THE NSTA READY-REFERENCE GUIDE TO SAFER SCIENCE

VOL. 2

Kenneth Russell Roy

NSTA press
National Science Teachers Association

THE NSTA READY-REFERENCE GUIDE TO SAFER SCIENCE

VOL. 2

THE NSTA READY-REFERENCE GUIDE TO SAFER SCIENCE

VOL. 2

KENNETH RUSSELL ROY

NSTApress
National Science Teachers Association

Arlington, Virginia

NSTA press®
National Science Teachers Association

Claire Reinburg, Director
Jennifer Horak, Managing Editor
Andrew Cooke, Senior Editor
Wendy Rubin, Associate Editor
Agnes Bannigan, Associate Editor
Amy America, Book Acquisitions Coordinator

Art and Design
Will Thomas Jr., Director
Joseph Butera, Senior Graphic Designer

Printing and Production
Catherine Lorrain, Director

National Science Teachers Association
Gerald F. Wheeler, Interim Executive Director
David Beacom, Publisher

Science Scope
Inez Liftig, Editor
Kenneth L. Roberts, Managing Editor

The Science Teacher
Steve Metz, Editor
Scott Stuckey, Managing Editor

1840 Wilson Blvd., Arlington, VA 22201
www.nsta.org/store
For customer service inquiries, please call 800-277-5300.

15 14 13 12 4 3 2 1

NSTA is committed to publishing material that promotes the best in inquiry-based science education. However, conditions of actual use may vary, and the safety procedures and practices described in this book are intended to serve only as a guide. Additional precautionary measures may be required. NSTA and the authors do not warrant or represent that the procedures and practices in this book meet any safety code or standard of federal, state, or local regulations. NSTA and the authors disclaim any liability for personal injury or damage to property arising out of or relating to the use of this book, including any of the recommendations, instructions, or materials contained therein.

Library of Congress Cataloging-in-Publication Data

Roy, Kenneth Russell.
The NSTA ready-reference guide to safer science / Kenneth Russell Roy.
p. cm.
Includes index.
ISBN 978-1-933531-28-1
1. Science--Experiments--Safety measures--Handbooks, manuals, etc. 2. Scientific apparatus and instruments--United States--Safety measures--Handbooks, manuals, etc. 3. Hazardous substances--United States--Safety measures--Handbooks, manuals, etc. 4. Science--Study and teaching--United States. I. Title.
Q182.3.R69 2007
507.8--dc22

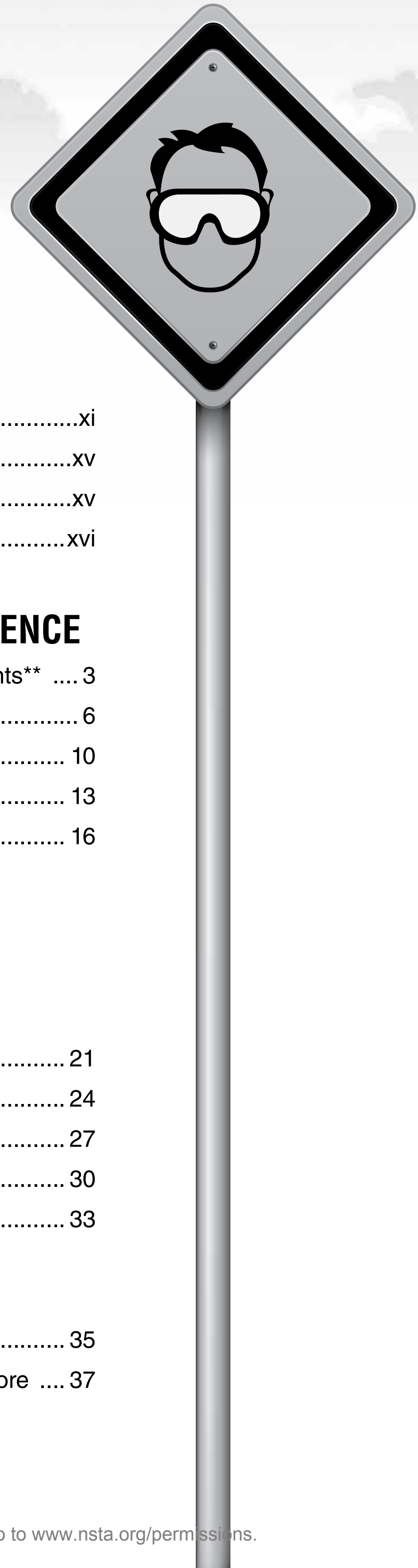
2007034665

The ISBN for *The NSTA Ready-Reference Guide to Safer Science, Volume 2* is 978-1-936959-06-8.

eISBN 978-1-936959-66-2

CONTENTS

(Note: All articles are from *Science Scope* except those with asterisks (**). In those cases, the articles are from *The Science Teacher*.)



