Chapter 3
Physical Layout of the Laboratory
3. 1 Safety Audit and Safety Inspections
An important tool for maintaining a safe environment in the science laboratory is a safety audit. A safety audit ensures that the necessary safety items are available and in proper working condition. A safety audit is also an important planning tool. If it reveals deficiencies in safety equipment, a prioritized list of needed safety items or modifications in the physical layout can be prepared and budgeted. Such an audit helps the school in meeting requirements of the chemical hygiene plan (chapter 12) and in defending a teacher against allegations of negligence (section 5.1). The safety audit checks for the availability of safety equipment such as eyewash fountains and fire extinguishers, personal protective equipment such as chemical splash goggles (section 6.4.1), physical features of the room such as master cut-off controls for water, gas, and electricity, and proper storage of chemicals. Frequent safety inspections, typically every three months, are needed to ensure safety equipment is ready in case of an emergency. The safety audit and safety inspections should be under the control of the school safety committee (section 9.2). Copies of the safety audit and safety inspections should be maintained as permanent records of the school.
An example of a safety audit is included below. More detailed discussion of these items will be found later in this manual. Please refer to these sections for more specific criteria. In many cases, the criteria may be defined by the school district.
Sample Safety Audit
School: _____
Room: _____ Area: _____ Location: _____
Teacher: _____
Grade level of students: _____ Type of Use: _____
This list is to be used as a means of identifying certain desirable features and fixtures as well as hazardous conditions that may exist in laboratories. More specific details regarding these items can be obtained in this guidebook and in the references cited.
Interior Layout of Room Section in Guidebook
Yes No
Are interior circulation paths adequate?
Are aisles and work areas free from clutter? 3.2.10
Is the room handicapped accessible? 3.2.11
Is there an adequate number of paths of travel leading to the outside of the building?
Do the exit door(s) open in the direction of the path of exit travel?
Policy and Procedures Section in Guidebook
Yes No
Are there school or district policies requiring inspections? 9.2
Are there requirements for reporting malfunctions?
Are all emergency procedures for fire, spills, and evacuation posted and highly visible? 4.1.3
Have emergency procedures for fire, spills, and evacuation been practiced with students?
Have you received proper training for the appropriate use of the type(s) of fire extinguishers in the lab?
3.2.4

Are local (room) cut-off controls and outlets for water, gas and electricity readily accessible, properly labeled and easily distinguished?
3.2.8
Is there an emergency communication system available from the classroom?
Are waste chemicals and waste solvent containers capped and clearly labeled with their contents?
Does mercury containing apparatus have a catch pan or other secondary container?
9.1.4

Fixtures, Equipment and Furnishings Section in Guidebook
Yes No Comments

Are eyewash fountains clearly labeled and have they been checked for proper operation?
3.2.2
Is the safety shower or drench hose clearly labeled and accessible from any part of the room in 10 seconds?
3.2.3
Are fire extinguishers clearly labeled and accessible from any part of the room within 10 seconds?
3.2.4
Does the fume hood have adequate air flow? Is it kept clean and not used to store chemicals? Is electrical equipment that may provide sparks such as variable transformers and power strips not located in hoods where flammable liquids are used?
3.2.9
Are fire blankets available, clearly labeled, and mounted for easy reach from the floor?
3.2.5
Is the first-aid kit adequately stocked 3.2.6
Are spill kits for acids, bases, flammable solvents, and mercury available, clearly marked and accessible?
Are special waste receptacles for broken glass and other sharp objects available and clearly labeled? Is the heavy plastic or ceramic container lined with a very tough plastic bag so custodians can remove the liner without handling the broken glass?
9.1.1
Are all pieces of equipment in proper working order or clearly marked “out of service” for repair?
Are all cords on electrical equipment in good condition?
Are belt guards present and properly functioning?
Are table tops or other work surfaces made of nonflammable, chemical resistant material?

