, DISPOSAL, AND SPILL PROCEDURES

- If material is spilled or released:
  - ◊ Keep away from ignition sources
  - ◊ Ventilate area
  - ◊ Large quantities may be collected and incinerated
  - ◊ Consult with local and state regulations

- Precautions when handling and storing material
  - ◊ Keep containers closed
  - ◊ Ground containers when emptying

NOTE: This sample is for educational use only. There is no guarantee of the reliability of the data on this sample, therefore, we are not liable for damages relating to the use of the information on this sample MSDS form.

Parent Letter for Field Trips
(Sample)

Date

Dear Parent,

On (date of trip), (science teacher's) science classes will be taking a one day field trip to (location of site) to (major objective of trip). Students have been studying (list current topics students have been studying in class so that learning in class connects with the learning on the trip). Students will be observing (list interesting events and features that the students will be seeing and doing on the trip).

We will be leaving at (time of departure) from (where parents are to bring students) and returning at approximately (time of return). Students will be traveling to the site by (list means of transportation). They will be supervised by (list all adult supervisors). We are pleased to have (list an administrator accompanying the students and a parent whose expertise will be used as a resource on the trip) join us.

Students should arrive at (site name) at (approximate time of arrival) and be led by (name of a professional or representative of the site). We should complete the major portion of our work at 12:00 and will have lunch at the site. During lunch (parent expert) will make a presentation on (related information to the objective of the trip) to the classes. Departure will be at (approximate time of departure).

In an emergency, you can reach your child at (list the site and telephone number if possible). Identify our group as (how the classes will be identified at the site). A list of the students will be given to the office.

Students should wear (list the types of appropriate clothing students should wear). Students will need to bring a lunch (if needed) and a canned drink. Ice chests will be available to keep the food and drinks cold.

Attached to this letter is a Permission Form for students to attend the field trip and a Medical Information Form. Please fill these out, sign, and return them to (teacher) by (deadline for returning the signed form).

We are all very excited about the trip and the opportunity to see firsthand what we have been learning in class. If you have other questions about the field trip please do not hesitate to call me. I can be reached at (business number) during my planning period from (times you can be reached).

Sincerely,

(teacher's signature)

Permission Form
(Sample)

(date)

I have read the information concerning (teacher's name) (classes going) field trip to (name of the site) on (date of trip).

☐ I give permission

☐ I do not give permission

for ______________________________ to participate in the activity.
(student's name)

I understand that students and sponsors will be traveling by (kind of transportation) and leaving at (time of departure). I will be at the school at (approximate time of return) to meet the returning students at (location at school) of the school.

____
Parent (print name)

____
Parent Signature

____
Date

PLEASE RETURN THIS PERMISSION FORM NO LATER THAN (date) TO:
(teacher's name)
(school name)

Science Laboratory Safety Contract
(Sample)

- I will act responsibly at all times in the laboratory.
- I will follow all instructions about laboratory procedures given by the teacher.
- I will keep my area clean in the laboratory.
- I will wear my safety goggles at all times in the laboratory and protective clothing when necessary.
- I know where the fire extinguisher is located in the laboratory and have been trained on its use.
- I will immediately notify the teacher of any emergency.
- I know who to contact for help in an emergency.
- I will tie back long hair, remove jewelry, and wear shoes with closed ends (toes and heels) while in the laboratory.
- I will never work alone in the laboratory.
- I will not take chemicals or equipment out of the laboratory without permission from the teacher.
- I will never eat or drink in the laboratory unless instructed to do so by the teacher.
- I will only handle living organisms or preserved specimens when authorized by the teacher.
- I will not enter or work in the storage room unless supervised by a teacher.

This contract is to be kept by the student.

Students should sign in the appropriate space below and return the bottom portion to the teacher.

— —

I, ______________________________ have read each of the statements in the Science Laboratory Safety Contract and understand these safety rules. I agree to abide by the safety regulations and any additional written or verbal instructions provided by the school district or my teacher.

______________________________ ______________

Student Signature Date

______________________________ ______________

Parent Signature Date

APPENDIX E

CHECKLISTS AND GUIDES

Checklists
- A Checklist for Science Field Investigations
- Science Facility Safety Checklist

Guides
- Microscale Chemistry Guide
- A Guide to Common Poisonous Plants

A Checklist for Science Field Investigations

General Preparations

- [ ] Has a representative from the site granted permission?
- [ ] Is the site accessible for physically challenged students?
- [ ] Has a date been established?
- [ ] Has an alternate date been established?
- [ ] Have sponsors been selected?
- [ ] Has the sponsor / student ratio been established?
- [ ] Have students been checked for eligibility and a discipline record?
- [ ] Are there other requirements that the site requests?
- [ ] Are admission fees required?
- [ ] Are there bathrooms and an area to eat meals at the site?
- [ ] Is it necessary for students to bring their own food?
- [ ] Will copies of the Permission Forms and a student list be left with an administrator?
- [ ] Will the Emergency Medical Forms be taken with the teacher?
- [ ] Is there a portable phone for emergency use?
- [ ] Are emergency procedures in place for handling an injured student or sponsor?
- [ ] Has the school district approval been received?
- [ ] Is it necessary to have a meeting with parents?

Purpose of the Investigation

- [ ] Have objectives (TEKS) for the investigation been determined?
- [ ] Does the field investigation integrate with other subjects?
- [ ] Do students have sufficient background knowledge to be successful?
- [ ] Are activities planned so students will be actively engaged in learning?
- [ ] If students miss other classes, have their teachers been notified?

Transportation Requirements

- [ ] Will school district or public transportation be used?
- [ ] Is it necessary to raise money to pay for transportation?
- [ ] Has transportation information been given to parents?
- [ ] Are transportation permission field trip forms required by the school district?
- [ ] Is additional insurance required by the school district for field trips?
- [ ] Have arrangements been made if a vehicle breaks down?

