For Safety Sake, One Class Size Does Not Fit All!

New Directions and Facility Implications!

The National Science Standards, AAAS Project 2061, NSTA Scope Sequence and Coordination Project and, state and local science curriculum initiatives all agree on one issue: Students need to do science, not just read about it! As a result, the philosophy of hands-on, inquiry and process-based science education seems to be having an effect on curriculum revisions and school building projects across our nation. At the middle and high school levels, the need for formal laboratory facilities is increasing as a result of growing student populations, adopting additional science graduation requirements, increasing Advanced Placement college level science courses, and meeting the national priority of science education. Through these formal laboratory facilities, teachers are better able to foster both qualitative and quantitative data acquisition and skill development in efforts to enhance the understanding and learning of science.

Science teachers and science leadership are being challenged to meet both academic and safety concerns with the advent of renovations and/or new construction of science laboratories. Items to be addressed on the safety agenda include engineering controls (e.g., acid shower, eyewash), work practice and/or administrative controls (e.g., laboratory standard operating procedures, scheduling), and personal protective equipment (e.g., splash goggles, gloves, aprons). However, the greater challenge for science educators is to meet occupancy load standards for the purpose of establishing and maintaining a safe working and learning environment. The controversial issue of science laboratory overcrowding has existed for many years. Many building administrators, central office administrators and even some science educators don't seem to have an understanding of the safety issues involved or are unable and in some cases unwilling to take the steps to address them. This situation has presented a dilemma for science educators.

How Many Occupants Can Science Labs Accommodate?

First, by definition, NFPA-45 (National Fire Protection Association, Standard on Fire Protection for Laboratories Using Chemicals NFPA-45, 1996) defines a laboratory as "a room or space for testing, analyzing research, instruction or similar activities that involve the use of chemicals." OSHA's Laboratory Safety Standard (CFR 1910.1450 Occupational exposure to hazardous chemicals in laboratories, Occupational Safety & Health Administration, US Department of Labor, 1990) defines the term "laboratory" as, "a facility where the 'laboratory use of hazardous chemicals' occurs. It is a workplace where relatively small quantities of hazardous chemicals are used in a non-production basis." Most, if not all, secondary science laboratories are usually classified under these and/or other appropriate safety standards. Science educators must remember not to confuse the terms "science laboratory" with that of "science classroom." A science classroom is for lecture/discussion—the talking about science. The laboratory is about doing the science. This is where the safety standards are most applicable.

Occupancy Loads are defined under Section 1008.1 of the national building code (The BOCA National Building Code/1996, Building Officials and Code Administrators International, Inc., 1996) as "... the number of occupants for whom exit facilities shall be provided." Additionally, Occupancy Loads are defined by NFPA (NFPA 101 Life Safety Code, National Fire Protection Association, 1997) as "The total number of persons that might occupy a building or portion thereof at any one time." In most states, these standards are adopted by state legislatures and become law. Additional legal and quasi/professional occupancy standards have been established by state legislatures, state education departments and professional organizations such as the National Science Teachers Association (NSTA) and the National Science Education Leadership Association (NSELA).
BOCA building codes are based on how a room is used. For example, there are two occupant load factors listed in BOCA Table 1008.1.2 (The BOCA National Building Code/1996, Building Officials & Code Administrators International, Inc., 1996) for educational occupancies: Classrooms at 20 net square feet (s.f.) and shops and vocational areas at 50 net s.f. Shops and vocational areas would include rooms where more floor area is needed for each occupant, such as wood, metal or auto shops and science labs. These standards recognize the need for additional space resulting from student workstations, equipment and more, to maintain occupant safety. This scenario is compared to a traditional classroom with primarily student desks and therefore less space for each occupant. According to BOCA, "A 'typical' shop or lab arrangement generally incorporates an arrangement of work stations or lab tables expressly equipped with apparatus or facilities germane to the curriculum. A 'typical' shop or laboratory arrangement is what the 50 s.f. net floor area per person is based on. For that matter, school conditions may allow for shop and laboratory classroom arrangements to facilitate simultaneous laboratory and classroom instruction. Therefore, it is quite possible that a science classroom would incorporate a combination of both laboratory and classroom arrangements. In which case, the appropriate allocation of 50 net s.f. and 20 net s.f. is necessary."

