FEATURE

Implementation of a science laboratory safety program in North Carolina schools

North Carolina is one of the 26 Occupational Safety and Health Administration (OSHA)-approved "State Plan" states, including Puerto Rico and the Virgin Islands [Occupational Safety and Health Administration. *Occupational Exposure to Hazardous Chemicals in Laboratories*; 29 CFR Part 1910.1450, 1990]. As a "State Plan" state, North Carolina Occupational Safety and Health (NC OSH) has jurisdiction over all schools – public, charter and private. NC OSH adopted the Lab Standard, 29 CFR §1910.1450 – Occupational Exposures to Hazardous Chemicals in Laboratories [North Carolina Department of Labor, Division of Occupational Safety and Health. *North Carolina Occupational Safety and Health Standards for General Industry*; 29 CFR Part 1910 as adopted in 13 NCAC 07F.0101 with amendments through February 1, 2001, 1970]. Statewide, schools have been slow to respond to this regulation even though a Chemical Hygiene Plan (CHP) was required January 31, 1991. The North Carolina State Board of Education (NCSBE) passed State Board Policy HSP-F-017 – Science Laboratory Safety Policy, August 4, 2005, requiring middle/secondary schools to submit their chemical hygiene plans to the NCSBE Office by January 31, 2007 [North Carolina State Board of Education. *SB HSP-F-017-Science Laboratory Safety Policy*, 2005].

By Linda M. Stroud, Clara Stallings, Todd J. Korbusieski

INTRODUCTION

Laboratory accidents happen. Students drop things, bump into equipment and make errors in judgment – it is a fact of life. Administrators and teachers make errors in judgment as well. Laboratory investigations and demonstrations sometimes simply go awry. However, just because laboratory accidents happen does not mean that laboratory injury is either inevitable or unavoidable. If schools properly train staff and through them students, and implement and adhere to appropriate laboratory safety protocols, the laboratory experience can be both safe and rewarding. Furthermore, schools that are proactive, instead of reactive, enable staff and students to minimize exposure to potentially hazardous or unhealthy situations within the school laboratory setting.

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School safety, as a concept, typically involves guns, knives and trespassers. It is essential, however, that the definition be broadened to include dangers which exist within the school walls and are assumed to be safe. Specifics

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include, but are not limited to, improper storage, use and disposal of hazardous chemicals in the science laboratory and poor air quality in labs due to improper ventilation. If you ask school administrators about their school safety plans, most will describe how students are protected from violent acts. Few encompass hazards associated with the science laboratory. Mr. Harry Wilson, Esq., NCSBE, states "school science laboratories may be the most dangerous places in our schools."[4]

Every day, students at all grade levels from kindergarten to seniors in high school participate in science instruction involving hands-on science activities. Many of these activities include heat, electricity and/or chemicals, thus presenting potentially dangerous or unsafe conditions. Parents expect safe conditions for their children, and school administrators are charged with providing a safe learning environment for the students in their care.

There is no question that accidents occur daily in science laboratories. Hellman et al., report that approximately 32,000 student accidents occur in schools each year with around 17% ($n = 5000$) directly related to science.[5] Private industry takes safety far more seriously. In an industrial setting, personnel do not assume their duties until they complete mandatory safety training. Can you imagine a science teacher not being able to report to the school laboratory to teach until having received science laboratory safety professional development as required by 29 CFR Part 1910.1450?[1,2] Many science laboratory accidents in schools are considered minor–just small cuts or burns–yet truly traumatic injuries, such as loss of eyesight due to chemical splash accidents and severe burns can and do happen. A survey done by Hagelburg found that slightly over one-fifth of all science teachers had a student suffer a serious injury, one requiring a physician's care at some time during their career.[6] There is not an agency–state or national–to whom laboratory accidents are reported unless they involve a mercury spill, an explosion or someone being seriously burned or injured. The lack of a systematic, strategic statewide policy for reporting all laboratory accidents seriously impacts the collection of data needed to establish effective safety protocols. The fact is that the vast majority of school accidents fall just short of these reporting criteria. By not collecting information on these "minor" accidents, we limit our ability to respond and prevent the "catastrophic" ones.

Table 1. Accidents and Lawsuits: Iowa 1990–1996

Accidents	Lawsuits
1990–1993 = 694	1990–1993 = 96
1993–1996 = 1000+	1993–1996 = 245

Numerous articles have been written on the role that science teachers play in science laboratory safety, as teachers are the front line of defense in preventing laboratory injuries. Ms. Clara Stallings conducted a science safety workshop in North Carolina in 2003 for new science teachers. Out of 100 teachers, only five had received science safety education in their teacher preparatory courses at the college level. Often overlooked, but equally important in science safety, are school principals who are ultimately responsible for student safety. Very little has been written on the responsibility of principals to ensure a safe laboratory environment. Authors who have written on the subject agree that administrators share in the responsibility for safe laboratory instruction along with teachers, students, and parents. Lab safety familiarization is virtually nonexistent in school-based administrator training and, as a result, administrators have been shown to lack knowledge regarding science laboratory safety.