Student Preparations

- [ ] Have students been notified of the type of clothing and shoes to wear?
- [ ] Has an information letter been sent to parents?
- [ ] Have medical forms, parental consent forms, etc. been given to students?
- [ ] Have deadlines for returning the forms been set?
- [ ] Have student behavior expectations been established?

MICROSCALE CHEMISTRY GUIDE

A pilot study, conducted by the Tyler Junior College chemistry department (the site of the South Central Regional Microscale Chemistry Center, SCRMCC), involved using a microscale technique in place of the macroscale procedure for determining boiling points which had been in their laboratory manual for a number of years. Due to the large number of students in the program (approximately 200 / semester), the original experiment, which called for 5 milliliters of both a known and unknown (to the student) organic liquid, generated almost 2 liters of organic waste. The semester that the microscale technique was used, less than 50 milliliters total of organic waste was collected. The experimental accuracy appeared to be at least as good if not better than the previous macroscale procedure.

To illustrate the advantages of using the microscale technique, a boiling point investigation is included paralleling the original macroscale procedure previously used with a microscale procedure.

EQUIPMENT REQUIREMENTS

Using Hot Plates as Heat Source		Using Bunsen Burners as Heat Source	
Equipment	**Quantity**	**Equipment**	**Quantity**
Thermometer	24	Iron ring	24
Ring stand	24	Wire gauze	24
Test tube clamp	24	Bunsen burner	24
Stirring rod	24	Rubber tubing (2’)	24
Capillary tube	24	Strikers	24
Hot plate	24		
Test tube	24		
Beaker	24	(these materials not needed if using hot plates)	

COMPARISON OF APPROXIMATE COST

Materials	Quantity	Cost	Materials	Quantity	Cost
16 x 150 mm test tube	24	$0.55	6 x 50 mm test tube	24	$0.04
400 mL beaker	24	$3.95	50 mL beaker	24	$3.03
	Subtotal	$90.00		Subtotal	$68.60

SAFETY ADVANTAGES

The microscale setup uses approximately 25 mL of water in the hot water bath where the macroscale requires approximately 250 mL of hot water. This reduces the danger of burns from hot water bath spills. Air quality is greatly improved because of the reduction in organic chemicals being vaporized. This should be important to the teacher who is exposed to chemicals during each laboratory period.

In addition, the time required to heat 25 mL to the correct temperature takes approximately 1 / 10 the time required to heat 250 mL of water to the same temperature.

Chemical Quantity and Cost Comparison

Macroscale Technique			Microscale Technique		
Materials	**Quantity**	**Cost**	**Materials**	**Quantity**	**Cost**
Acetone (known)	120 mL	$0.55	Acetone (known)	5.0 mL	$0.16
Methanol	25 mL	0.35	Methanol	1.0 mL	0.04
Isopropanol	25 mL	1.25	Isopropanol	1.0 mL	0.02
t-Butanol	25 mL	0.34	t-Butanol	1.0 mL	0.05
Ethanol	25 mL	1.00	Ethanol	1.0 mL	0.02
Acetone	25 mL	1.00	Acetone	1.0 mL	0.04
Total	245 mL	$8.94	Total	10 mL	$0.29

A Guide to Common Poisonous Plants

Common Name	Scientific Name	Poisonous Plant Part
Milkweed, Broadleaf	*Aesclepias latifolia*	sap and young shoots
Milkweed, Antelope Horn	*Aesclepias asperula*	sap and young shoots
Century Plant	*Agave* spp.	sap—any part of plant
Ragweed	*Ambrosia artemisiifolia*	leaves and pollen
Trumpet Creeper	*Campsis radians*	leaves and flowers
Virgin's Bower	*Clematis virginana*	leaves
Water Hemlock	*Circuta maculata*	roots and young plants
Bull Nettle	*Cnidoscolus stimulosus*	stinging hairs
Texas Bull Nettle	*Cnidoscolus texanus*	stinging hairs
Lady's Slipper Orchid	*Cypripedium* spp.	leaves
Jimsonweed	*Datura stramonium*	leaves and flowers
Wild Carrot	*Dacus carota*	leaves
Larkspur	*Delphinium ajacis*	leaves and seeds
Horsetail	*Equisetum* spp.	all parts
Daisy Fleabane	*Erigeron canadensis*	leaves
Spurge	*Euphorbia* spp.	milky juice
Wild Poinsettia	*Euphorbia heterophylla*	milky juice
Yellow Jessamine	*Glesemium sempervirens*	leaves and stems
Ginko	*Ginko biloba*	seeds
Western Stinging Nettle	*Hesperocnide* spp.	stinging hairs
St. John's Wort	*Hypericum perforatum*	leaves
Juniper	*Juniperus virginiana*	leaves
Osage Orange	*Malcura pomifera*	milky juice
Red Mulberry	*Morus rubra*	leaves, stem

Common Name	Scientific Name	Poisonous Plant Part
Oleander	*Nerium oleander*	leaves
Redbird-cactus	*Pedilantus tithymaloides*	sap
Mayapple	*Podophyllum peltatum*	roots
Primrose	*Primula* spp.	all parts
Buttercup	*Ranunculus* spp.	leaves
Dock	*Rumex* spp.	leaves
Mexican Flame Vine	*Senecio confusus*	all parts
Poison Oak	*Toxicodendron quercrifolia*	leaves
Poison Ivy	*Toxicodendron radicans*	leaves
Poison Sumac	*Toxicodendron vernix*	all parts
Clover, Alsike	*Trifolium hybridum*	leaves
Chinese Tallow	*Sapium sebiferum*	leaves and berries
Cardinal Flower	*Lovelia cardinalis*	all parts
Carolina Horsenettle	*Solanum carolinense*	all parts
Silver Nightshade	*Solanum eleagnifolium*	all parts
Elderberry	*Sambucus canadensis*	all green parts
Mescal Bean	*Sophora secundiflora*	all parts
Mistletoe	*Phoradendron serotinum*	all parts
Oak	*Quercus* spp.	young shoots and acorns
Peyote	*Lophophora williamsii*	cactus tops
Pokeweed	*Phytolacca americana*	all parts
White Snakeroot	*Eupatorium rugosium*	all parts
Virginia Creeper	*Parthenocissus quinquefolia*	all parts
Yaupon Holly	*Ilex vomitoria*	berries

Science Facility Safety Checklist

The science facilities in your school should be checked annually to ensure a safe learning environment for you and your students. A copy of the Science Facility Safety Checklist should be filed with the building principal and district science coordinator so that appropriate action can be taken to correct any problem.