Personal protective equipment Yes No

Are approved safety goggles available for each student and for visitors?
6.4.1
Is there a means of sanitizing safety goggles between usage?
3.2.1
Are protective gloves available that are appropriate for the chemicals being used?
6.4.2
Are there lab aprons available? 6.2
Are there beaker and crucible tongs available for handling hot glassware?

9.1.1
Are there suction bulbs available for pipetting? 9.1.5
Electrical and Ventilation Systems Yes No
Are there a sufficient number of appropriate kinds of electrical outlets in the appropriate locations?
Is the room lighting adequate?
Is the room ventilation adequate with at least 4 air exchanges per hour?
3.2.9
Is there an exhaust or purge fan available? 3.2.9
Is there a fire detection system?
Chemical Storeroom Section in Guidebook
Yes No Comments Guidebook
Can the storeroom can be locked and access restricted? 7.5.1
Does the storeroom have a smoke alarm?
Are there are fire resistant cabinets for flammable solvents?
7.5.1.1
Is the chemical refrigerator explosion proof and labeled "**No Food**"?
7.5.5
Is chemical shelving secured to the wall or floor? 7.5.1
Do the shelves have lips to prevent bottles from sliding off?
7.5.1
Is there adequate ventilation? 3.2.9
Are chemicals stored according to their chemical properties with color coded labels used to identify compatible chemicals?
7.5.1
Are acids stored in corrosion-resistant cabinets? 7.5.1
Is an ABC fire extinguisher available and have you been trained to use it?
3.2.4
Are protective leakproof containers available for transporting corrosive chemicals?
7.5.1
Is an inventory of chemicals in the storeroom available and has it been updated annually?
8.1.2
Are peroxide-forming chemicals marked with the date opened and tested for peroxides every 6 months or disposed of?
7.4.7
Are glass containers stored in a location where there is little chance breakage will occur?
7.5.1
Are gas cylinders firmly secured? 7.5.4
Are waste-chemical and waste-solvent containers are capped and clearly labeled with their contents and the word "**WASTE**"?
Are all containers of chemicals clearly labeled with the name of chemical, appropriate hazard warning, name of manufacturer or responsible party? Does the label on prepared solutions include the date mixed and the name of preparer?
7.5.6
Sample Safety Inspection
School: _____

Room: _____
Inspector: _____
Date: _____

Check for proper operation of:	**Satisfactory**	**Unsatisfactory**	**Date Remedied**
Eyewash fountain			
Safety shower			
Fume hood			
Auxiliary ventilation			

Condition of:	**Satisfactory**	**Unsatisfactory**	**Date Remedied**
Fire extinguishers			
Fire blanket			
First-aid kit			
Spill clean-up kits			

Hazards	**Satisfactory**	**Unsatisfactory**	**Date Remedied**
Exits are not blocked.			
Aisles are not cluttered.			
Chemicals are not stored in room.			
Glassware is not cracked or broken.			
Chemicals are properly labeled.			

Housekeeping	**Satisfactory**	**Unsatisfactory**	**Date Remedied**
Sinks and sink traps			
Fume hood			
Work counter tops			
Table tops			
Floors			
No food or drink			
Broken glass container			
Waste containers for chemicals			

This safety inspection should be repeated every three months.

3.2 Use and Maintenance of Safety Items that Should be Available in All Laboratories

All of the safety equipment should be clearly labeled for easy location.. Safety equipment must be inspected regularly, typically every three months, and these inspections recorded. All faculty and students using the laboratory must be trained in the use of safety equipment.