A recent study performed in North Carolina by Dr. Todd Korbusieski confirmed this assertion. An electronic survey was given to all principals in the public schools of North Carolina who were employed during the 2004–2005 school year. The survey was designed to determine both the knowledge and perceptions that school principals had concerning science laboratory safety.[7]

Almost 60% of principals felt their knowledge of science laboratory safety was minimal. Principals had some knowledge of specific safety equipment such as fire extinguishers, goggles, and eyewashes but they lacked more in-depth knowledge such as types of goggles or maintenance requirements for eyewashes and showers. Most did not know basic laboratory design such as laboratory square footage requirements or the need for a compatible chemical storage system. Very few principals were assigned to schools that had dedicated, well ventilated chemical storage areas or standard operating procedures (SOPs) necessary whenever chemicals are in use. Elementary principals perceived laboratory science instruction was not as important as their middle and high school counterparts. Statistical analysis showed that high school principals did report more knowledge of science safety than their middle and elementary school counterparts. Only one-third of all principals reported that they had any formal science laboratory safety training either as teachers or administrators (25% of principals were previously science teachers). There is a wide disparity between the perceived importance of safety knowledge and the actual knowledge principals possess. Principals at all school levels are in need of further training in science laboratory safety.

Both the number of accidents in school science laboratories and the resulting lawsuits have dramatically increased since the National Science Education Standards (NSES) were developed and adopted by the National Research Council in 1995. One of the essential guiding principles in the development of the NSES is "Learning science is an active process."[8] The National Science Teachers Association (1995) suggests that 70% of middle school science instruction and 40% of high school science instruction should be hands-on laboratory experiences. Obviously, as more students are engaged in these activities, the likelihood for laboratory-related accidents rises, as well as potential litigation due to laboratory-related

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accidents. As science inquiry in our school laboratories has increased so has the number of accidents and lawsuits as Gerlovich et al., found in Iowa (Table 1).[9]

As the number of accidents and lawsuits accelerate so do litigation costs and monetary settlements. Teachers and administrators alike have been found guilty of negligence and have suffered the legal consequences.

Science laboratory safety must receive more emphasis at all levels to prevent accidents and to allow students to learn in a safer environment. There are challenges in the way. The increase in student enrollment over the past 20 years has strained current facilities. Many science laboratories also serve as Social Studies or English classrooms during science teachers' planning periods and many laboratories are severely overcrowded. Additionally, many science instructors are "roaming" teachers who teach science in non-science classrooms.

Many schools lack basic science safety equipment. Recent surveys by Stallings et al.,[10] in 2001 and Korbusieski[7] in 2005 show many schools do not have properly functioning eyewashes, safety showers or the correct goggles for chemistry wet labs. Most injuries can be prevented with the proper safety equipment.

Teachers and administrators do not receive sufficient safety training. Proper training at all levels will contribute to a safer learning environment for our students. It is imperative that more emphasis is placed on safe hands-on science instruction because Science IS – Inquiry . . . Safely.

HISTORY OF NORTH CAROLINA SCHOOLS SAFETY PROGRAM

There has been a concerted effort to provide science laboratory safety training for North Carolina school personnel. Dr. Bill Spooner, a former Science Consultant and Director of Instructional Services at NCDPI initiated the Science Laboratory Safety Program for North Carolina Public Schools. Dr. Spooner served on the Council of State Science Supervisors (CSSS) that worked with the National Institute of Occupational Safety and Health (NIOSH) to develop a national science laboratory safety manual. Dr. Spooner published the science laboratory safety manual, *Safety First in Science Teaching*, in 1977, with revisions in 1983 and 1988. Dr. Jake Brown, NCDPI Science Consultant, assisted Dr. Spooner in the development of this safety program. The long-range, statewide plan consisted of the following:

Each school, administrative office and teacher preparatory college/university received a copy of this manual.

- Statewide Local Education Agencies (LEA) Leadership Awareness Conferences were held at each of the eight Regional Education Service Alliances (RESAs) to inform school administrators of emerging issues in science laboratory safety.
- Three-day Summer Leadership Safety Institutes were established to provide LEA science supervisors and lead science teachers with in-depth knowledge to replicate a safety course in their respective LEAs.
- NCDPI supplied these safety trainers with manuals, overhead transparencies, a 35 mm slide presentation and 16 mm safety films to provide professional development for science teachers in the LEAs.
- Dr. Spooner also obtained a $10,000 grant to remove hazardous chemicals from schools.

