Clearing the AIR at School

Parents, administrators, school nurses, teachers, and students share a vested interest in providing a safe and healthy environment for our school-age community and themselves.

The air occupying our classrooms and schools in many ways resembles electronic technology. When computers operate properly, we often take for granted that they will always be there, patiently waiting to communicate that critical E-mail or provide access to the Internet. Likewise, we arrive at work expecting the air to be clear of pollen and dust, odorless, not overly drafty, and tempered to perfection. When the computer malfunctions, we experience hair-raising frustration over something that for many of us is simply incomprehensible. When the air is too hot or cold in our offices, a student suffers an asthma attack in class, or we detect formaldehyde odors wafting from the nearby biology lab, we may feel just as frustrated and baffled about the cause and what to do about it.

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BY DAVID T. DYJACK AND ANGELA B. DYJACK

This article will provide a primer on school indoor air quality, as well as some guidance on how to anticipate and prevent indoor air-quality problems before they arise.

Fortunately, the critical factors governing air quality in school buildings are fairly straightforward. This article will describe the major pollutant sources typically found in buildings and clarify the role of heating, ventilating, and air-conditioning systems in providing a healthful school environment. References for additional reading appear at the end of the article to assist those who desire more information about building-related health issues.

Indoor Air Quality: Significance and Relevance

Indoor air pollution became a health issue thousands of years ago when people began to prepare meals indoors and to heat their living areas with unvented open fires. Today, most individuals spend upwards of 90 percent of their time indoors—in their homes, various forms of transportation, places of employment, or at school.[1] The average student's school day provides a fitting illustration. Except for brief interludes outdoors, young people

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spend most of each day inside classrooms, laboratories, gymnasiums, libraries, auditoriums, etc. In fact, between kindergarten and grade 12, children spend approximately 14,000 hours in classrooms. This may at first glance seem inconsequential. But the 1987 U.S. Environmental Protection Agency Total Exposure Assessment Methodology (TEAM) report[2] revealed that air pollutants are often two to five times higher indoors than outdoors.

Unlike outdoor air quality, which is often highly controlled and scrutinized, air quality in schools is largely unregulated. The United States has national recommendations for classroom ventilation and occupational health standards to protect teachers from work-related hazards. Some locations may even have local health codes mandating minimal air quality for occupied buildings. However, no universal air-quality standard for schools currently exists. Therefore, educators and administrators need to understand indoor air circulation, some of the illnesses associated with the indoor environment, and most importantly, some basics for anticipating and controlling exposure to harmful substances.

Indoor Air Quality Contaminants

Six major categories of building contaminants can affect human health. Let us examine each of these in turn.

1. *Radon*—An odorless, colorless, naturally occurring gas often found in soils containing uranium, granite, shale, and phosphates, among others.[3] When radon decays, it emits a charged (alpha) particle, which readily attaches itself to airborne dust. Inhaling these particles can damage sensitive lung tissue. After sufficient exposure (length of time and/or intensity), lung cancer may result.

Radon typically enters buildings through cracks in concrete floors, floor drains, sump pumps, and similar pathways. At highest risk are structures with large surface areas that directly touch the earth (such as basements) in geographic locations where soils release large amounts of radon.

2. *Non-Viable Particulates*—Particles and dust from non-living sources. The two most common, which also present the greatest risks, are lead and asbestos. Both of these substances were widely used (and may still be used in many parts of the world) in building construction because of their durability and aesthetic properties. Unfortunately, both present serious health hazards for younger populations.

Because of its malleability, lead has endeared itself to generations of artisans and building-parts fabricators. Most older buildings still have lead paint, which for decades was added as a corrosion inhibitor or a pigment. Some buildings may also have leaded water pipes. Exposure to lead, particularly in young children, has been linked to brain damage and developmental problems.

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Children come into contact with lead at school by ingesting or inhaling it. Ingestion may occur from lead dust on the floors and windowsills or on the playground. Children, particularly younger ones, may accumulate the dust on their fingers, then insert their fingers in their mouths. Lead may enter the school's drinking water through pipes containing lead. Finally, students may breathe lead particles that become airborne during remodeling activities.[4]

Asbestos, a naturally occurring fibrous mineral, is fire resistant and has great tensile strength. This makes it attractive for many purposes in school buildings such as insulation on hot-water pipes, acoustic tile, and spray-on fireproofing. Asbestos, like radon, is hazardous when inhaled and contributes to lung cancer and other pulmonary diseases in individuals who breathe high levels of airborne asbestos or experience long-term exposure.[5] Like lead, asbestos often becomes airborne during building remodeling.