Notification should be made in writing if a hazard is identified that could jeopardize the safety of an individual.

Communications

Communication System	K–5	6–8	9–12
• Intercom system available			
• Telephone accessible and nearby			
• General fire alarm system functioning for entire building			
• Fire-drill instructions posted in each room			
• Emergency lights available in rooms without exterior windows			

Personal Protection

	√	√	√
Emergency Showers	K–5	6–8	9–12
• Shower (ADA compliant) present in chemistry laboratory rooms			
• Shower unobstructed			
• Valve handle functional			
• Floor drain present			
Eye/Face Wash Stations			
• Available in all laboratory rooms (5% ADA-compliant)			
• Stations marked clearly with a sign			
• Provides simultaneous tepid (60–90°F) water treatment to both eyes			
• Stations flushed for five minutes each week			
Protective Clothing			
• Laboratory aprons or coats available for each student			
• Gloves (acid resistant and heat resistant) available			
Safety Goggles			
• Approved ANSI safety goggles available for each student and teacher			
• Materials available for disinfecting goggles after their use			
• Face shields available when appropriate			
First Aid			
• Kits available in each laboratory room			
• Kits clearly marked and visible			
• Kits checked on a regular basis and supplies replenished			
• Located near a sink			

CHEMICAL STORAGE ROOM

	√ K–5	√ 6–8	√ 9–12
Combination BC Fire Extinguisher (flammable liquids & electrical)			
• Extinguisher located in room where chemicals are stored			
• Fire extinguisher properly charged; checked quarterly; safety seal intact			
• Located near exit, clearly visible, and marked with a sign			
Class D Fire Extinguisher (flammable solids)			
• Extinguisher properly charged			
• Extinguisher in rooms using metals (sodium, potassium)			
Fire Blankets			
• Standard fireproof blanket in each chemical storage room			
• Blankets located at eye level, clearly visible, and marked with a sign			
Fire or Emergency Exits			
• Two emergency exits; visible sign marking exits			
• Emergency exits unobstructed and unlocked to traffic moving out of the room			
Other Fire Protection			
• Exit signs clearly visible			
• Emergency lights available in rooms without exterior windows			
• General fire-alarm system functioning for building			
• Fire-drill procedures posted in storage rooms			
• 4- to 9-liter container of dry sand or absorbant clay (cat litter)			
• Utility carts available to transport chemicals			
Ventilation			
• Six air changes per hour			

PREPARATION AND EQUIPMENT STORAGE ROOMS

	√ K–5	√ 6–8	√ 9–12
General Storage Requirements			
• Combination BC extinguisher in preparatory rooms			
• Work surface of nonporous chemical-resistant materials			
• Large sink with hot water available			
• Emergency shower accessible			
• Materials Safety Data Sheets (MSDS) available			
• Room well lighted and clutter-free			
• Space to store chemicals			
• Chemical waste container and broken glass container available			
• Two emergency exits, with locks on doors			
• Smoke detectors present			
• Refrigerator marked “For Chemical Storage Only—No Food Allowed”			
• Adequate storage space (15 square feet per student)			
• Ventilation–six air changes per hour			

LABORATORY ROOM

	√ K–5	√ 6–8	√ 9–12
Laboratory Work Stations			
• Number of students does not exceed the number of work stations			
• Work surfaces nonporous and chemical resistant			
• At least one work station that is ADA compliant			
Master Utility Controls			
• Natural gas shut-off valve present, labeled with room identification			
• Electrical shut-off valve present, labeled with room identification			
• Water shut-off valve present, labeled with room identification			
Fume Hood			
• Located in rooms where hazardous chemicals are used (ADA compliant)			
• Not used for storage			
• Correct air movement provided at hood face			
• Vented to outside above roof level away from vents			
• Located away from doors and windows			
Spill Control Kits			
• Chemical spill kits available			
• 4- to 9-liter container of dry sand or absorbent clay (cat litter)			
Sinks			
• One available for every 4 students (15” x 15” minimum size)			
• One equipped with hot water			
• 5% of sinks ADA compliant			
Ventilation			
• Forced floor to ceiling			
• Six air changes per hour			
• Emergency exhaust fan available			
General Safety Requirements			
• 40 square feet of space per student for elementary schools; 45 square feet of space per student for middle and high schools			
• Safety rules posted and visible			
• Space available for chemical storage			
• Material Safety Data Sheets (MSDS) readily accessible			
• Broken glass container present			
• Two emergency exits in laboratory rooms larger than 1000 square feet			
• Safety and exit signs posted and visible			
• Room not cluttered; movement in work area unobstructed			

LABORATORY ROOM

Fire Protection	√ K–5	√ 6–8	√ 9–12
• Type ABC (dry chemical) fire extinguisher located by exit			
• Class D (flammable solids) available in rooms using metals			
• Extinguishers properly charged, checked quarterly, and marked with a sign			
• Fireproof blanket available, located at eye level, and marked with a sign			

ELECTRICAL SAFETY

Electrical System	√ K–5	√ 6–8	√ 9–12
• Electrical outlets equipped with ground fault circuit interrupter (GFCI)			
• Sufficient electrical outlets to eliminate extension cords			
• Electrical outlets located away from water source (faucets, sinks)			
• Electrical system equipped with accessible circuit breaker box			
• Circuit breakers identified by area or item controlled			

This information represents an assessment of the school's science facilities and should serve as a guide for establishing a safe working and learning environment.