The result was that from 1977 to 1988, 5000 individuals, mostly science teachers, received in-depth laboratory safety training. To quote Dr. Spooner: "Safety had never been a part of the science teacher preparatory program in colleges and most teachers came to the workshops thinking they did not need the in-service. Most left in a mild state of shock at their ignorance!"[11]

In the mid-90s, Dr. Jack Gerlovich, JaKel Inc., worked with the NCDPI science consultants, Dr. Brown and Ms. Stallings, to provide science laboratory safety professional development using *JaKel's* Total Science Safety System (TSSS) specifically designed for North Carolina schools. Ms. Stallings worked as the NCDPI Middle School Science Consultant and NCDPI Project Director of the science laboratory safety program from October 1997 until February 2006. Stallings et al. (2001) conducted a survey of North Carolina middle and secondary science teachers regarding the status of science safety in North Carolina Schools. Common findings relating to schools and ultimately science safety were:

- Lack of, or inappropriate, personal protective equipment (PPE) for students and teachers (Figure 1).
- Need for updated facilities – 40% are outdated buildings.
- Failure of new facilities being built to meet safety standards/regulations (i.e., lack of eyewash stations or water in laboratories).
- Inadequate chemical management system for procurement, Material Safety Data Sheets (MSDSs), inventory, storage and disposal (Figures 2 and 3).
- Lack of equipment and materials to support the North Carolina Standard Course of Study in Science.
- Poor air quality in laboratories and chemical storerooms.
- Overcrowding in laboratories.

Science laboratory assessments conducted by Science & Safety Consulting Services (S&SCS) in over 200 North Carolina middle and secondary schools in 29 of 115 LEAs verify the survey results obtained in Stallings et al. study.[10] New schools often lack the same safety equipment and exhibit the same problems as older schools. LEAs with a high tax base are no different from low-wealth LEAs.