I. INTRODUCTION TO SAFETY IN SCIENCE

II. SAFETY PRACTICES AND LEGAL STANDARDS

General Safety in Science

Legal Issues

Laboratory Construction and Renovation

III. SAFETY IN SCIENCE INSTRUCTION

General Science

Chemical Science

Earth and Space Science

Physical Science

Biological Science

IV. QUESTIONS FROM TEACHERS

General Questions

Chemical Questions

Earth and Space Science Questions

Physical Science Questions

Biological Questions

APPENDIXES

NSTA Position Statements

∇ PREFACE

Science education has been on a roller coaster ride since the 1950s. During the late 1950s and early 1960s, in the age of the Sputnik race, science education in the United States had a rebirth. Science education placed a focus on learning about science through the *doing* of science. A number of hands-on process- and inquiry-based programs were developed with support from the National Science Foundation (NSF) and other private groups and companies. The "alphabet soup" programs—such as SCIS (Science Curriculum Improvement Study), SAPA (Science A Process Approach), ESS (Earth Systems Science), IPS (Introductory Physical Science), and BSCS (Biological Sciences Curriculum Study)—were introduced and used in many schools throughout the United States at the K–12 levels. In the 1980s and early 1990s, these programs fell out of favor for a variety of curricular, administrative, and financial reasons. A return to the pre-1950s "textbook reading about science" approach again came into play.

Fast forward to the 1990s, when we saw the creation of the National Science Education Standards on the heels of *A Nation At Risk*, followed by No Child Left Behind legislation and the development of curriculum programs such as AAAS Project 2061; NSTA Scope, Sequence and Coordination; and State Science Frameworks. Thus began the rebirth of the "doing of science" approach in science education.

In 2012, the Next Generation Science Standards (NGSS) are being released with the goal of inspiring new generations of science and engineering professionals and scientifically literate citizens. Along with this goal comes a whole new challenge for safety in the science classroom, with an expanded emphasis on the *doing* of science for the learning of science. One potential engine embracing the NGSS is the science, technology, engineering, and mathematics (STEM) education approach, which is being adapted from comprehensive high school science curricula for STEM magnet schools. Here again is another new realm relative to safety hazards that will need to be addressed over the coming decade.

A second factor in the changes in science education during the early 1990s was the Occupational Safety and Health Administration (OSHA) unveiling and putting into effect a new federal law covering laboratory safety, known as 29 CFR 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories, or the Laboratory Standard. This law notifies general industry employers, including school boards of education, that they must provide a safe workplace in laboratories to deal with hazardous chemicals and the use of prudent practices.

In 2012, OSHA adopted the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). The main purpose of GHS is to provide consistent information (health, physical, and environmental hazards) and definitions for hazardous chemicals based on the internationally accepted GHS. Adoption of this program has safety compliance implications for science teachers in the area of the OSHA Hazard Communication Standard and the Laboratory Standard.

A third factor that has influenced the direction of science education and safety is the focus on a more diverse student population, including groups such as special needs students. A series of legislative actions, such as the Americans With Disabilities Act (ADA), required that all students have the opportunities to participate in general education, including science education. Laboratory design and construction—in addition to curriculum, instruction, and safety strategies—must attempt to address these needs.

The fourth factor in the evolution of science education is the revolution taking place in the cadre of science educators. As in the late 1960s and 1970s, many science educators are reaching retirement age and leaving the profession. As these educators retire, science education loses many years of professional experience and knowledge. Neophytes are taking these teachers' places, with limited experience in laboratory work and little to no safety preparation.

The fifth factor is the economic downturn worldwide during the past decade. Economic struggles have affected supply-intensive disciplines such as science at both the elementary and secondary levels. "Provide more by using less" has been the operative strategy. This strategy certainly has put limits on the science curriculum, instruction, and safety.

The last important factor is liability. We still live in a litigious society in which teachers are held to very high standards. Teachers and administrators need to become aware of and concerned about liability for their actions. This is especially of interest to science teachers at the middle and high school levels given the potential safety issues they face by working with students in formal laboratories and the field.

All of these factors have science teachers asking how they can improve safety in their laboratories and still carry out meaningful activities. To address some of these challenges relative to safety, the National Science Teachers Association (NSTA) introduced the safety column "Scope on Safety" in *Science Scope*, a journal for middle and junior high school science teachers. The purpose of the column was simple: provide safety information for middle-grade science teachers that will help them address safety issues when dealing with hands-on instruction in the laboratory and the field. Most of this safety information is also applicable to high school–level science laboratories, though *The*

Science Teacher (NSTA's journal for high school teachers) includes the column "Safer Science" to address questions at this level.

This book is the second compendium of those articles, picking up where the first book left off in 2007. The articles are based on inquiries from science teachers nationwide. The topics focus on everyday safety issues that middle-grade science teachers and supervisors deal with when doing science. Each column is written to help science teachers become aware of legal standards and prudent practices that make for safer laboratory experiences and protect both students and teachers. Unfortunately, some architects, building contractors, school administrators, and board of education members have taken advantage of science teachers on issues such as facility design, occupancy loads, and protective equipment. This has happened because science teachers lack the expertise—in both knowledge and experience—in legal building and safety standards and prudent practices in the laboratory. Unsafe laboratory activities and facilities can get science teachers into legal challenges with professional and civil consequences.