3.2.1 Sanitation of Safety Goggles

If safety glasses and goggles are used by multiple students, it is important to sanitize them between each student use. Ultraviolet (UV) cabinets that hold up to 30 goggles and take from 5 to 15 minutes for a sterilization cycle are commercially available. A lower cost, but less convenient, alternative is to use a chemical disinfectant. Commercial goggle and facemask disinfectant cleaners are available in packets from goggle distributors. Household bleach and disinfectants can be used by diluting to the strength recommended on the label. Dip the goggles in the disinfectant solution and allow to air dry. Goggles are easily scratched and should not be wiped with cloth or paper towels. Products that contain alcohol dry faster but may adversely affect some plastics. If

alcohol is used for disinfection, commercial alcohol wipes available from local drug stores may be used. Be sure to test your goggles with alcohol to make sure the plastic is not damaged.

3.2.2 Eyewash Fountains

Eyewash fountains are essential in any area when chemicals are used. Caustic chemicals can damage the eye within seconds of contact. John Brodemus has described a demonstration using cow eyes to illustrate the rapid damage of corrosive solutions to the eye. 1 If someone gets foreign material in the eye, the person must reach the eyewash in a few seconds. The American National Standards Institute (ANSI) requires that an eyewash be reached within 10 seconds and be within 100 feet of the hazard. Within the 7ANSI Z358.1-1990 standard is the recommendation that the time required to reach an eyewash should be determined by the hazard. For strong acids or strong caustic chemicals, the eyewash should be located immediately adjacent or within 10 feet of the hazard (ANSI Z.358.1-1990 E 7.4.4). 2

An eyewash fountain should:

- Treat both eyes simultaneously
- Provide a gentle flow of water for at least 15 minutes
- Be accessible within 10 seconds from the time of injury
- Leave both hands free to hold eyelids open
- Be accessible for all students

A plumbed eyewash fountain is best. A hand-held spray which can be a commercial model or a faucet shower attachment sold at local retail stores may supplement but not replace, a plumbed eyewash. This attachment must be modified by cutting off the faucet attachment and inserting the tubing over a laboratory sink faucet outlet. 3 Portable eyewash squeeze bottles are not an acceptable alternative because they can treat only one eye, provide an inadequate supply of water, are susceptible to contamination, and provide a good environment for the growth of microorganisms.

The National Safety Council recommends that all plumbed eyewash fountains be flushed for three minutes a week to reduce the risk of eye infections. All maintenance should be recorded. 4

Use of Eyewash Fountains 5

1. Begin washing the face, eyelids, and eyes for at least 15 minutes as soon as possible. The eyelids should be held open and the eyes rotated as much as possible to ensure removal of the chemical.
2. If the student is wearing contact lenses, the lenses should be removed immediately if at all possible. Continue flushing even if contacts cannot be removed.
3. If the student is lying down, gently hold the eyelids open and pour water from the inner corner of the eye outward. Do not allow the chemical to run into the other eye.
4. In the case of an alkaline burn or any other serious eye injury, immediately send for an ambulance so that first aid will not have to be discontinued during transport to medical facilities

3.2.3 Safety Showers

A safety shower must be available in each laboratory. The safety shower is used to wash hazardous chemicals from the skin and may be used on clothing fires. The Emergency Eyewash and Shower Equipment Standard (ANSI. Z, 358.1-1990) requires that an

emergency shower should be located no more than 10 seconds in time nor greater than 100 feet in distance from the site of the emergency. The ANSI recommendation is that the maximum time to reach the shower should be determined by the potential effects of the chemicals being used. For strong acid and strong caustic chemicals, safety showers should be located within 10 to 20 feet of the hazard (ANSI Z.358.1-1990 E4.6.1). 2 The shower should be labeled, easily accessible, and free from obstructions. Deluge showers should provide uninterrupted flow of water until the valve is intentionally closed. Deluge showers are intended for major spills. A floor drain is a useful feature, but its absence should not prevent installation of a safety shower. The mess can be tolerated on the rare times the shower is used; however, care should be taken to avoid shock from contact with electrical equipment and the water that collects on the floor. Anti-slip floor mats may be provided. The shower should be tested on a regular basis and a record kept. A hand-held water sprayer with a 6-foot hose is a good alternative for small spills such as usually occur in the teaching laboratory. The hand-held spray can be directed to the affected part of the body and can also function as an eye wash. 3 This drench hose is a supplement, not a replacement for a plumbed safety shower.