In 2001, Stallings and Gerlovich revised the 1990's version of the

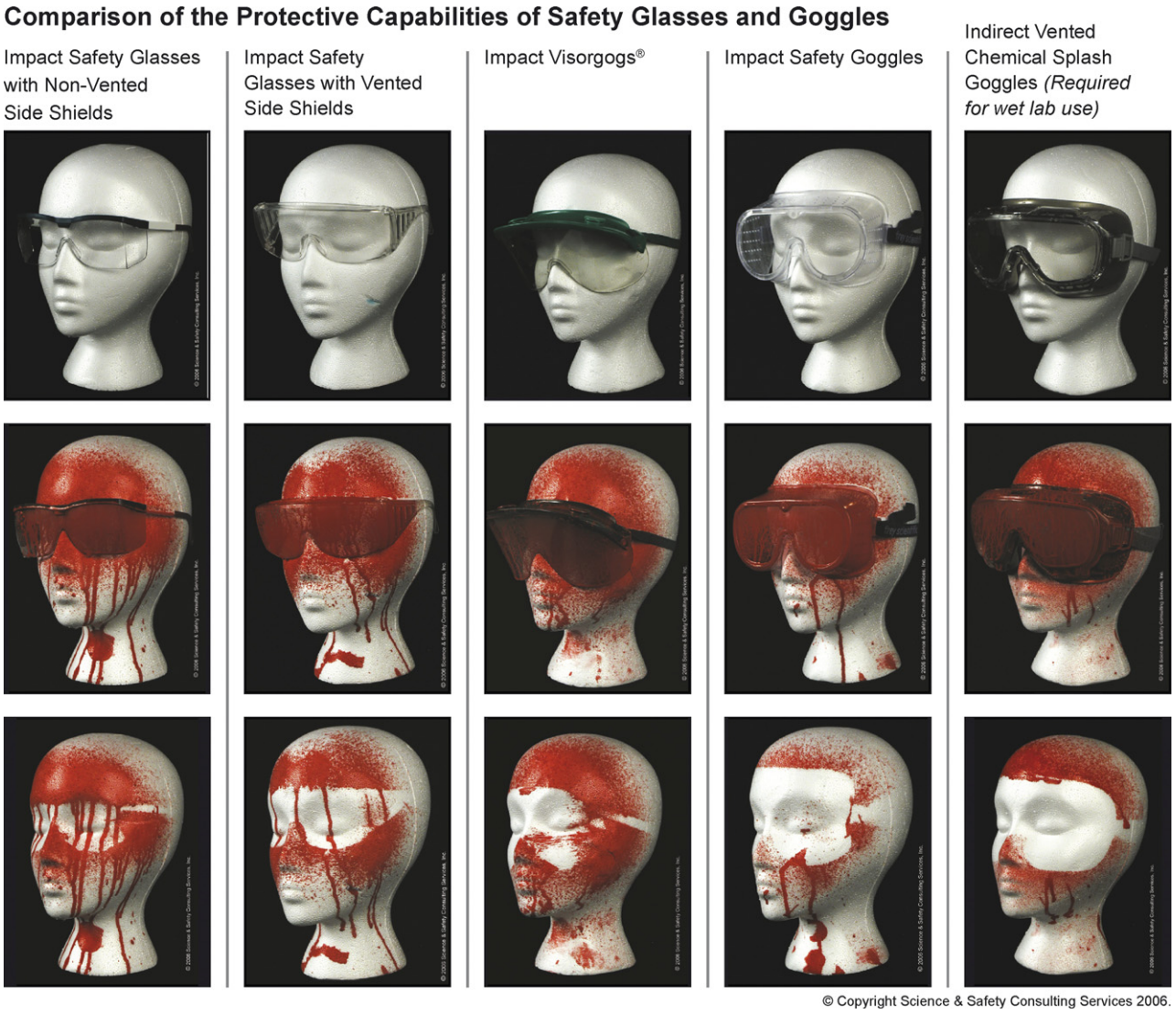

Figure 1. Courtesy S&SCS, used with permission.

North Carolina TSSS Compact Disk (CD) with input from the North Carolina Science Safety Committee.[12] This committee represented most stakeholders in science education. All aspects of the North Carolina science curriculum; North Carolina and federal laws, regulations, and standards; building and fire codes; personal protective equipment; and chemical management are included on the TSSS CD. Gerlovich has developed TSSS CDs for more than 20 states in the US. In 2001–2005, NCDPI sponsored workshops conducted by Mr. Bill Tucci, Stallings, and Gerlovich throughout the state. NCDPI supplied CDs for each school in LEAs that sponsored science safety professional development for their science teachers. Safety training was held at the NCDPI Middle/Secondary School Summer Conferences and at the North Carolina Science Teachers Association (NCSTA) annual conferences.

From 2001 to 2003, NCDPI (Stallings and Tucci) piloted the TSSS Program with volunteer LEAs. The ultimate goal was to develop a Needs Prioritization of laboratory safety deficiencies in middle/secondary school laboratories in these LEAs. This information was used to develop a Chemical Hygiene Plan (CHP) for the schools and a Science Safety Program that would be sustainable. Stallings and Tucci summarize the "lessons learned" as follows:

- One-size-does-not-fit-all. Generic guidelines are spring boards for locally determined protocols and processes. Site specificity is imperative.
- Science instructional and science laboratory safety programs will not just happen. Safety must be an integral part of instruction. The infrastructure to support, maintain, manage, and sustain safe inquiry-based science must be designed.
- Many issues encountered in schools can be resolved when protocols are

Figure 2. Incorrect chemical storage system: unlabeled bottles, inappropriate chemicals for secondary school laboratories and incompatible chemical storage, courtesy Larry Cockrell, NCDPI, used with permission.

established, communicated and implemented. For example,

- Teachers expressed frustration at "having asked for a fire blanket for three consecutive years without results." Safety needs historically have low priority.
- Teachers and supervisors identified chemicals for disposal, yet the disposal process was never implemented.

- School systems must realize that many of the critical issues and problems with chemicals are the result of years of stockpiling and non-disposal habits. LEAs must plan, prioritize, and implement correctly. For example, the first step in chemical management is to get a current, accurate inventory. This can be a daunting task. Therefore, completing a chemical inventory must be a priority and must be supported with time for science staff to accomplish it. The cycle never ends. The resources to manage and sustain a comprehensive, safe science program are needed both short and long term. Reassessment must follow assessment. Continuing professional development in laboratory safety for teachers and administrators is required by law and necessitates dedication of resources.

Figure 3. Correct chemical storage system: bottles labeled, appropriate chemicals for secondary school laboratories, compatible chemical storage. Courtesy S&SCS, used with permission.