Like the first book, this book is divided into five areas. The first section is a short introduction to the topics of hands-on science for all students, as well as the protection afforded to the science teacher through the OSHA Laboratory Standard. The second section addresses safety practices and legal standards, with a focus on current issues facing science teachers. The third section deals with safety in science instruction by providing specific information on how to best incorporate safety in various aspects of science teaching. The fourth section answers questions about everyday issues that middle-grade teachers have asked through the "Scope on Safety" column. The final section provides appendixes, including relevant NSTA position papers and internet resources.

Building safer science behaviors begins at the elementary and middle school levels. These practices serve as guidelines for future laboratory work, with many carryovers into everyday life. Safer science is critical for the teacher as an instructor and employee and for the student as a learner and citizen. Learning to teach and practice safer science is a lifelong endeavor, and I hope you will join me in this process.

Ken Roy

ACKNOWLEDGMENTS

I wish to especially thank several people who have helped beyond expectations to make the journal safety columns highly effective for in-the-trenches science teachers and school administrators. Thanks to Ken Roberts, *Science Scope*'s managing editor, and Inez Fugate Liftig, the journal's field editor, for their guidance and direction in the development and operation of the column over the years. Thanks goes to David Beacom, publisher at NSTA, for his continued support and action relative to addressing safety issues in NSTA publications. Additional thanks goes to attorney Harold R. Cummings of Cummings, Lanza & Purnhagen, LLC Law Firm (South Windsor, CT), and attorney Kelly Ryan, The Ryan Law Firm (Pasadena, CA), for their professional reviews of and contributions to many safety articles. Final acknowledgment goes to my wife, Marisa; my two daughters, Lisa Marie Bride and Louise Irene Roy; and my grandson, Michael Patrick Bride, for their continued support, understanding, and patience.

ABOUT THE AUTHOR

Dr. Kenneth Russell Roy has been a science educator, K–12 administrator, and safety compliance officer for more than 44 years. In addition, he has a large number of experiences as an author and editor, with more than 200 published articles and 4 books dealing with science education and laboratory safety. He has served in numerous leadership positions for state, national, and international science education organizations. He currently serves as the director of environmental health and safety for Glastonbury Public Schools (Glastonbury, CT). Dr. Roy is also an independent safety consultant and advisor for professional organizations, school districts, magnet schools, insurance companies, textbook publishers, and other organizations dealing with safety and science education issues.

Dr. Roy earned a bachelor's degree in 1968 and a master's degree in 1974, both from Central Connecticut State University, and a doctorate in 1985 from the University of Connecticut. In addition, he received a diploma in professional education from the University of Connecticut in 1981 and has a certificate of instruction as an authorized OSHA instructor from the Keene State College OSHA (Office of Safety and Health Administration) Extension School.

Dr. Roy is a past chairperson of the NSTA Science Safety Advisory Board and also the NSTA Science Safety Compliance Consultant, serving as NSTA's liaison to the board. He is an NSTA author and safety columnist.

ABOUT THIS BOOK

Beginning in February 2003, *Science Scope* started publishing the column "Scope on Safety" in each issue. In 2007, *The Science Teacher* began publishing the column "Safer Science" to provide safety information for high school teachers. In these columns, author Ken Roy, NSTA Science Safety Consultant and past chairperson for the NSTA Safety Advisory Board, shares the knowledge, skills, and attitudes that help guide planning for safer science instruction and laboratory facilities. Like the first book, this book includes information, anecdotes, advisories, warnings, and good leads to the newest resources and answers teachers' questions about safety.

This book is a compilation of updated columns from both journals (though primarily from *Science Scope*), beginning where the first book left off in 2007, and it covers a wide range of safety issues in quick-reference form. You can use the index or the table of contents to locate a quick answer to your questions about practicing safer science.

Science teachers are charged with meeting "duty of care." They must therefore make decisions based on the maturity and knowledge base of their students. This responsibility is in concert with students' exposure to the potential hazards associated with hands-on activities in laboratories and the field. The charge is clear: to secure and foster safer learning and working environments for both students and teachers.

Science safety doesn't just mean following a set of rules. Safer science practice requires common sense and the teacher's intuition that helps predict what might happen when we least expect it. To foster inquiry in a safer environment, teachers must not only keep up-to-date with the latest information about products, hazards, and best practice but also consider the developmental level of their budding scientists.

As always, remember that the best piece of safety equipment in your classroom is you—the informed adult shaping and controlling the learning and working environment.

I

INTRODUCTION TO SAFETY IN SCIENCE

∇ INTRODUCTION TO SAFETY IN SCIENCE

1. Making Adjustments for Mobility-Impaired Students

In 1985, the year Halley's Comet last passed near Earth, the American Association for the Advancement of Science (AAAS) initiated Project 2061. *Science for All Americans*, the project's cornerstone publication, was recognized as the first step in establishing national standards in science for all students, including those with disabilities. With the help of this project and legislation such as the Americans With Disabilities Act (ADA), individuals with disabilities are assured equal opportunity and full participation in school and out. As a result, accommodations must be made to help disabled students fully participate in science classrooms and laboratories, including making the laboratory accessible to students with mobility impairments.