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Teacher   Date

APPENDIX F

HAZARDOUS CHEMICALS LIST

The Environmnental Protection Agency
Acutely Hazardous Chemicals List

The Occupational Safety and Health Administration (OSHA)
List of Highly Hazardous Chemicals, Toxics and Reactives

THE ENVIRONMENTAL PROTECTION AGENCY'S ACUTELY HAZARDOUS CHEMICALS LIST

CAS Number	Chemical Name
107-20-0	Acetaldehyde, chloro-
591-08-2	Acetamide, N-(aminothioxo-methyl)-
640-19-7	Acetamide, 2-fluoro-
62-74-8	Acetic acid, fluoro-, sodium salt
591-08-2	1-Acetyl-2-thiourea
107-02-8	Acrolein
116-06-3	Aldicarb
309-00-2	Aldrin
107-18-6	Allyl alcohol
20859-73-8	Aluminum phosphide
2763-96-4	5-(Aminomethyl)-3-isoxazolol
504-24-5	4-Aminopyridine
131-74-8	Ammonium picrate
7803-55-6	Ammonium vanadate
506-61-6	Argentate (1-), bis(cyano-C)-, potassium
7778-39-4	Arsenic acid
1327-53-3	Arsenic oxide
1303-28-2	Arsenic pentoxide
1327-53-3	Arsenic trioxide
692-42-2	Arsine, diethyl-
696-28-6	Arsonous dichloride, phenyl-
151-56-4	Aziridine
75-55-8	Aziridine, 2-methyl-
542-62-1	Barium cyanide
106-47-8	Benzeneamine, 4-chloro-
100-01-6	Benzeneamine, 4-nitro-
100-44-7	Benzene, (chloromethyl)-
51-43-4	1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-
12-09-8	Benzeneethanamine, alpha, alpha-dimethyl-
108-98-5	Benzenethiol
100-44-7	Benzyl chloride
7440-41-7	Beryllium powder
598-31-2	Bromoacetone
357-57-3	Brucine
39196-18-4	2-Butanone, 3,3-dimethyl-1-(methylthio)-O-[(methylamino) carbonyl]oxime
592-01-8	Calcium cyanide
75-15-1	Carbon disulfide
75-44-5	Carbonic dichloride
107-20-0	Chloroacetaldehyde
106-47-8	p-Chloroaniline
5344-82-1	1-(O-Chlorophenyl)thiourea
542-76-7	3-Chloropropionitrile
544-92-3	Copper cyanide
———	Cyanide salts (soluble)
460-19-5	Cyanogen
506-77-4	Cyanogen chloride
131-89-5	2-Cyclohexyl-4,6-dinitrophenol
542-88-1	Dichloromethyl ether
696-28-6	Dichlorophenylarsine
60-57-1	Dieldrin
692-42-2	Diethylarsine
311-45-5	Diethyl-p-nitrophenyl phosphate
297-97-2	O,O-Diethyl O-pyrazinyl phosphorothioate
55-91-4	Diisopropylfluorophosphate (DFP)
309-00-2	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa-chloro-1,4,4a,5,8,8a,-hexahydro-, (1alpha, 4alpha, 4abeta, 5alpha, 8alpha, 8abeta)-
465-73-6	1,4,5,8-Dimethanonaphtahalen, 1,2,3,4,10,10, hexa-chloro-1,4,4a,5,8,8a-hexahydro-, (1alpha, 4alpha, 4abeta, 5beta, 8beta, 8abeta)-
60-57-1	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexa-chloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2aalpha,3beta, 6beta,6aalpha,7beta,7aalpha)-
72-20-8	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2abeta,3alpha, 6alpha,6abeta,7beta,7aalpha)-& metabolites
60-51-5	Dimethoate
122-09-8	alpha,alpha-Dimethylphene-thylamine
534-52-1	4,6-Dinitro-o-cresol, & salts
51-28-5	2,4-Dinitrophenol
88-85-7	Dinoseb
152-16-9	Diphosphoramide, octamethyl-
107-49-3	Diphosphoric acid, tetratethyl ester
298-04-4	Disulfoton
541-53-7	Dithiobiuret
115-29-7	Endosulfan
145-73-3	Endothal
72-20-8	Endrin & metabolites