School systems have consistently asked for state-level policy and assistance. Dr. Mike Ward, former NC State School Superintendent, pushed for both intra-agency support at NCDPI and interagency support for laboratory safety between state agencies and LEAs. Dr. Ben Matthews, NCDPI School Support Services Director, and Ms. Eileen Townsend, Insurance Section Chief, supported the training for NCDPI Fire Safety Inspectors during the 2005 and 2006 Summer Science Laboratory Safety Facilitators Seminars conducted by S&SCS. Fire Safety Inspector, Larry Cockrell, has made significant contributions to the Science Safety Program through presentations on fire safety. When he inspects schools, the chemical storeroom is an essential part of the fire inspection process. Additionally, Mr. Wilson became the legal advisor for technical aspects of the NCDPI safety initiative. He also served as counsel for drafting science safety policy for the NCDPI science staff and was a co-presenter of SB HSP-F-017–Science Laboratory Safety Policy–to the NCSBE. Interagency networking between NCDPI and the NC Department of Agriculture (NCDA), NC Department of Labor (NCDOL), and NC Department of Environment and Natural Resources (NCDENR) was established in order to avoid "re-inventing the wheel" and to ensure that industrial and business standards were appropriately translated to apply to the school laboratory setting.

Ms. Stallings approached the North Carolina School Boards Association (NCSBA) for assistance with state-level policy to serve as guidelines for administrators. In 2002, the NCSBA

adopted Policy 7265, establishing 29 CFR §1910.1450 – Occupational Exposures to Hazardous Chemicals in Laboratories and "Universal Precautions" as part of the North Carolina Administrative Code for School Administrators.[13] North Carolina General Statute, NC G.S. § 115C-105.47 "Safe, Orderly & Caring Schools Assessment Inventory," also includes science laboratory standards.[14] The North Carolina Science Standard Course of Study has two strands–science inquiry and safety.[15] Under the leadership of Dr. June Atkinson, current NCDPI State School Superintendent; Dr. Wandra Polk, NCDPI Director of the Division of Secondary Education; Tucci and Stallings; the NCSBE passed SB HSP-F-017–Science Laboratory Safety Policy in 2005.[3] This policy requires schools to submit their CHP to the NCSBE office by January 31, 2007. It also established criteria for the endorsement of professional development providers by NCDPI for Science Safety.[16] This policy is the impetus for LEAs taking science laboratory safety more seriously. Now, all stakeholders must build on this foundation to provide a stronger, sustainable science laboratory safety program in North Carolina.

BUILDING A SUSTAINABLE SCIENCE LABORATORY SAFETY PROGRAM

Customized Comprehensive Science Safety Laboratory Program (C^2S^2LP)[17]

Building on the lesson "one size does not fit all," the S&SCS C^2S^2LP, is flexible and adaptable for each LEA. LEAs vary in size and numbers of personnel at each LEA Central Office. Cost Analysis and Problem Solving tools aid LEAs and school administrators in prioritizing, budgeting and developing timelines needed to address and rectify the safety needs detailed on the Needs Assessment Report. The process of classifying assessed needs allows school teams and LEAs to determine if the need is an action, protocol, policy, or budget item, as well as the person responsible for resolving the safety need. The steps of the C^2S^2LP are:

- Initial meeting with LEA leaders to explain the need for science laboratory safety and the C^2S^2LP
- Awareness session
  - Process explanation
    - Explains components of C^2S^2LP
    - Establishes a need for science laboratory safety program
    - Prepares lead science teachers to conduct self-assessments of their school laboratories and storerooms
    - Establishes need for a LEA Safety Committee
    - Develops support from all stakeholders for the Science Safety Program
    - Discusses the requirement for the CHP and a sustainable Science Safety Program
  - Stakeholders
    - LEA Superintendent or Associate
    - LEA Instructional Services Director
    - LEA Science Consultant
    - LEA Facilities Director
    - LEA Safety Officer
    - Principal from each middle/secondary school
    - Lead science teacher from each middle/secondary school

- Laboratory assessments of middle/secondary schools
  - Safety consultant uses a laboratory assessment form that lists safety equipment, chemical management protocols, facility related problems, and security issues required to meet 29 CFR 1910.1450 (Figure 4).[18]
  - Teachers use the same laboratory assessment form as the safety consultant uses to assess middle/secondary school laboratories.
- Needs Assessment Report[19]
  - Utilizes the teachers' self-assessment and the safety consultant's assessment for each science laboratory.
  - Lists safety problems for each laboratory, chemical storeroom, science storeroom and prep room in each school.
  - Prepares assessment report for the LEA based on overall safety needs of the schools to develop policies and SOPs for the LEA.[20]
- Needs assessment prioritization session
  - Same stakeholders are present from the awareness session
  - Stakeholders categorize safety needs on the Needs Assessment Report as:
    - Action
    - Policy
    - SOP
    - Budget
  - Stakeholders determine required safety equipment and needs using the *Science Safety Requirements: Middle and Secondary School Science Classrooms*, Lenk & Stroud[21]
  - Stakeholders assign cost of each item on Needs Assessment Report using *Cost Analysis* (Figure 5), Lenk & Stroud[22]
  - Stakeholders establish responsibility and timeline for completion of each item using Problem Resolution (Figure 6), Lenk & Stroud[23]
  - Prioritization Plan will become an essential part of the Chemical Hygiene Plan.
- Development of the CHP
  - LEA Safety Committee is established composed of LEA and school personnel
  - Committee decides on a CHP model to use for developing its own CHP
  - Committee establishes LEA policies, SOPs
  - Committee writes an "Umbrella CHP"
  - Each middle/secondary school modifies the "Umbrella CHP" to fit the specific school
  - CHP goes to Local School Board for approval
  - CHP is distributed to appropriate personnel
  - Each middle/secondary school submits CHP to NCSBE
- Professional Development Plan
  - LEA Safety Committee establishes a Professional Development Plan for science teachers and administrators
  - New science teachers in the LEA must receive science laboratory safety training upon employment.
  - Veteran teachers are updated as necessary (i.e., as new information