1. Begin use of the shower as soon as possible, removing any contaminated clothing while in the shower (the fire blanket may be used for privacy).
2. The victim should remain in the shower for a minimum of 15 minutes, washing the skin with water or with soap and water for some organic chemical splashes. The water temperature should not be at extremes which might discourage the use of the shower. Precautions should be taken to protect the user from frigid conditions.
3. Avoid use of neutralizing solutions unless recommended by medical personnel.

3.2.4 Fire Extinguishers

In the event of a fire, you must decide if you can fight the fire or should evacuate the building and leave the job for professionals.. Most laboratory fires are small fires that can be extinguished easily without calling the fire department. However, even small fires can spread very quickly and become major fires. It may be better to call the fire department and evacuate the building even if someone is fighting a small fire, since any lost response time can make the difference between a lab fire and a building fire. The first few minutes can be critical. The decision whether or not to fight a fire will depend on the size and location of the fire and your comfort level in dealing with the situation. The safety of you and your students, not school property, is the first priority.

In case of a fire, the following course of actions have been recommended: 6, 7

- Alert other people in the laboratory and send for assistance. Never attempt to fight a fire alone.
- A fire contained in a small vessel can usually be suffocated by covering the vessel with a watch glass or inverted beaker.
- A clothing fire should be extinguished by using the stop, drop, and roll procedure or smothering with water or a fire blanket. **Fire extinguishers are not to be used on people**.
- In case of a serious fire, evacuate everyone except those persons trained to fight fires.
- Sound the fire alarm and call the fire department.
- Shut off master gas and electrical power.
- Close windows and doors if possible.

- If the fire is spreading or could block your escape route, leave immediately and leave the job to professionals.

If you choose to fight the fire, make sure you are using the correct fire extinguisher. There are 4 classes of fires:
Class A - wood, paper, plastic, cloth
Class B - flammable liquids
Class C - electrical
Class D - combustible metals (Na, K, Mg, etc.)
Water is useful **only** for Class A fires, the common trash-can fire, and should **never** be used with Class B, C, or D fires. Multipurpose Class ABC dry chemical fire extinguishers contain monoammonium phosphate and are recommended for use in all classrooms. However, powder from dry chemical extinguishers may rapidly enter computers and cause permanent damage. CO2 fire extinguishers are recommended in labs where computers are present. Small combustible metal fires can be extinguished using dry sand. Special Class D fire extinguishers are available and are recommended if you use combustible metals such as magnesium, sodium, or potassium in experiments or demonstrations. Do not use CO2 fire extinguishers on Class D fires.
Fire extinguishers must be hung or placed where they are easily accessible but cannot be knocked over. Signs indicating the location of the fire extinguishers should be easily visible.
Fire extinguishers should be of an appropriate size for the incident. A UL rating system on the label indicates the coverage. For example, 4A:60B:C means that the extinguisher is adequate for 4 square feet of a Class A fire, 60 square feet of a Class B fire, or may be used on a Class C fire. It is important to know that the standard 10-15 pound fire extinguisher provides an uninterrupted stream of material for only about 30 seconds. All teachers and students should know how to use a fire extinguisher. A helpful mnemonic is the **PASS** rule:

Use of the Fire Extinguisher

1. **P**ull the ring or lock pin without squeezing the handle.
2. **A**im the nozzle at the base of the flame.
3. **S**queeze the handle.
4. **S**weep the fire retardant across the fire. Short blasts of the fire extinguisher should be directed at the base, not the center, of the fire.

Pull **A**im, **S**queeze **S**weep
When the fire goes out, stop squeezing and wait in case it flares up again. While you are fighting the fire, have someone get a second fire extinguisher in case the one you are using runs out.
After use, have the fire extinguisher recharged immediately.