CAS Number	Chemical Name
51-43-4	Epinephrine
460-19-5	Ethanedinitrile
16752-77-5	Ethanimidothioic acid
107-12-0	Ethyl cyanide
151-56-4	Ethyleneimine
52-85-7	Famphur
7782-41-4	Fluorine
640-19-7	Fluoroacetamide
62-74-8	Fluoroacetic acid, sodium salt
628-86-4	Fulminic acid, mercury(2+) salt
76-44-8	Heptachlor
757-58-4	Hexaethyl tetraphosphate
79-19-6	Hydrazinecarbothioamide
60-34-4	Hydrazine, methyl-
74-90-8	Hydrocyanic acid
74-90-8	Hydrogen cyanide
7803-51-2	Hydrogen phosphide
465-73-6	Isodrin
2763-96-4	3(2H)-Isoxazolone, 5-(aminomethyl)-
62-38-4	Mercury, (aceto-O)phenyl-
628-86-4	Mercury fulminate
62-75-9	Methanamine, N-methyl-N-nitroso-
624-83-9	Methane, isocyanato-
542-88-1	Methane, oxybis(chloro-
509-14-8	Methane, tetranitro-
75-70-7	Methanethiol, trichloro-
115-29-7	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexacloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide
76-44-8	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
16752-77-5	Methomyl
60-34-4	Methyl hydrazine
624-83-9	Methyl isocyanate
75-86-5	2-Methyllactonitrile
298-00-0	Methyl parathion
86-88-4	alpha-Naphthylthiourea
13463-39-3	Nickel carbonyl
557-19-7	Nickel cyanide
54-11-5	Nicotine & salts
10102-43-9	Nitric oxide
100-01-6	p-Nitroaniline
10102-44-0	Nitrogen dioxide
10102-43-9	Nitrogen oxide
55-63-0	Nitroglycerine
62-75-9	N-Nitrosodimethylamine
4549-40-0	N-Nitrosomethylvinylamine
20816-12-0	Osmium oxide
20816-12-0	Osmium tetroxide
145-73-3	7-Oxabicyclo(2,2,1)heptane-2, 3-dicarboxylic acid
56-38-2	Parathion
131-89-5	Phenol, 2-cyclohexyl-4,6-dinitro-
51-28-5	Phenol, 2,4-dinitro-
534-52-1	Phenol, 2-methyl-4,6-dintro-, & salts
88-85-7	Phenol, 2-(1-methylpropyl)-4,6-dinitro-
131-74-8	Phenol, 2,4,6-trinitro-, ammonium salt
62-38-4	Phenylmercury acetate
103-85-5	Phenylthiourea
298-02-2	Phorate
75-44-5	Phosgene
7803-51-2	Phosphine
311-45-5	Phosphoric acid, diethyl 4-nitrophenyl ester
298-04-4	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester
298-02-2	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)methyl] ester
60-51-5	Phosphorodithioic acid, O,O-dim ethyl S-[2-(methylamino)-2 oxoethyl]ester
55-91-4	Phosphorofluoridic acid, bis(1-methylethyl) ester
56-38-2	Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester
297-97-2	Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
298-00-0	Phosphorothioic acid, O,O,-dimethyl O-(4-nitrophenyl) ester
52-85-7	Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]pheny] O,O-dimethyl ester
78-00-2	Plumbane, tetraethyl-
151-50-8	Potassium cyanide
506-61-6	Potassium silver cyanide
116-06-3	Propanal, 2-methyl-2-(methylthio)-O-[(methylamino)carbonyl] oxime
107-12-0	Propanenitrile
542-76-7	Propanenitrile,3-chloro
75-86-5	Propanenitrile, 2-hydroxy-2-methyl
55-63-0	1,2,3-Propanetriol, trinitrate
598-31-2	2,Propanone, 1-bromo
107-19-7	Propargyl alcohol
107-02-8	2-Propenal
107-18-6	2-Propen-1-ol
75-55-8	1,2-Propylenimine
107-19-7	2-Propyn-1-ol
504-24-5	4-Pyridinamine
54-11-5	Pyridine,3-(1-methyl-2-pyrrolidinyl)-& salts

CAS Number	Chemical Name	CAS Number	Chemical Name
12039-52-0	Selenious acid, dithallium (1+) salt		
630-10-4	Selenourea		
506-64-9	Silver cyanide		
26628-22-8	Sodium azide		
143-33-9	Sodium cyanide		
57-24-9	Strychnidin-10-one, & salts		
357-57-3	Strychnidin-10-one, 2,3-dimethoxy-		
57-24-9	Strychnine, & salts		
7446-18-6	Sulfuric acid, dithallium (1+) salt		
3689-24-5	Tetraethyldithiopyrophosphate		
78-00-2	Tetraethyl lead		
107-49-3	Tetraethyl pyrophosphate		
509-14-8	Tetranitromethane		
757-58-4	Tetraphosphoric acid, hexaethyl ester		
1314-32-5	Thallic oxide		
12039-52-0	Thallium(I) selenite		
7446-18-6	Thallium(I) sulfate		
3689-24-5	Thiodiphosphoric acid, tetraethyl ester		
39196-18-4	Thiofanox		
541-53-7	Thioimidodicarbonic diamide		
108-98-5	Thiophenol		
79-19-6	Thiosemicarbazide		
5344-82-1	Thiourea, (2-chlorphenyl)-		
86-88-4	Thiourea, 1-naphthalenyl-		
103-85-5	Thiourea, phenyl-		
8001-35-2	Toxaphene		
75-70-7	Trichloromethanethiol		
7803-55-6	Vanadic acid, ammonium salt		
1314-62-1	Vandium oxide		
1314-62-1	Vanadium pentoxide		
4549-40-0	Vinylamine, N-methyl-N-nitroso-		
81-81-2	Warfarin, & salts, greater than 0.3%		
557-21-1	Zinc cyanide		
1314-84-7	Zinc phosphide		

OSHA's List of Highly Hazardous Chemicals, Toxics, and Reactives

THIS APPENDIX CONTAINS A LISTING OF TOXIC AND REACTIVE HIGHLY HAZARDOUS CHEMICALS WHICH PRESENT A POTENTIAL FOR A CATASTROPHIC EVENT AT OR ABOVE THE THRESHOLD QUANTITY.