Lab Assessment Form

SCHOOL	ROOM #	CLASS / GRADE LEVEL			
Location	Problems / Concerns / Issues— Suggestions for _____ based on findings from site visit to schools	Action Taken - Policy / Protocol - Budget Item Facilities / Maintenance request	Date Planned	Person Responsible for Follow-through	Date Completed
	CHEMICAL INVENTORY				
	Current (up to date)				
	Computerized				
	Any hazards on list				
	Absolute need determined for each chemical				
	Need to purge				
	Purge process in place				
	Disposals marked				
	Inventory for bids				
	Process to order				
	Process to check in				
	Process to check out				
	Process to reshelve				
	Responsibility				
	Containment materials for spills				
	Bucket of sand for metals				
	NFPA Diamond on Chemical Storeroom Door				
	Copy of chemical inventory for Fire Department				

Figure 4. Partial laboratory assessment form, courtesy S&SCS, used with permission.

becomes available). Veteran teachers require a science laboratory safety professional development course minimally every three to five years.

- Each school establishes a school science laboratory professional development library consisting of resources to provide teachers with ready reference materials, since workloads rarely afford teachers time to conduct web research. Often state and local laws/regulations differ from national regulations. Inadequate safety training in college/university teacher preparatory courses is often lacking.
- Science Safety Facilitators
  - One-week Summer Science Laboratory Safety Facilitators Seminars are presented annually by S&SCS. National science safety consultants, representatives from NIOSH, NC OSH, the NCDPI Insurance Section, and NCDENR share their expertise. It is imperative that a person in each LEA understands the laws, regulations, standards and codes to assist all stakeholders in comprehending the requirements for a science laboratory safety program. In 2005 and 2006, facilitators from 49 of 115 LEAs in the North Carolina acquired the tools and information to conduct science laboratory safety professional development for their respective LEAs. These individuals are essential keys, leading their LEAs in the development of sustainable science safety programs.

- Science laboratory safety sustainability plan

Cost Analysis

SCHOOL	ROOM #	CLASS/GRADE LEVEL			
Location	Problems/Concerns/Issues— Suggestions for _____ based on findings from site visit to schools	Action Taken -Policy/Protocol -Budget Item Facilities/Maintenance Request	Date Planned	Person Responsible for Follow-through	Date Completed
L-1	Chemical Inventory				
L-1	Current (up to date)				
L-1	Computerized				
L-1	Any hazards on list				
L-1	Absolute need determined for each chemical				
L-1	Need to purge				
L-1	Purge process in place				
L-1	Disposals marked				
L-1	Inventory for bids				
L-1	Process to order				
L-1	Process to check in				
L-1	Process to check out				
L-1	Process to reshelf				
L-1	Responsibility				
L-1	Containment materials for spills				
L-1	Bucket of sand for metals				
L-1	NFPA Diamond on Chemical Store Room Door				
L-1	Copy of chemical inventory for Fire Department				

Figure 5. Partial cost analysis form, courtesy S&SCS and Alan Lenk, used with permission.

- A science laboratory safety program cannot be sustained without all stakeholders' continued support and involvement.
- Administrative support from LEA and school is imperative.
- Administrators must give the LEA Chemical Hygiene Officer (CHO) and the school CHO the authority and resources to enforce the safety program and CHP.
- The CHP must be updated annually and the safety program must have an annual evaluation as well.
- Safety facilitators to provide professional development for LEA personnel is required.

MODEL SCIENCE SAFETY PROGRAMS

Several exemplary programs developing in North Carolina schools are as follows.