Given the variety of needs relative to science, lab facilities, and each student's physical abilities, no spectral standards exist for establishing science laboratories. However, several sources do exist for specific guidelines that should serve as the basis for design considerations in constructing or renovating science laboratories, which can help provide both access and safer science for students with disabilities. These include the ADA, created to eliminate discrimination against persons with disabilities; the Uniform Federal Accessibility Standards (UFAS) for facility accessibility for physically handicapped persons in schools receiving federal financial assistance; and state and local regulations. (*Note:* See Internet Resources for a list of helpful resources.)

Students' mobility impairments need to be addressed for access to and safety in science laboratories. Typical accommodations for mobility-impaired students include workstations, sinks, fume hoods, and safety eyewashes and showers, in addition to other adaptations. The following are some of the higher-profile accommodations based primarily on ADA and UFAS expectations for mobility-impaired students and faculty members. It should be noted that the ADA and UFAS are not always in agreement, as UFAS tends to be more restrictive in some cases. Be sure to check local and state regulations as well.

Laboratory Workstations

The traditional science laboratory workstation is equipped with electrical receptacles, gas jets, water faucets, sinks, and apparatus rod sockets. Controls for these fixtures should be easy to operate using a maximum of 2.3 kg (5 lbs.) of force and should also require only a loose grip to operate, as opposed to pinching the fingers or twisting the wrist. Single-action lever controls should be used in place of knob-type controls.

At least one workstation should be designed to accommodate students with mobility impairments. Dimensions for access to this workstation should include a maximum height of 86 cm (34 in.) from the floor to the work surface. Accommodating dimensions for knee space should be 69 (height) × 76 (width) × 48 cm (depth) (27 × 30 × 19 in.). Clear floor space with dimensions of 76 (width) × 122 cm (length) (30 × 48 in.) is required for a wheelchair front approach, with adequate space provided to maneuver to and from the workstation. In addition, the workstation should be in a place with no physical barriers and allow for visual access to instruction and demonstrations. Mirrors or electronic camera devices can also help provide visual access.

Laboratory Sinks

ADA Accessibility Guidelines (ADAAG) for Buildings and Facilities specify that sink depth in the laboratory should be no more than 16.5 cm (6.5 in.) so that a wheelchair can fit under the sink. The minimum knee space required is 69 × 76 × 48 cm. The counter or rim of the sink must be mounted at a maximum height of 86 cm from the finished floor. Faucets should have easy access, lever-operated controls, or a similar alternative, such as push-type, touch-type, or electronically controlled mechanisms. Clear floor space with dimensions of 76 × 122 cm is also required for laboratory sinks. Exposed hot water and drain pipes under sinks are to be insulated or configured to protect against contact. In addition, to avoid injury, there should be no abrasive or sharp surfaces under the sinks.

Fume Hoods

As with workstations and lab sinks, fume-hood decks should also be lowered to the required maximum height of 86 cm from the finished floor. Required knee space is also the same (69 × 76 × 48 cm), as is the required floor space (76 × 122 cm). Easily operable hood controls should be placed at a maximum height of 122 cm; this height is referenced by the International Building Code (IBC/ANSI A117.1) for new construction and is a requirement for state departments of education and other jurisdictions using this code. However, existing installations that have controls within 137 cm (54 in.) of the floor may remain at this height.

Safety Eyewashes and Showers

Modifications to the standard safety-eyewash station bowl and the pull-handle shower are also required. The eyewash bowl should be lowered so that the maximum height of the water-discharge outlets is 91 cm (36 in.) above the finished floor. For new showers, the pull handle should be at a maximum height of 122 cm above the floor to accommodate a wheelchair side approach—this is a requirement for state departments of education and other jurisdictions using this code. Existing shower installations that have the pull handle within 137 cm of the floor may remain at this height. Clear floor space of 76 × 122 cm is also required for the shower. (*Note*: Flexible-hose-type showers installed in the laboratory stations are not permitted by the Occupational Safety and Health Administration [OSHA] as the sole means of providing this safety feature.)

Additional Access Items

The sharp corners of cabinets, bookcases, and other equipment or furniture also need to be addressed. Alternative laboratory storage units, such as a storage cabinet on rollers, can be helpful in this regard. Items on storage shelving must be a maximum of 122 cm above the finished floor for easy and safe access from a wheelchair side approach—again, this is a requirement for state departments of education and other jurisdictions using this code. Adequate maneuvering space and accessible hardware (similar to controls described in the sections Laboratory Workstations, Laboratory Sinks, and Fume Hoods) are required to ease the opening of cabinet doors. Existing installations that store items within 137 cm of the floor may remain at this height.

In cases where specific equipment is required, adaptations are often available. For example, extended eyepieces for microscope viewing can be secured for students' use in wheelchairs. Another example is glassware such as beakers with handles for easier access and use.

Finally, doorway width should be a minimum of 81 cm (32 in.) for wheelchair clearance, and aisle width should be a minimum of 91 cm. For mobility clearance, a turning radius of 152 cm (60 in.) is needed.

If teachers have concerns about accommodations and safety in their own laboratory, they should contact the building administrator in writing. Ultimately, it is up to the administration to provide alternatives, such as a portable unit, needed to meet ADA specifications.