3.2.5 Fire Blankets

Fire blankets are made of flame-retardant wool. Some old fire blankets were made from asbestos and should have been removed from school premises. 8 Fire blankets may be either folded or rolled vertically in wall-mounted cases and should be prominently labeled. Fire blankets are useful for smothering small fires. Clean fire blankets are useful in keeping accident victims warm to help prevent shock or to cover a wet victim after being under the emergency shower. The maximum suggested distance a person should travel to reach a fire blanket is 30 feet. 9 A folded fire blanket should be unfolded and

placed on the floor so the victim can wrap it around his/her body. When using a vertically mounted blanket, the victim should lie on the floor as soon as the blanket leaves the case. There is concern about using a fire blanket to wrap a person when his/her clothing or hair is on fire. The stop, drop, and roll procedure is probably the safest in most situations. A safety shower is very useful for extinguishing burning clothing. Fire blankets must be used cautiously because wrapping the body can force flames toward the face and neck, can hold heat next to the body, thus increasing severity of burns. Fire blankets are laden with fibers, dirt, and bacteria than can infect or further damage wounds from burns.

3.2.6 First-aid Kits

A medical treatment program is required as part of the chemical hygiene plan.

An adequately stocked first-aid kit is necessary to provide emergency aid until medical treatment is available. The first-aid kit should be stocked according to school policy following recommendations by the nurse or advising physician. For chemical exposure, the MSDS describes emergency medical treatment. Emergency phone numbers should be prominently posted. These numbers may include 911, local poison control center, and local hospital or ambulance. Staff should be trained in basic first aid and CPR according to school policy. Disposable latex gloves should be part of any first-aid kit to prevent the spread of blood-borne pathogens (section 6.5).

3.2.7 Refrigerators 6

Household refrigerators should never be used for chemical storage because the controls, switches, and defroster can spark and ignite flammable material. Food should **never** be stored in a chemical refrigerator. Chemical refrigerators should be clearly labeled "**No Food**". See section 7.5.5 for a more complete discussion of chemical refrigerators.

3.2.8 Master Gas and Electrical Cut-offs

In case of a fire or electrical accident, you should shut off the gas and/or electricity in the laboratory. Master electrical and gas cut-off switches should be available in each laboratory, clearly labeled, and should be readily accessible and easy to use. A master switch in a locked cabinet or one that requires a wrench to operate will not be useful in an emergency situation.

3.2.9 Ventilation: Fume Hoods and Exhaust Fans 6, 7, 10

Adequate ventilation is important in any room in which chemicals are used or stored. Inadequate ventilation limits the kinds of activities that can be done and the chemicals used in the laboratory. An adequate ventilation system should change the room air 4-12 times per hour. The Illinois Administrative Code specifies requirements for all educational rooms. The requirements under this code depends on the age of construction. Pre-1965 construction is covered under section 185, construction from 1965 until March 24, 1995 is covered under section 175, and construction after March 24, 1995 is covered under section 180. All air from laboratories should be exhausted outdoors and not recirculated in the building. The ducts should be situated so that exhausted air does not enter fresh air intakes.

Each classroom should have an emergency ventilation fan that can exhaust room air during an accidental spill or release of hazardous or irritating vapors. Lack of odor is not an adequate criteria of good ventilation since many chemicals such as mercury have no odor at hazardous levels. A knowledge of the hazardous chemicals being used helps reduce risk from exposure. If the presence of hazardous vapors is suspected, monitoring may be required. Emergency auxiliary ventilation should put a negative pressure on the

room so air moves into the room and prevents vapors from being recirculated through the building. The occasional use of such auxiliary ventilation can reduce the conflict between the high energy costs of ventilation and the need to protect students and teachers from harmful levels of chemicals.