Buncombe County Schools

Dr. Alan Lenk, Science Supervisor, has been the leader in this program. Buncombe County was one of the pilot programs in the Science Laboratory Safety Program, which started in 2003. Dr. Lenk developed three documents that were instrumental in helping administrators determine the required safety equipment and associated costs to bring the science laboratories to standard:

- Requirements for Middle/Secondary Science Laboratories[23]
- Cost Analysis[22]
- Problem Resolution[23]

The Cost Analysis and Problem Resolution documents helped administrators prioritize their safety needs and develop a timeline for completion. This analysis enabled a school and an LEA to determine budget planning. Will the school be able to absorb the costs or will the LEA have to fund the costs? Will the LEA have to go to the local School Board and request more funds, and ultimately, will the local School Board have to go to the County or City Board of Commissioners? In

Science Safety Problem Resolution: Cost Levels and Primary Responsibility

Every item on the Needs Assessment List has a corresponding management cost. In any of the following levels, you can have so many needs to meet the OSHA Laboratory Standard, that it may become a financial liability that an individual school cannot meet, thus requiring additional funding sources from the LEA. For example, in Level 2, so many items may be needed in a given school depending on its size and "state of safety issues" the LEA or outside monetary assistance may be needed.

Level 1: Problem can be resolved at the school level with no or very little funding required. Often a policy decision is all that is required. *Example: creation of a computerized inventory.*

Level 2: Problem can be resolved at the school level. Materials and supplies and/or equipment funding is required.

Example: the purchase and mounting of a wool fire blanket; Lips on chemical storage shelves, non-exit and exit lights in science laboratories/classrooms.

Level 3: Problem will require assistance outside the school building to resolve. The district maintenance department or agency or company outside the school system may be required. Significant capital outlay resources will be required.

Example: Exhaust ventilation to building exterior for chemical storage.

Level 4: Problem will require major school and/or classroom renovation. On this item, we pick our battles: we try to rectify the situation as soon as we can to make the science classroom/laboratory as safe as possible according to 29 CFR 1910.1450 and 29 CFR 1910.1200. *Example: Science classroom size issues or number of exits in classrooms.*

Developed by Linda M. Stroud and Alan Lenk, Science Consultant, Buncombe County Schools.

Figure 6. Courtesy S&SCS and Alan Lenk, used with permission.

North Carolina, the Elementary and Secondary Education Act, NC G.S. §115C-521 – Erection of Schools and NC G.S. §115C-522 – Provision of Equipment for Buildings, requires the local school boards and Boards of Commissioners to provide appropriate facilities and equipment and instructional materials for science.[24] Buncombe County is well on its way in developing a sustainable science safety program.

Northwest Regional Education Services Alliance (NWRESA)

This RESA has 15 LEAs that range from very large to very small. Some of these systems are classified as low-wealth LEAs. The NWRESA was a recipient of a 2004 Math/Science Partnership (MSP) Grant. Safety was a requirement to obtain this grant. The NWRESA sent a representative from each of the 15 LEAs to the one-week Summer Science Laboratory Safety Facilitators Seminar that is conducted by S&SCS. These individuals are trained in Science Laboratory Safety to serve as facilitators in their respective LEAs. The participants include lead science teachers, principals, LEA Curriculum Specialists, Safety Officers and Facilities Directors. S&SCS has developed a *Science Laboratory Safety Facilitators Manual*,[25] a *Science Laboratory Safety Manual*,[26] a *Chemical Inventory CD*[27] and a *Science Safety Presentation CD*[28] that can be used by the facilitators to develop a science laboratory safety professional development program for their respective LEAs and a sustainable laboratory safety program. Ms. Dee Hanlin, MSP Project Director, NWRESA, has funded all support materials needed for these facilitators. Each school was given a *Science Safety Laboratory Safety Manual* and a *Chemical Inventory CD* for reference. The NWRESA also has a retired Science Consultant to help these LEAs.

Nash/Rocky Mount Schools

Nash/Rocky Mount Schools were also recipients of a 2004 MSP Grant. S&SCS conducted the C^2S^2LP for this LEA. Nash/Rocky Mount Schools supported the C^2S^2LP initiative for secondary schools. The LEA sent its Safety Officer and Facilities Director to the Summer Science Laboratory Safety Facilitators Seminar. Mr. Scott Hedgepeth, former Nash/Rocky Mount CHO, started the initial science laboratory safety program working on the disposal of hazardous chemicals found in the schools. Ms. Carol Turner-White, current MSP Director, and Superintendent, Rick McMahon, have been essential keys to making this an exemplary program. Ms. White recognized the requirement for the LEA to provide science laboratory safety professional development for all science teachers at the beginning of the 2006 school year. *Science Laboratory Safety Manuals* were provided for all schools by the LEA. The "Pursuing Excellence in Middle School Math and Science" MSP Grant funded the Safety Assessments of all middle schools and professional development for all K-12 science teachers. To indicate the need for continued professional development for administrators as well as teachers for sustainability, the Superintendent is requiring all principals to attend a Science Laboratory Safety Workshop to inform them of their legal responsibilities and the need to support their school science laboratory safety program.