A safer laboratory for all students involves keeping the designed laboratory landscape uncluttered. Laboratories that are messy or poorly designed foster trip-and-fall hazards and other safety incidents, which can put both students and teachers in harm's way.

Acknowledgments

Special thanks to Architectural Design Reviewer Richard Snedeker of the Connecticut State Department of Education's Bureau of School Facilities for his professional review and contributions to this column.

Resource

Motz, L. L., J. T. Biehle, and S. S. West. 2007. *NSTA guide to planning school science facilities.* 2nd ed. Arlington, VA: NSTA Press.

Internet Resources

International Code Council: *www.iccsafe.org*

United States Access Board. ADA Accessibility Guidelines for Buildings and Facilities (ADAAG). *www.access-board.gov/adaag/html/adaag.htm#4.244*

United States Access Board. Uniform Federal Accessibility Standards (UFAS). *www.access-board.gov/ufas/ufas-html/ufas.htm*

2. Laboratory Safety: Welcome Aboard!

Why did *The Science Teacher* initiate a safety column? Walk into a typical science classroom today and you are likely to see the teacher conducting a demonstration or students doing hands-on laboratory work. This key instructional strategy has been re-embraced since the advent of the *National Science Education Standards*, state science curriculum reforms, and No Child Left Behind legislation. In the mix of these initiatives is a major retirement revolution and effects of the economic downturn. Teachers with many years of skill and knowledge in laboratory work are coming of age to leave the profession. In addition, a myriad of schools need renovations or new construction because of overcrowded conditions and outdated laboratory facilities. Some of these issues unfortunately have not been addressed due to limited funding.

Safety in the science laboratory and field work is all the more important as a result of these events and changes. The mission of this column is to address the "in the trenches" safety issues and help teachers successfully maneuver through these revolutionary and evolutionary times in science education.

OSHA Laboratory Standard: The Locomotive Driving Safety

Where does a science teacher or supervisor start to ensure that laboratory work is conducted with safety in mind? Federal government legislation from 1990 is the major force in helping establish a safe working environment in academic laboratories for teachers and students. This legislation is based on the Occupational Safety and Health Administration's (OSHA) Occupational Exposure to Hazardous Chemicals in Laboratories, otherwise known as the Science Laboratory Standard for employees working in laboratories.

All school employees protected under Federal OSHA or similar state plans are covered by the 1986 Hazard Communication Standard or HazCom/Right to Know law (29 CFR 1910.1200). However, as of 1990, because of the dangers and uniqueness inherent in laboratory work, employers under Federal OSHA or similar state plans are required to cover laboratory workers specifically (including science teachers) with the OSHA Laboratory Standard (29 CFR 1910.1450 Subpart Z).

Moving on the Right Track

The OSHA Laboratory Standard is performance based. OSHA provides the basic outline requirements, then each employer (e.g., board of education) writes a plan tailored to its independent needs. For example, plans may vary from district to district relative to differing standard operating procedures, but all plans must contain standard operating procedures.

Three important components of the standard include the development of a chemical hygiene plan (CHP), the appointment of a chemical hygiene officer (CHO), and employee training. The written CHP must be developed to protect employees from hazards associated with chemicals in the laboratory. Although generic plans are available, each plan must be unique to address the specific needs of individual workplaces. The employer is responsible for developing and enforcing the plan. The standard also requires that the employer appoint a CHO to develop and implement the CHP. The CHO position is an appointment under the OSHA standard as opposed to a required new hiring.

The CHP Itinerary

OSHA requires the CHP be composed of the following minimum parts:

- Standard operating procedures (SOPs): What are the standards for laboratory operation that all employees are required to follow? For example, what is the protocol for testing showers and eyewash stations in laboratories? SOPs should be rooted in standards, codes, or other professional expectations.
- Criteria to determine and implement control measures to reduce employee exposure: What type of engineering controls (e.g., eyewash stations), use of personal protective equipment (e.g., chemical-splash goggles), and hygiene practices (hand washing) are required?
- Requirement that fume hoods and other engineering controls are functioning properly and within specific measures: Is there a preventive maintenance program in place that fosters optimal performance of engineering controls?
- Provisions for employee information and training: What types of (and how much) safety training and information are provided for employees?
- Circumstances where laboratory operation requires prior approval from the employer: What is the protocol used to undertake a special laboratory activity or new procedure?
- Provisions for medical consultation and examinations: What procedure has been established to provide for medical assistance if an employee has a chemical exposure or incident?
- Designation of personnel responsible for implementation of CHP, including CHO: Who is the employer-designated CHO? This person—often a chemistry teacher, department head, or laboratory technician—must be qualified by training or experience to provide technical guidance in the development and implementation of the CHP.
- Provision for additional employee protection when working with particularly hazardous substances: What procedures are in place for employees if they

work with substances such as toxins and flammables?