Chemical storerooms should have ventilation adequate to keep atmospheric levels of chemicals below their hazardous limits (threshold limit value (TLV) or permissible exposure limit (PEL)). As with room ventilation, 4-12 air changes per hour are recommended on a continuous basis to prevent buildup of toxic or hazardous concentrations of vapors. All ventilation systems should be regularly evaluated to ensure they are operating properly.

Fume hoods are intended to keep flammable gases, toxic vapors, or noxious odors from entering the general room atmosphere. The American Conference of Government Industrial Hygienists (ACGIH) recommends that hoods be used when working with chemicals having a TLV of 50 ppm or less. The concentrations of vapors in the room must be below the TLV listed in the MSDS for the chemical(s) used. Microscale procedures in which smaller quantities of chemicals are used can reduce exposure to hazardous and noxious vapors.

Rules for Using Fume Hoods

1. Do not store chemicals in a fume hood.
2. Fume hoods must be inspected for proper operation. Exhaust rates of 60-120 lfpm (linear feet per minute) have been recommended, but the ACS points out that exhaust velocity is not a reliable single criterion for hood performance.

A smoke bomb may be used to visually monitor air flow. If you use a smoke bomb, you should notify others in the building and the fire department to prevent a false alarm. Inexpensive (less than $30) vaneometers are available to measure face velocity. The Illinois Administrative Code contains specific requirements for exhaust rate from laboratory fume. For specific requirements sections 185, 175, and 180 of the Illinois Administrative Code should be consulted depending upon the year of construction of the laboratory.

3. Keep the sash at its most efficient level.
4. Work as far inside the hood as possible, but keep your head outside the hood.

A minimum working distance of 6 inches from the front of the hood is recommended.

5. Locate the hood away from windows, doors, and heavily trafficked areas because drafts can adversely affect the effectiveness of a hood.
6. The canopy-style hoods that are built over a lab bench are inadequate to ensure proper exhaust rates.

3.2.10 Evacuation Route

In case of an accident, evacuation may be necessary. When an emergency occurs, it is too late to develop a plan. Procedures for emergency evacuation from the laboratory must be carefully prepared and written into the chemical hygiene plan. The plans used for mandated fire and tornado drills can be adopted. You and your students should practice this plan so you can respond in case of an emergency. Establish a chain of communication so it is clear who notifies the office, who calls the fire department, and so on. Everyone in the laboratory should meet at a predetermined place to make sure everyone is out of the building. There should be two unobstructed paths of exits from the laboratory (for specific details consult Illinois Administrative Code 185, 175, or 180

depending upon the year of construction). In order to keep the aisles clear, students should not sit during the laboratory exercise. Stools should be pushed under the laboratory benches, and laboratory drawers should be kept closed.

3.2.11 Handicap Access

The manual "Teaching Chemistry to Students with Disabilities" is a valuable guide to ensure that students with disabilities receive the level of laboratory experience that is appropriate for the individual student (section 5.3.4). 11 In some cases, handicapped students are paired with another student or a laboratory assistant may help the student. Students with impaired mobility must have access to safety equipment, utility controls such as faucets and gas jets, restrooms, telephones, doors, and exits. Eye wash fountains and chains on safety showers must be accessible to students with impaired mobility.

Visually impaired students may need extra time to familiarize themselves with the location of sinks, eye wash stations, safety showers, exits, and other laboratory facilities and safety equipment. These students may need larger letters on labels, a magnifying glass, or Braille or large print instructions. Copies of the safety rules and safety contract should be made available in Braille or large print.

Students with impaired hearing may require visual warnings instead of the normal audible alarms. Hearing impaired students should be placed in a part of the laboratory where they have unrestricted view of the instructor.