CHEMICAL NAME	CAS*	TQ**
Acetaldehyde	75-07-0	2500
Acrolein (2-Popenal)	107-02-8	150
Acrylyl Chlorde	814-68-6	250
Allyl Chlorid	107-05-1	1000
Allylamine	107-11-9	1000
Alkylaluminum	Varies	5000
Ammonia, Anhydrous	7664-41-7	10000
Ammonia solutions (greater than 44% ammonia by weight)	7664-41-7	15000
Ammonium Perchlorate	7790-98-9	7500
Ammonium Permanganate	7787-36-2	7500
Arsine (also called Arsenic Hydride)	7784-42-1	100
Bis(Chloromethyl) Ether	542-88-1	100
Boron Trichloride	10294-34-5	2500
Boron Trifluoride	7637-07-2	250
Bromine	7726-95-6	1500
Bromine Chloride	13863-41-7	1500
Bromine Pentafluoride	7789-30-2	2500
Bromine Trifluoride	7787-71-5	15000
3-Bromopropyne (also called Propargyl Bromide)	106-96-7	100
Butyl Hydroperoxide (Tertiary)	75-91-2	5000
Butyl Perbenzoate (Tertiary)	614-45-9	7500
Carbonyl Chloride (see Phosgene)	75-44-5	100
Carbonyl Fluoride	353-50-4	2500
Cellulose Nitrate (concentration greater than 12.6% nitrogen)	9004-70-0	2500
Chlorine	7782-50-5	1500
Chlorine Dioxide	10049-04-4	1000
Chlorine Pentrafluoride	13637-63-3	1000
Chlorine Trifluoride	7790-91-2	1000
Chlorodiethylaluminum (also called Diethylaluminum Chloride)	96-10-6	5000
1-Chloro-2,4-Dinitrobenzene	97-00-7	5000
Chloromethyl Methyl Ether	107-30-2	500
Chloropicrin	76-06-2	500
Chloropicrin and Methyl Bromide mixture	None	1500

* CHEMICAL ABSTRACT SERVICE NUMBER

** THRESHOLD QUANTITY IN POUNDS (AMOUNT NECESSARY TO BE COVERED BY THIS STANDARD.)

CHEMICAL NAME	CAS*	TQ**
Chloropicrin and Methyl Chloride mixture	None	1500
Commune Hydroperoxide	80-15-9	5000
Cyanogen	460-19-5	2500
Cyanogen Chloride	506-77-4	500
Cyanuric Fluoride	675-14-9	100
Diacetyl Peroxide (concentration greater than 70%)	10-22-5	5000
Diazomethane	334-88-3	500
Dibenzoyl Peroxide	94-36-0	7500
Diborane	19287-45-7	100
Dibutyl Peroxide (Tertiary)	110-05-4	5000
Dichloro Acetylene	7572-29-4	250
Dichlorosilane	4109-96-0	2500
Diethylzinc	557-20-0	10000
Diisopropyl Peroxydicarbonate	105-64-6	7500
Dilauroyl Peroxide	105-74-8	7500
Dimethyldichlorosilane	75-78-5	1000
Dimethylhydrazine, 1,1-	57-14-7	1000
Dimethylamine, Anhydrous	124-40-3	2500
2,4-Dinitroaniline	97-02-9	5000
Ethyl Methyl Ketone Peroxide (also Methyl Ethyl Ketone Peroxide; concentration greater than 60%)	1338-23-4	5000
Ethyl Nitrite	109-95-5	5000
Ethylamine	75-04-7	7500
Ethylene Fluorohydrin	371-62-0	100
Ethylene Oxide	75-21-8	5000
Ethyleneimine	151-56-4	1000
Fluorine	7782-41-4	1000
Formaldehyde (Formalin)	50-00-0	1000
Furan	110-00-9	500
Hexafluoroacetone	684-16-2	5000
Hydrochloric Acid, Anhydrous	7647-01-0	5000
Hydrofluoric Acid, Anhydrous	7664-39-3	1000
Hydrogen Bromide	10035-10-6	5000
Hydrogen Chloride	7647-01-0	5000
Hydrogen Cyanide, Anhydrous	74-90-8	1000
Hydrogen Fluoride	7664-39-3	1000
Hydrogen Peroxide (52% by weight or greater)	7722-84-1	7500
Hydrogen Selenide	7783-07-5	150
Hydrogen Sulfide	7783-06-4	1500
Hydroxylamine	7803-49-8	2500
Iron, Pentacarbonyl	13463-40-6	250
Isopropylamine	75-31-0	5000
Ketene	463-51-4	100

* Chemical Abstract Service Number

** Threshold Quantity in Pounds (Amount necessary to be covered by this standard.)

CHEMICAL NAME	CAS*	TQ**
Methacrylaldehyde	78-85-3	1000
Methacryloyl Chloride	920-46-7	150
Methacryloyloxyethyl Isocyanate	30674-80-7	100
Methyl Acrylonitrile	126-98-7	250
Methylamine, Anhydrous	74-89-5	1000
Methyl Bromide	74-83-9	2500
Methyl Chloride	74-87-3	15000
Methyl Chloroformate	79-22-1	500
Methyl Ethyl Ketone Peroxide (concentration greater than 60%)	1338-23-4	5000
Methyl Fluoroacetate	453-18-9	100
Methyl Fluorosulfate	421-20-5	100
Methyl Hydrazine	60-34-4	100
Methyl Iodide	74-88-4	7500
Methyl Isocyanate	624-83-9	250
Methyl Mercaptan	74-93-1	5000
Methyl Vinyl Ketone	79-84-4	100
Methyltrichlorosilane	75-79-6	500
Nickel Carbonly (Nickel Tetracarbonyl)	13463-39-3	150
Nitric Acid (94.5% by weight or greater)	7697-37-2	500
Nitric Oxide	10102-43-9	250
Nitroaniline (para Nitroaniline	100-01-6	5000
Nitromethane	75-52-5	2500
Nitrogen Dioxide	10102-44-0	250
Nitrogen Oxides (NO; NO(2); N_2O_4; N_2O_3)	10102-44-0	250
Nitrogen Tetroxide (also called Nitrogen Peroxide)	10544-72-6	250
Nitrogen Trifluoride	7783-54-2	5000
Nitrogen Trioxide	10544-73-7	250
Oleum (65% to 80% by weight; also called Fuming Sulfuric Acid)	8014-94-7	1000
Osmium Tetroxide	20816-12-0	100
Oxygen Difluoride (Fluorine Monoxide)	7783-41-7	100
Ozone	10028-15-6	100
Pentaborane	19624-22-7	100
Peracetic Acid (concentration greater than 60% Acetic Acid; also called Peroxyacetic Acid)	79-21-0	1000
Perchloric Acid (concentration greater than 60% by weight)	7601-90-3	5000