Making the Connection for Training

The CHP must include employee information and training relevant to laboratory work. The training must be provided at the time of initial employment and when new chemicals or hazards are introduced into the workplace. Information must include CHP contents, laboratory standards, personal exposure levels (PEL), threshold limit values (TLV), exposure signs, and the location of related reference materials. Training must minimally include methods to detect the presence of hazardous chemicals, physical and chemical health hazards in the laboratory or work area, procedures such as emergency procedures, work practices, and protective equipment.

Additional Items to Consider

Remember, OSHA standards represent only the minimum expectations for safety. Also, OSHA covers employees, not students. However, to maintain a safe working environment for employees such as science teachers, the school's CHP should also include students. The rationale is that to maintain a safe working environment for teachers as employees, students must also be accountable for following SOPs in the lab.

Those working with the employer in the development of the CHP need to consider additional policies and regulations that go beyond the minimal safety expectations, such as the following:

- Use of lab facility: The CHP should address policies on use of laboratories by noncertified instructors and nonscience students—for example, the assignment of study halls or English classes to science laboratories.
- Occupancy load: Legal standards such as fire and building codes restrict occupancy loads in science laboratories. Quasi-legal and professional standards provide academic occupancy loads in science labs. This in effect limits the number of occupants allowed in a science laboratory. Be careful to distinguish between the terms *science laboratory* and *science classroom*. Those designations have different ramifications relative to code applications.
- Security: Science laboratories are considered secured areas, given the inherent dangers from elements such as gas, electricity, and hazardous chemicals. Policies need to be written to foster security relative to entering laboratories and storerooms. For example, only chemistry teachers are provided with a key to the chemical storeroom. Science laboratories should be locked when they are not in use.
- Special needs: Policies in working with students or employees who are physically challenged or have other special needs should be addressed in the CHP. A variety of options are available to

meet both the safety and educational needs of all students and employees in the laboratory.

All Aboard for Safety's Sake

The OSHA Laboratory Standard is the foundation for an effective laboratory safety program. Science teachers and school administrators need to be advocates for safe science in the laboratory or field. They must help educate central office administrators, board of education members, and legislators and other government officials to promote and facilitate a safe working environment for employees and students. Science teachers who make safety a priority for their students will not only make the lab safer for themselves but also will instill a commitment on the part of their students as future employees.

References

Occupational Safety and Health Administration (OSHA). Occupational Safety and Health Administration laboratories, other resources. *www.osha.gov/SLTC/laboratories/otherresources.html*

Occupational Safety and Health Administration (OSHA). Occupational Safety and Health Administration laboratory standard. *www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10106*

3. Yes, You Need a Chemical Hygiene Officer

Chemical hygiene is everyone's business in middle school science labs. Middle schools with formal lab facilities (except for those in Delaware, Georgia, Massachusetts, North Dakota, and Texas) are legally required to appoint an employee to serve in the role of chemical hygiene officer (CHO). This position is absolutely critical in fostering and ensuring both chemical hygiene practices and the chemical hygiene plan (CHP).

According to OSHA (see References), the employer is required to appoint a CHO. OSHA defines the CHO as "an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan." In those schools where the employer has not appointed a CHO, the superintendent of schools has the responsibility. Most superintendents are unaware of this fact and lack the qualifications needed for such a position.

The OSHA Laboratory Standard is necessary to ensure that all employees working in science laboratories are appropriately informed about hazardous chemicals being used, aware of the risks involved, and familiar with the standard operating procedures the employer has established to minimize employee exposure to these hazards.

Who Is Responsible for Chemical Hygiene In Middle School Labs?

The simple answer is that *everyone* is responsible for chemical hygiene.

- The superintendent of schools has ultimate responsibility for chemical hygiene within the institutions they supervise and must (with other administrators) provide continuing support for institutional chemical hygiene.
- The science department head, chairperson, or head teacher is responsible for chemical hygiene in his or her school.
- The CHO helps all stakeholders operate within the expectations of the CHP. The National Research Council (NRC; see References) recommends that CHOs
  - work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices;
  - monitor procurement, use, and disposal of chemicals used in the lab;
  - see that appropriate audits are maintained;
  - help project directors develop precautions and adequate facilities;

  - know the current legal requirements concerning regulated substances; and
  - seek ways to improve the chemical hygiene program.
- The laboratory supervisor is responsible for chemical hygiene in the laboratory. (The science teacher is considered to be the laboratory supervisor for school academic labs.) The laboratory supervisor should
  - ensure that workers know and follow the chemical hygiene rules, protective equipment is available and in working order, and appropriate training has been provided;
  - provide regular, formal chemical hygiene and housekeeping inspections, including routine inspections of emergency equipment;
  - know the current legal requirements concerning regulated substances;
  - determine the required levels of protective apparel and equipment; and
  - ensure that facilities and training for use of any material being ordered are adequate.