3. *Viable Particulates*—Small particles produced by living organisms, including mold, bacteria, and viruses. Exposure to these particles may exacerbate pre-existing allergies, trigger asthma attacks, spread various diseases, and even be life-threatening for persons with compromised immune systems. Substantial concern has been expressed in the United States in the past few years about

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Each school's heating and air conditioning system should be adequate for the building's current number of occupants, and should receive regularly scheduled maintenance.

Sources of Information

National Safety Council, Indoor Air Program
http://www.nsc.org/ehc/indoor/iaq.htm

U.S. Environmental Protection Agency
http://www.epa.gov/iaq

Consumer Product Safety Commission, Indoor Air Quality Publications
http://www.cpsc.gov/cpscpub/pubs/iaq.html

American Lung Association
http://www.lungusa.org

the organism, *Stachybotris Chartrum*. Some researchers believe exposure to this mold may be responsible for multiple infant deaths.[6]

Although molds are ubiquitous, they seldom cause severe health concerns unless they find ample nutrition and moisture to propagate. In other words, unless your school has continuous roof or plumbing leaks or other sources of excess moisture (such as periodic flooding), exposure to these types of particles should not present a problem.

4. *Products of Combustion*—Gases and particles produced by the burning of heating fuel, trash, and even the operation of emergency generators. These include oxides of nitrogen, carbon monoxide, and small carbon-containing particles. A good rule of thumb is that if it "smells like smoke," then one or all of these may be present. These pollutants may at the very least cause lung irritation, and in the case of carbon monoxide, may be lethal at high concentrations.

5. *Volatile Organic Compounds* (VOCs)—Many housekeeping and building products contain petroleum derivatives, which can produce potentially dangerous vapors. Because they occur in so many common products, such as polishes, paints, enamels, window and carpet cleaners, nail polish, adhesives, plastics, mimeograph correction fluid, laboratory chemicals, and pesticides among (many) others, exposure to VOCs is routine for most of us. Breathing the vapors from VOCs can cause susceptible individuals to suffer asthma episodes; eye, nose, and throat irritation; fatigue; headache; and dizziness.

6. *Environmental Tobacco Smoke* (ETS)—Pollutants released by burning cigarettes, pipes, and cigars. ETS contains a mixture of more than 4,000 compounds, including more than 40 known or suspected human carcinogens.[7] Childhood exposure to ETS places children at elevated risk for lung cancer, asthma, and respiratory illnesses. ETS should be less of a problem in schools, especially Adventist institutions, than elsewhere, since many administrators have declared their buildings to be smoke-free.

Heating, Ventilating, and Air Conditioning (HVAC) Systems

Familiarity with common indoor contaminants is central to any discussion of indoor air quality. Now that we understand these, it is

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important to consider the role of heating, ventilating, and air-conditioning (HVAC) systems.[8] These systems are perhaps the single most important factor that affects a building's air quality.

HVAC systems are the circulatory apparatus of building air. Their primary purpose is to:

- provide thermal comfort;
- dilute and remove office contaminants;
- provide minimum quantities of fresh outdoor air;
- provide humidity control; and
- filter contaminants in the ventilation system.

The contents and operation of a typical HVAC system are depicted in Figure 1. A HVAC system typically includes a fan, a filter, a method of tempering air (heating and cooling), and an arrangement of ducts that direct the air from one place to another. Air outside the building (OA) enters the system because

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of the vacuum created by the fan. This air is filtered, then blown through the fan and across coils that typically contain hot or cold water (depending on seasonal demand for heating or cooling) to produce the desired temperature.

Once this conditioning is complete, the air is sent through a supply air (SA) duct system to the office or classroom. There, the air is breathed by the occupants, polluted by their activities, or is unused. The air is then returned to the system by a series of return air (RA) ducts. Some of the used air is vented outdoors either intentionally or unintentionally, but most is recirculated through the building.