3.3 Class Size

The National Science Teachers Association (NSTA) recommends that there be a maximum of 24 students in a laboratory class. These students must have immediate access to the teacher. 12 Large class size as a result of increased enrollment or budgetary constraints is an important issue for science teachers, since safety problems increase with larger class size. 13,14 The correlation of increased class size with increased accident rate has been documented. Not only does the chance of an accident increase as more students move about the room carrying equipment or chemicals, but direct supervision and instruction by the teacher becomes difficult in large classes. The presence of too many students in a lab can also create problems when they have to wait too long for chemicals and equipment or have too much down time. Under these circumstances, boredom sets in and increases the possibility of someone removing safety goggles, engaging in horseplay, or otherwise violating safety rules with the resulting risk of an accident. 15

A 1992 survey of state requirements revealed that only Florida has enforceable guidelines for class size in laboratories. Of the 43 states and Territory of Samoa that responded to the survey, twenty other states have guidelines which set class size at 25 or fewer or set limits based on the size of the room. Illinois and 16 other states have no class-size legislation.

If a teacher believes that the laboratory is too crowded for safety, he/she should place the concerns in writing to the department chair, principal, and superintendent. If the situation is not corrected, the teacher may request a liability waiver. If the situation is still not corrected, Steele, Conroy, and Kauffman recommend the teacher make a presentation of safety conditions and accident descriptions from local sources or the literature to the school board. The teacher and administration may enlist community support for a comprehensive laboratory safety program. Such a program would involve teachers, administrators, parents, industry, and the fire department in seeking a solution. Consider

creative alternatives to increasing budgets: revise scheduling plans instead of adding staff.15

3.4 References

1. Flinn Scientific Inc. 1992. Cow Eye/Goggle Demo. *CHEM FAX* 10062
2. American National Standards Institute, I. 1990. *American National Standard for Emergency Eyewash and Shower Equipment*, Vol. ANSI Z358.1-1990. New York: American National Standards Institute, Inc.
3. Flinn Scientific Co. Inc. 1994. *Flinn Chemical Catalog & Reference Manual*, p. 567. Batavia, IL: Flinn Scientific Inc.
4. Committee on Chemical Safety. 1990. *Safety in Academic Chemistry Laboratories*, p. 47. Washington, D.C.: American Chemical Society. 5th ed.
5. Missouri Department of Elementary and Secondary Education. 1990. *Missouri Secondary Science Safety Manual*. Columbia, MO: Missouri Department of Elementary and Secondary Education
6. Committee on Chemical Safety. 1990. *Safety in Academic Chemistry Laboratories*. Washington, D.C.: American Chemical Society. 5th ed.
7. Committee on Hazardous Substances in the Laboratory. Assembly of Mathematical and Physical Sciences. National Research Council., ed. 1981. *Prudent Practices for Handling Hazardous Chemicals In Laboratories*. Washington, D.C.: National Academy Press
8. Illinois State Bar Association. 1992. Asbestos Abatement Act. In *Illinois Compiled Statutes*:105 ILCS 105.
9. Flinn Scientific Co. Inc. 1994. *Flinn Chemical Catalog & Reference Manual*, p. 532. Batavia, IL: Flinn Scientific Inc.
10. Flinn Scientific Co. Inc. 1987. Science Department Ventilation: Safety in the School Laboratory. *Flinn Fax* 87-1
11. Kucera, T. J., ed. 1993. *Teaching Chemistry to Students with Disabilities*. Washington, D.C.: American Chemical Society. 3rd ed.
12. National Science Teachers Association, ed. 1992. *NSTA Handbook 1992-1993*.
13. Holliday, W. G. 1992. Should We Reduce Class Size?: What the Research Really Says. *The Science Teacher* January: 14-17
14. Flinn, III, LC. 1994. Overcrowding in the Science Laboratory. In *Flinn Chemical Catalog and Reference Manual* :588-89. Batavia, IL: Flinn Scientific Inc.
15. Steele, M. M., Conroy, P. A., Kaufman, J. A. 1992. There's no Safety in Numbers: Class Size and High School Laboratory Safety - A Survey of State Legislation and Guidelines for Action at Local Levels.