Zeroing In on the Chemical Hygiene Officer

The specific CHO responsibilities in most school districts are an outgrowth of the sample responsibilities provided in the OSHA Lab Standard Appendix A. The following are the basic responsibilities of a middle school CHO:

- Chemical hygiene plan (CHP): The CHO should work in concert with the science faculty and administration to develop the OSHA-mandated CHP and provide copies to all employees and school and central office administrators.
- Training: The CHO should provide appropriate training (initial and annual updates) and resources relative to the CHP.
- Recordkeeping: The CHO should maintain training records (three years minimum) and have an up-to-date laboratory chemical inventory with corresponding Material Safety Data Sheets (MSDS) or Safety Data Sheets (SDS).
- Compliance inspections: The CHO should make sure that training, accident, and other records, in addition to the CHP, are available to safety and health enforcement officers.
- Personal protection: The CHO should ensure the engineering controls, standard operating procedures, and personal protective equipment are provided, operating as designed, and followed as per the CHP.
- Medical consultations: The CHO should report any chemical exposure incidents to the administration, document cir-

cumstances of the exposure, and work with the exposed employee on medical consultation, evaluation, and follow-up.

- Safety audit: The CHO should provide an annual laboratory safety checkup audit and submit it to the superintendent of schools.

Final Word

Safety is a communal responsibility for all involved in the science laboratory. The CHO is critical in helping facilitate the safeguards put in place as part of the CHP to protect both the teacher and students. Science teachers should petition their administration to make sure at least one CHO is appointed at their schools.

References

Occupational Safety and Health Administration (OSHA). OSHA 29 CFR 1910.1450: Occupational exposure to hazardous chemicals in laboratories. *www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106*

National Research Council (NRC). National Research Council (NRC) recommendations concerning chemical hygiene in laboratories. *www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10107*

4. NSTA's Portal Into the Safety Zone

In 2010, NSTA's Science Safety Advisory Board launched the Safety in the Science Classroom web portal, which contains safety resources for teachers, supervisors, and administrators. Upon entering the portal, visitors first see an interesting overview of mandated employer or board of education safety responsibilities for employees, titled OSHA Training Requirements and Guidelines for K–14 School Personnel. This document provides a definitive summary of all relevant OSHA training requirements and guidelines that most boards of education are required to provide. This resource includes training guidelines, characteristics of an acceptable trainer, and topics required. It further points out varied legal requirements at both the national and state levels.

The Safety Resources List

The balance of the portal contains an evolving list of safety resources for both elementary and middle/secondary schools. The list includes professional societies, federal and state agencies, nonprofit and for-profit companies, and science supply houses that provide safety services and products for K–12 schools. Any for-profit company listed must make free materials or services available to K–12 schools.

Resources for Middle and Secondary School Teachers

So what kind of resources can middle school science educators expect to find? Here is a partial listing of some of the groups you can connect to through the portal, as well as examples of specific resources the groups have available:

- American Association of Poison Control Centers: poison prevention resources, tips, etc.
- American Chemical Society: *Safety in Academic Chemistry Labs*, recommendations for goggle cleaning, chemical storage resources
- California State Department of Education: *Science Safety Handbook for California Public Schools*
- Centers for Disease Control and Prevention: *School Chemistry Laboratory Safety Guide*
- Cole-Parmer: *Interactive Chemical Compatibility*
- Connecticut State Department of Education: *Middle School Science Safety: Prudent Practices and Regulations*
- Council of State Science Supervisors: *Science and Safety: Making the Connection—A Secondary Safety Guide*
- Environmental Protection Agency: Schools Chemical Cleanout Campaign (SC3), *Chemical Management Resource Guide for School Administrators*

- Fermi Science Support Center: science safety issues
- Fisher Scientific: *Safety in High School and College Laboratories*
- Flinn Scientific: model chemical hygiene plan, overcrowding in science labs
- The Hartford: *An Overview of OSHA's Laboratory Standard*
- Howard Hughes Medical Institute: lab safety
- Laboratory Safety Institute: numerous safety publications
- Lab Safety Supply: *E-Z Facts*
- Local Hazardous Waste Management Program in King County (Seattle): *Rehab the Lab* (advisory list of acceptable chemicals for use in the science lab)
- Maryland State Department of Education: lab safety manual
- Massachusetts Institute of Technology: *Tips for Sustainable Solvent Practice*, *Generic Solvents Alternative Guide*
- National Institutes of Health: household products Material Safety Data Sheet (MSDS) database
- National Oceanic and Atmospheric Administration: chemical database with response recommendations for more than 6,000 chemicals
- National Research Council: *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals*
- National Science Education Leadership Association: professional safety practice position statements, including Occupancy Loads in School Science Laboratories and Experiments/Activities With Human Blood and Other Potentially Infectious Materials (OPIMs)
- National Science Teachers Association: books on safety, position statements such as Liability of Science Educators for Laboratory Safety
- New York State Department of Education: chemical storage guidelines
- Occupational Safety and Health Administration: 29 CFR 1910.1450 Lab Standard and 29 CFR 1910.1200 Hazard Communication Standard
- Science and Safety Consulting Services: Chemical Substitution List, Eye Protection Options poster
- University of New Hampshire: *University of New Hampshire Biological and Chemical Safety Plan*
- U.S. Department of Transportation: *Emergency Response Guidebook*
- Virginia State Department of Education: *Safety in Science Teaching* manual

- Web resources for MSDS (SDS): various online resources for MSDS (SDS)

Final Safety Thought

Teachers should be aware that the list does not supersede school or school-system policy; local, state, or federal laws, regulations, or codes; or professional standards. Ultimately, it is the science teacher's and school administrator's responsibility to use appropriate legal standards and best professional practices under "duty of care" to make the science laboratory safer.