* CHEMICAL ABSTRACT SERVICE NUMBER

** THRESHOLD QUANTITY IN POUNDS (AMOUNT NECESSARY TO BE COVERED BY THIS STANDARD.)

CHEMICAL NAME	CAS*	TQ**
Perchloromethyl Mercaptan	594-42-3	150
Perchloryl Fluoride	7616-94-6	5000
Peroxyacetic Acid (concentration greater than 60% Acetic Acid; also called Peracetic Acid)	79-21-0	1000
Phosgene (also called Carbonyl Chloride)	75-44-5	100
Phosphine (Hydrogen Phosphide)	7803-51-2	100
Phosphorus Oxychloride (also called Phosphoryl Chloride)	10025-87-3	1000
Phosphorus Trichloride	7719-12-2	1000
Phosphoryl Chloride (also called Phosphorus Oxychloride)	10025-87-3	1000
Propargyl Bromide	106-96-7	100
Propyl Nitrate	627-3-4	2500
Sarin	107-44-8	100
Selenium Hexafluoride	7783-79-1	1000
Stibine (Antimony Hydride)	7803-52-3	500
Sulfur Dioxide (liquid)	7446-09-5	1000
Sulfur Pentafluoride	5714-22-7	250
Sulfur Tetrafluoride	7783-60-0	250
Sulfur Trioxide (also called Sulfuric Anhydride)	7446-11-9	1000
Sulfuric Anhydride (also called Sulfur Trioxide)	7446-11-9	1000
Tellurium Hexafluoride	7783-80-4	250
Tetrafluoroethylene	116-14-3	5000
Tetrafluorohydrazine	10036-47-2	5000
Tetramethyl Lead	75-74-1	1000
Thionyl Chloride	7719-09-7	250
Trichloro (chloromethyl) Silane	1558-25-4	100
Trichloro (dichlorophenyl) Silane	27137-85-5	2500
Trichlorosilane	10025-78-2	5000
Trifluorochloroethylene	79-38-9	10000
Trimethyoxysilane	2487-90-3	1500

* CHEMICAL ABSTRACT SERVICE NUMBER

** THRESHOLD QUANTITY IN POUNDS (AMOUNT NECESSARY TO BE COVERED BY THIS STANDARD.)

APPENDIX G
SAFETY SYMBOLS

Examples of Common Safety Symbols
Fire Extinguishers and Agents
National Fire Protection Association (NFPA) Hazard Labels

Examples of Common Safety Symbols

Fire Extinguishers and Agents

A	B	C	D
Class A Fire Common Combustibles	Class B Fire Flammable Liquids	Class C Fire Electrical	Class D Fire Flammable Metals

Fire Extinguishers and Agents

Suitable for Use on This Type Fire	Agent Characteristics	Horizontal Range	Discharge Time
B	**Regular Dry Chemical** Sodium Bicarbonate Discharges white cloud Leaves residue Non-freezing	5–20 feet	8–25 seconds
A B or B	**Multipurpose Dry Chemical** Ammonium Phosphate Discharges yellow cloud Leaves residue Non-freezing	5–20 feet	8–25 seconds
B	**Purple-K Dry Chemical** Potassium Bicarbonate Discharges blue cloud Leaves residue Non-freezing	5–20 feet	8–25 seconds
B	**KCl Dry Chemical** Potassium Chloride Discharges white cloud Leaves residue Non-freezing	5–20 feet	8–25 seconds
B	**Carbon Dioxide** Inert carbon dioxide gas Discharges cold white cloud Leaves no residue Non-freezing	3–8 feet	8–30 seconds
B C	**Halogenated Agent** Halogenated hydrocarbons Discharges white vapor Leaves no residue Non-freezing	4–8 feet	8–10 seconds

Suitable for Use on This Type Fire	Agent Characteristics	Horizontal Range	Discharge Time
A	**Water** Tap water with corrosive inhibitor Discharges spray or stream Leaves yellow residue Protect from freezing	30–40 feet	1 minute
A	**Anti-freeze Solution** Calcium Chloride Discharges spray or stream Leaves residue Non-freezing	30–40 feet	1 minute
A B	**Loaded Stream** Alkali-Metal-Salt Discharges spray or stream Leaves residue Non-freezing	30–40 feet	1 minute
B	**Foam** Water and Detergent Discharges foamy solution Leaves powder residue Non-freezing	10–15 feet	24 minutes
D	**Dry Powder Special Compound** Soduim Chloride or Graphite materials Discharges in stream Leaves residue Non-freezing	5–20 feet	25–30 seconds

Using a Fire Extinguisher

1. Extinguishers must be located and marked to be easily seen and the area around the extinguisher must be kept clean.
2. Regular inspections and tagging or marking of inspection dates is essential.
3. Gauges should be checked for readings to insure that unit is functional.
4. Pressurized units are considered as “unfired pressure vessels” and require periodic static pressure tests in accordance with NFPA Codes.
5. Users must be well trained in their use. This requires hands-on and repeated training.
6. Water-type extinguishers must never be used on electrical or metal fires.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) HAZARD LABELS

4 Severe
3 Serious
2 Dangerous
1 Minor
0 Slight

NFPA HAZARD RATINGS: HEALTH

Rating	Description
4	Materials that could cause death or major residual injury. This rating includes: • materials that can penetrate ordinary rubber protective clothing. • materials that, under normal conditions or fire conditions, give off gases that are toxic or corrosive through inhalation or contact with the skin.
3	Materials that, upon short exposure, could cause serious temporary or residual injury. This rating includes: • materials giving off highly toxic combustion products. • materials corrosive to living tissue or toxic by skin absorption.
2	Materials that, on intense or continued exposure, cause temporary incapacitation or residual injury. This rating includes: • materials giving off toxic combustion products. • materials giving off highly irritating combustion products. • materials that, under normal conditions or fire conditions, give off toxic vapors.
1	Materials that, on exposure, cause irritation and minor residual injury. This rating includes: • materials that, under fire conditions, would give off irritating combustion products. • materials that cause irritation of the skin without destruction of tissue.
0	Materials that, on exposure under fire conditions, would offer no hazard beyond that of combustible material.