(Interpretation dated 24 May 1999 by BOCA International on interpretation of Section 1008.1.2 of BOCA National Building Code)

The NFPA on the other hand, bases its standard on classification of a building. Education facilities with science laboratories have an occupancy load classification as follows:

Classrooms: one person per 20 net sq. ft. (1.9 net sq. m);

Shops, laboratories, and similar vocational rooms, one person for each 50 net sq. ft. (4.6 net sq. m)


What Does Class Size Have To Do With Occupancy Load?

To maintain a safe working environment in a science laboratory at the middle or high school level, the science laboratory must be analyzed on the basis of determining the design load for safe exiting capacity.

Factors such as type of furniture, utilities, chemicals, sprinkler system, and number of exits are considered in determining the occupancy load level. The bottom line is the laboratory needs to be as safe a place as possible for students and teachers to work. Should an accident happen, there needs to be an effective means for all occupants to safely evacuate the laboratory. A laboratory class size over the design load does not meet the standard. Therefore, such a situation would be considered as a potentially unsafe working environment for students and teachers. For example, 1250 s.f. net laboratory having a class size of 24 students and one teacher meets the standard if the design load of the laboratory is 50 s.f. net/occupant. On the other hand, the same laboratory with 30 occupants would have a greater density and therefore could prove to be an unsafe working environment.

An employer such as a school board or superintendent can formally request modification of the 50 s.f. net/occupant as an occupant load level by proposing alterations in furniture floor plans, adding sprinkler systems, adding an additional exit door to the laboratory, and/or changing other factors. These factors tend to improve the safety level of the laboratory as a work environment. However, the request for modification must be approved by the "authority having jurisdiction;" i.e., town fire marshal, state fire marshal, state safety officer.

Where Do Science Teachers/Leadership Go From Here?
The stage of development a facility is at will dictate what actions need to be taken. As an advocate for a safe working environment in the science laboratory, teachers and leadership need to be knowledgeable in legal and professional codes/standards. They also need to help advocate for the standards.

For new construction or renovations in science laboratories—

1. Review NFPA and BOCA codes for educational institutions (science laboratories). Depending on the science educator's state or town, additional or alternative codes may be applicable and therefore should be researched.

2. Consult with the local and or state fire marshal, building inspector or safety officer for applicable codes/standards;

3. Be active in contributing to or directly involved in writing education specifications for facilities in efforts to meet occupancy load design expectations;

4. Help to educate administrators, board of education members, architects and others associated with decision-making power in efforts to better meet or exceed codes/standards for a safer working environment based on functions being affected.

For existing science laboratories—

1. Review NFPA and BOCA codes for education institutions (science laboratories). Again, the science educator's state or town may have additional or alternative codes, which need to be researched and met.

2. Have the "authority of jurisdiction" assist you to determine the occupancy load design of your laboratory facility;

3. Work with administrators in efforts to achieve and exceed the code/standard; e.g., changing factors necessary to better meet code/standard, reduction in class size to meet occupancy load.

Final Thought!

Remember that because you are a licensed science education professional, there is an expectation by the legal system relative to your performance. The science educator may determine, based on these safety codes/standards, that it is in fact unsafe in their science laboratory to conduct certain experimentation. In such cases, the science educator needs to consider alternatives for the short term such as altering the curriculum or omitting unsafe laboratory activities. The legal system would not look favorably on a science professional who was aware of an unsafe working environment, but didn't attempt to effect any change and had a safety incident. Negligence and liability can be very costly for all involved! Science can be fun, a learning experience and safe. In the long term, it takes knowledge, planning, commitment and cooperative initiatives with the school's administration/board of education to provide for a laboratory with a safe working environment.

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Dr. Ken Roy
K-12 Director of Science & Safety & authorized OSHA instructor
c/o Glastonbury Public Schools
Glastonbury, CT 06033-3099
Fax 860-652-7275
E-Mail: royk@glastonburyus.org