Resource

National Science Teachers Association (NSTA). NSTA Portal: Safety in the Science Classroom: *www.nsta.org/portals/safety.aspx*

5. Good-Bye MSDS, Hello SDS!

Science teachers who use the Material Safety Data Sheet (MSDS)—a form listing the properties of a particular substance—know that the potential hazards identified by different suppliers aren't always consistent. Unfortunately, this issue goes well beyond the secondary science laboratory—it's a global problem.

The Occupational Safety and Health Administration (OSHA) addressed this issue and other concerns with the adoption of a rule to change the Hazard Communication Standard (HCS), a national standard that addresses chemical management and employee safety. OSHA's new rule includes the adoption of the Globally Harmonized System for the Classification and Labeling of Chemicals (GHS)—a standardized system created by the United Nations to provide a worldwide standard for safety hazards—into the HCS. The goals of the GHS are to

- provide consistent information (e.g., health, physical, and environmental hazards) and definitions for hazardous chemicals,
- establish a standard format for Safety Data Sheets (SDS) and labels, and
- increase understanding by using standardized pictograms and harmonized hazard statements.

With the adoption of the GHS, the revised HCS will include the following major changes:

- Hazard classification: Chemical manufacturers will be expected to use specific criteria to classify health and physical hazards for pure chemicals and mixtures.
- Labels: Chemical manufacturers and importers will be mandated to provide precautions and labels that include signal words, pictograms, and hazard statements for each hazard class and category.
- SDS: The SDS will have a 16-section format with specific categories and information and will replace the existing MSDS.
- Information and training: Although the GHS does not address training, the proposed HCS will require that workers be trained within two years of the publication of the final rule.

Specific Changes

The existing HCS is performance based. It provides guidance for hazard determination but doesn't specify an approach, format, or language to convey hazards and other information on labels or MSDS. The new GHS has performance-based aspects, but the key provisions are uniformity oriented. For example, Health Hazards categories will be classified and defined via GHS protocols.

The new standard format for SDS includes these sections:

1. identification
2. hazard(s) identification
3. composition and information on ingredients

4. first-aid measures
5. firefighting measures
6. accidental release measures
7. handling and storage
8. exposure control and personal protection
9. physical and chemical properties
10. stability and reactivity
11. toxicological information
12. ecological information
13. disposal considerations
14. transport information
15. regulatory information
16. other information

OSHA will probably not enforce the sections that require information outside of its jurisdiction (i.e., #12–16).

Labeling is another improvement. Labels will include

- the product name,
- a signal word (e.g., *danger* or *warning*),
- a hazard statement (explaining the nature and degree of risk),
- pictograms and symbols,
- a precautionary statement (how the product should be handled to minimize risks),
- the name and address of the company, and
- telephone numbers.

In the End

All of these changes will help science teachers better assess the risk of using hazardous chemicals in the laboratory.

Science teachers can track regulation changes and the adoption process on OSHA's website (see Internet Resource).

Internet Resource

Globally Harmonized System for Hazard Communication: *www.osha.gov/dsg/hazcom/global.html*

INDEX

THE NSTA READY-REFERENCE GUIDE TO SAFER SCIENCE

VOL. 2

"The purpose of this volume is to raise awareness of safety issues and of how to develop a safer learning and working environment in middle schools. In addition to protecting students, the guides address legal standards and professional best practices to help teachers stay out of harm's legal way."

—Author Ken Roy on *The NSTA Ready-Reference Guides to Safer Science*

Safer science is a daily requirement for every teacher in every science classroom and laboratory. Get up-to-date information from *The NSTA Ready-Reference Guide to Safer Science, Volume 2*. This second volume is a collection of more than 40 of the latest quick-read "Scope on Safety" columns from *Science Scope*, NSTA's middle school journal (plus some adaptable "Safer Science" columns from *The Science Teacher*, NSTA's high school journal). As easy to read as it is practical, the book is chock-full of safety information, anecdotes, and advisories you can use every day.

The book's rich array of offerings includes

- general safety practices;
- legal issues, including negligence and liability;
- safety concerns in specific disciplines, including chemistry, Earth and space science, biology, and physical science;
- more than 40 teacher questions on everything from acrylic nails to latex goggles to ventilation; and
- helpful safety-related NSTA position papers and internet resources.

Learn more with these other great resources:

The NSTA Ready-Reference Guide to Safer Science, Volume 1, for grades 5–8: This collection of articles covers more safety practices and legal standards (on subjects from asbestos to ergonomics to blood-borne pathogens) and instructional safety (such as occupancy loads, field trips, special-needs students, and more).

The NSTA Ready-Reference Guide to Safer Science, Volume 3, for grades 9–12: This collection covers systems to help prevent and control lab safety hazards, from eyewash showers to ventilation, and standard operating procedures covering general safety precautions and specific disciplines.

Grades 5–8

NSTA press
National Science Teachers Association

PB215X2
ISBN: 978-1-936959-06-8
9 781936 959068