NFPA HAZARD RATINGS: SPECIAL

Rating	Description
OX	Denotes materials that are oxidizing agents. These compounds give up oxygen readily, remove hydrogen easily, remove hydrogen from other compounds, or attract negative electrons.
~~W~~	Denotes materials that are water-reactive. These compounds undergo rapid energy releases on contact with water.

NFPA Hazard Ratings: Flammability

Rating	Description	Flash Point
4	Materials that will rapidly or completely vaporize at atmospheric pressure and normal temperatures or that are readily dispersed in air, and that will burn readily. This rating includes: • very flammable gases • extremely volatile liquids • dust that readily burns or explodes when dispersed in the air	below 22.8° C
3	Liquids and solids that can be ignited under all temperature conditions. These produce hazardous atmospheres with air under all temperatures. This rating includes: • liquids which vaporize enough to ignite under normal conditions • solids that ignite spontaneously	between 22.8° C and 37.7° C
2	Materials that must be moderately heated or exposed to high temperatures before ignition occurs. These materials would not form hazardous atmospheres under normal conditions. This rating includes: • liquids which must be moderately heated to ignite. • solids and semisolids that readily give off flammable vapors.	liquids between 37.7° C and 200° C
1	Materials that must be preheated before ignition can occur. These require considerable preheating, under all temperature conditions. This rating includes most ordinary combustible materials.	200° C
0	Materials that do not burn. This rating includes materials that will not burn in air or when exposed to a temperature of 1500° C for a period of 5 minutes.	1500° C

NFPA Hazard Ratings: Reactivity

Rating	Description
4	Materials that are readily capable of detonation or of explosive decomposition or explosive reaction at normal temperatures and pressures. This rating includes materials that are sensitive to thermal shock at normal temperatures and pressures.
3	Materials that are capable of detonation or explosive reaction but that require a strong initiating source or that must be heated under confinement before initiation. This rating includes materials that are sensitive to shock at elevated temperatures and pressures or that react explosively with water without requiring heat or confinement.
2	Materials that are normally unstable and readily undergo violent chemical change but do not detonate. This rating includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures or undergo violent chemical change at elevated temperatures and pressures. Also includes materials that react violently with water or which may form potentially explosive mixtures with water.
1	Materials that are normally stable, but that can become unstable at elevated temperatures and pressures or that may react with water with some release of energy but not violently.
0	Materials that are normally stable, even under fire exposure conditions, and are not reactive with water.

INDEX

G

H

I

L

M

O

P

R

S

T

U

V

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COMPLIANCE STATEMENT

TITLE VI, CIVIL RIGHTS ACT OF 1964; THE MODIFIED COURT ORDER, CIVIL ACTION 5281, FEDERAL DISTRICT COURT, EASTERN DISTRICT OF TEXAS, TYLER DIVISION

Reviews of local education agencies pertaining to compliance with Title VI Civil Rights Act of 1964 and with specific requirements of the Modified Court Order, Civil Action No. 5281, Federal District Court, Eastern District of Texas, Tyler Division are conducted periodically by staff representatives of the Texas Education Agency. These reviews cover at least the following policies and practices:

(1) acceptance policies on student transfers from other school districts;

(2) operation of school bus routes or runs on a nonsegregated basis;

(3) nondiscrimination in extracurricular activities and the use of school facilities;

(4) nondiscriminatory practices in the hiring, assigning, promoting, paying, demoting, reassigning, or dismissing of faculty and staff members who work with children;

(5) enrollment and assignment of students without discrimination on the basis of race, color, or national origin;

(6) nondiscriminatory practices relating to the use of a student's first language; and

(7) evidence of published procedures for hearing complaints and grievances.

In addition to conducting reviews, the Texas Education Agency staff representatives check complaints of discrimination made by a citizen or citizens residing in a school district where it is alleged discriminatory practices have occurred or are occurring.

Where a violation of Title VI of the Civil Rights Act is found, the findings are reported to the Office for Civil Rights, U.S. Department of Education.

If there is a direct violation of the Court Order in Civil Action No. 5281 that cannot be cleared though negotiation, the sanctions required by the Court Order are applied.

TITLE VII, CIVIL RIGHTS ACT OF 1964 AS AMENDED BY THE EQUAL EMPLOYMENT OPPORTUNITY ACT OF 1972; EXECUTIVE ORDERS 11246 AND 11375; EQUAL PAY ACT OF 1964; TITLE IX, EDUCATION AMENDMENTS; REHABILITATION ACT OF 1973 AS AMENDED; 1974 AMENDMENTS TO THE WAGE-HOUR LAW EXPANDING THE AGE DISCRIMINATION IN EMPLOYMENT ACT OF 1967; VIETNAM ERA VETERANS READJUSTMENT ASSISTANCE ACT OF 1972 AS AMENDED; IMMIGRATION REFORM AND CONTROL ACT OF 1986; AMERICANS WITH DISABILITIES ACT OF 1990; AND THE CIVIL RIGHTS ACT OF 1991.

The Texas Education Agency shall comply fully with the nondiscrimination provisions of all federal and state laws, rules, and regulations by assuring that no person shall be excluded by consideration for recruitment, selection, appointment, training, promotion, retention, or any other personnel action, or be denied any benefits or participation in any educational programs or activities which it operates on the grounds of race, religion, color, national origin, sex, disability, age, or veteran status (except where age, sex, or disability constitutes a bona fide occupational qualification necessary to proper and efficient administration). The Texas Education Agency is an Equal Employment Opportunity / Affirmative Action employer.