Harnett County Schools

Ms. Rebecca Hunter, Harnett County Director of Grades 9–12 Instruction, funded Ms. Stephanie Kincaid, secondary science teacher, to attend the Summer Science Laboratory Safety Facilitators Seminar for two consecutive years and Ms. Pandora Matthews, a middle school teacher, in 2006. Harnett County Schools purchased a *Science Laboratory Safety Manual*[26] and provided professional development for all science teachers in the LEA at the beginning of the 2006 school year. Ms. Kincaid feels confident to assess the Harnett County science laboratories and storerooms. When inspecting a chemical storeroom in one of the schools, Ms. Kincaid found NI_3 stored in a glass mayonnaise jar. She knew when and where to seek support on how to safely dispose of this chemical.

In each of these model programs, there is a key leader who is dedicated to meeting the CHP requirement and developing a sustainable science laboratory safety program. Safety facilitator training and support materials needed are provided in each program. S&SCS also maintains a listserve of all Seminar participants and LEAs who have used the C^2S^2LP. This listserve enables networking and dissemination of the most current safety updates.

RECOMMENDATIONS

- The NCSBE must require SB HSP-F-017–Science Laboratory Safety Policy to be fully implemented by NCDPI, LEAs and schools.
- NCDPI needs a Science Safety Officer to develop and implement a five-year plan to bring all LEAs into NC OSH compliance. The Safety Officer would audit school CHPs and school science laboratories to ensure implementation of the laboratory standard. Grants need to be written to develop and fund science safety professional development courses for LEAs.
- Colleges and universities that have undergraduate and graduate science education teacher programs must include science safety education. Student teachers and novice science teachers must have science safety training when they enter the school science laboratory. College and university science education schools must adopt this policy in their science teacher preparation courses.
- All school administration certification programs must include science safety education as a part of the required curriculum. Administrators need to know the laws, regulations, and standards that apply to science laboratories. College and university school administrator education departments and Principal Leadership Programs must adopt this policy in their administrator preparation courses.
- The NCSBE and NCDPI must develop a science safety test that all school administrators and science teachers must pass before employment and certification granted.
- The NCSBE and the NC Legislature need to mandate that new schools and remodeled schools be built with the required safety equipment needed in science laboratories. A chemical storeroom and the science departments must have a separate heating, ventilation and air conditioning system from the school's system.
- A statewide chemical cleanup is needed to remove unwanted, decomposing and hazardous chemicals from schools. Possible sources of funds for a hazardous waste removal program are the North Carolina Legislature and EPA. NCDENR has received a $40,000 grant for chemical cleanup from EPA's Schools Chemical Cleanout Campaign (SC^3).

CONCLUSIONS

A sustainable science laboratory safety program requires top–down support. The North Carolina Safety Initiative began with NCDPI science consultants in 1977. Science laboratory safety professional development for key school leaders was the core of the long-range, statewide science safety plan. Support materials provided by NCDPI to these leaders ensured science teachers received consistent science laboratory safety training. From the 1977 to 2004, the safety program went through changes that focused on "lessons learned." The Initiative finally gained the support from top NCDPI administrators such as the Director of Curriculum and Instruction, State School Superintendent, State School Board Attorney and other state agencies (NCDOL and NCDENR) and professional organizations (NCSBA). The NCSBE adopted the SB HSP-F-017–Science Laboratory Safety Policy. This policy requires all schools to submit their CHP to the NCSBE Office by January 31, 2007. The NCSBE has the authority to establish policy for North Carolina schools. NCDPI must develop audits to ensure enforcement of SB HSP-F-O17 in LEAs and schools.

Professional development in science laboratory safety for LEA personnel, school principals and science teachers is essential for an LEA and school to have a sustainable science laboratory safety program.

Professional development in science laboratory safety for LEA personnel, school principals and science teachers is essential for an LEA and school to have a sustainable science laboratory safety program. From 2004 to present, S&SCS assessed over 200 middle/secondary schools, assisted LEAs in the development of CHPs, provided professional development for K-12 science teachers and LEA personnel and held two Summer Science Laboratory Safety Facilitators Seminars. These "lessons learned" and experiences culminated in the development of an evolving school science labora-

tory safety model–the Customized Comprehensive Science Safety Laboratory Program (C^2S^2LP). In every model science laboratory safety program we have observed, someone is making it happen–an LEA Science Safety Facilitator with support and authority from his/her LEA Superintendent and school board.

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