A properly operated and maintained HVAC system provides ample fresh outdoor air and filters the recycled air. However, if preventive maintenance suffers or if too much air is recirculated, the normal by-products created by people and their equipment can accumulate inside of buildings. This is particularly problematic in tightly sealed buildings whose windows cannot be opened. Poor ventilation can lead to Sick Building Syndrome.

Sick Building Syndrome (sometimes referred to as Tight Building Syndrome) occurs when more than 20 percent of occupants experience various symptoms, such as eye, nose, and throat irritation, headache, and irritability while they are in a particular building.[9] These symptoms generally disappear rather quickly after the persons leave the building.

What causes Sick Building Syndrome? Frankly, scientists have not identified a specific cause. However, the problem occurs more frequently when overall ventilation is poor. It can be especially problematic in overcrowded classrooms, temporary buildings, and newer facilities where building design limits the quantity of fresh air entering the HVAC system.

Preventive Measures

The old cliche about an ounce of prevention being worth a pound of cure is particularly appropriate in the case of indoor air quality. The authors provide the following recommendations:

1. Consult with your building maintenance department to ensure that the existing HVAC system is suitable for the current number of occupants and that the system receives regularly scheduled maintenance. This includes inspecting and changing filters as needed and ensuring that the system is maintained in a hygienic fashion.

2. Conduct an inventory of your facilities to see if the six contaminants listed above are present. If so, at what levels? What are health risks of this level of exposure? What steps need to be taken to deal with these pollutants?

3. Consider the possible impact of non-routine activities such as renovations, insect/pest treatments, use of housekeeping chemicals, and roof leaks on the air quality of the affected buildings.

4. If building occupants complain about air quality (throughout the building, on a particular floor, or in a specific room) ask the persons experiencing the difficulties to help you create a diary or record-keeping system that documents the time, place, and symptoms. This will often reveal a pattern that helps identify the problem and suggests possible methods for resolving it.

5. If you have a highly sensitive or allergic person at your school, work with health professionals to determine the cause of the condition. Make a reasonable effort to remove the source of the problem, find a substitute for the chemical irritant, or relocate the affected person to another class or activity where his or her health will not be affected.

6. When planning field trips or outdoor activities, particularly if your school is located in a major metropolitan area, consider the potential impact of outdoor air pollution on your students, faculty, and staff.

7. Stay abreast of current developments and new information by periodically reviewing technical information from various sources.

Conclusion

Providing a suitable learning environment involves more than ensuring that schools are equipped with computers, books, laboratories, gymnasiums, playgrounds, and competent instructors. As educators, we are entrusted with children's minds and bodies throughout a large portion of their developing years. By applying common sense and basic preventive measures, we can nurture our collective future in schools free from the hazards of indoor air pollution.

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2. L. A. Wallace, *The Total Exposure Assessment Methodology* (TEAM Study); EPA/600/6-87/002, 1987.4.

3. *A Citizen's Guide to Radon*, Document No. OPA-86-004 (Washington, D.C.: EPA, 1987), 13 pages.

4. J. Doull, ed., *Toxicology: The Basic Science of Poisons* (New York: Macmillan Publishing Company, 1980), 2nd edition, pp. 415-421.

5. R. B. Wallace, ed., *Public Health and Preventive Medicine* (Stanford, Conn.: Appleton and Lange Publ., 1998), pp. 459-474.

6. U.S. Centers for Disease Control and Prevention, *Morbidity and Mortality Weekly Report. Update: Pulmonary Hemorrhage/Hemosiderosis Among Infants—Cleveland, Ohio*, 1993-1996, 49:9 (March 10, 2000), pp. 180-183.

7. D. J. Ecobichon, ed., *Environmental Tobacco Smoke. Proceedings of the International Symposium at McGill University, 1989* (Toronto, Ont.: Lexington Books, 1990), pp. 1-39; EPA, *Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders*; EPA/600/6-90/006F (1992), pp. 1-1 to 1-16 and 2-1 to 2-11.

8. Passive systems that used circulated hot air for heating do not generate the air-quality issues of forced-air systems. However, if the water is heated inside the building, this can produce combustion products that enter the air. Also, the pipes in such systems can create a hazard. The energy-saving insulation used on such pipes frequently contains asbestos, while the scalding hot water circulated through uninsulated papes and radiators can create the risk of severe burns for building occupants.

9. D. L. Hansen, *Indoor Air Quality Issues* (New York: Taylor and Francis, 1999), pp. 16-18.