



INDOOR AIR QUALITY

OVERVIEW

Most people spend the majority of their time indoors, where air can be much more polluted than it is outdoors. A growing body of evidence suggests that poor indoor air quality contributes to increased health care costs and productivity loss. Still, there are no public health standards for indoor air quality outside of regulations for occupational exposures. Concern about potential health effects and related costs have prompted some states to enact legislation to improve indoor air quality in schools, offices, and private residences.

INDOOR AIR POLLUTION AND HEALTH

Air consists of various elements and differs substantially from place to place. The number of health problems caused by polluted indoor air varies as well, ranging from temporary discomfort to more serious conditions such as lung disease and cancer. Some of the most common indoor air pollutants are:

- Second-hand smoke;
- Biological pollutants (mold, bacteria, dust mites);
- Nitrogen dioxide;
- Carbon monoxide;
- Radon;
- Volatile organic compounds (paints, varnishes, pesticides, and cleaning products); and
- Formaldehyde (contained in some forms of pressed and laminated wood products, and also in tobacco smoke)

Air quality is paramount to human health because the lungs, which are well-designed for extracting oxygen from the air, provide a significant pathway for toxicants. The human lung has a large surface area of approximately 140 square meters that is in direct contact with inhaled air. The average adult breathes 22,000 liters (62 pounds) of air and drinks 2 liters

(4.4 pounds) of water every day, which means the average person encounters 14 times more air than water on a weight basis.¹

The large surface area of the lungs and the sensitivity of the tissues make them susceptible to air pollution. According to the American Lung Association, the death rate from lung disease has risen faster than the death rate for almost any other disease during the past decade—lung disease now claims nearly 335,000 lives each year in the United States, making it the third leading cause of death. Rates for asthma, a disease that is exacerbated by poor air quality, have nearly doubled in the last 20 years.

Those who are most susceptible to indoor air pollution are the ones who spend the most time at home—children, pregnant women, the elderly, and those with chronic illnesses. U.S. EPA studies have found that, for many pollutants, indoor levels are two to five times higher than outside levels, and can be 100 times higher.

Poor indoor air quality tends to cause a wide-ranging and diverse set of health effects; the more common symptoms usually are non-specific, including irritation of the eyes, nose

March 2002, Volume 6

In This Issue

Overview	1
Causes of Indoor Air Problems	2
Federal Regulation	3
State Activity	3
Links and Resources	4
Notes	4



and throat; headaches; fatigue; and dizziness. Illnesses that can be caused or exacerbated by indoor air pollution include cancer, lung disease, asthma and allergies.

Probably the most common group of health complaints relates to “sick building syndrome,” reports of which have risen significantly since the 1970s. Sick building syndrome occurs when a large number of people in a building report a variety of non-specific health symptoms, which usually subside after people leave the building. Unfortunately, no general cause for this problem has been found, and research has resulted in numerous and sometimes contradictory explanations, ranging from ventilation, mold, the combined effects of multiple pollutants at low concentrations, and other environmental factors (e.g., heating, lighting, or noise). In many cases, investigators do not find measurable indoor air quality problems, and some research suggests that employee satisfaction and mass psychogenic illness may play a role.

CAUSES OF INDOOR AIR PROBLEMS

Much of the rise in indoor air quality complaints is attributed to an increase in air conditioning and weather-proofing, both of which can reduce the circulation of outdoor air. The energy crunch of the 1970s brought about a trend of sealing up houses and buildings to reduce heating and cooling costs. During these renovations and energy improvements, contractors often overlooked the effects of inadequate ventilation. As a result, reduced inflow of outside air allowed indoor air pollutant concentrations to increase.

Low ventilation rates also can lead to moisture build-up, another source of indoor air problems. High humidity caused by malfunctioning or inadequate ventilation systems, leaky roofs, or water damage can promote mold growth, which can trigger asthma and cause lung and other health

problems. Humidity also encourages the growth of dust mites—microscopic arthropods that live in bedding, upholstered furniture and carpeting. Dust mites are a potent allergen and can trigger asthma attacks.

Other sources of indoor air pollution include the following:

New carpet and carpet adhesive that, when new, release a variety of volatile chemical compounds. Allergens, mold and moisture can find haven in carpets and be difficult to remove.

Gas stoves, fireplaces, gas space heaters and water heaters, which can release hazardous combustion byproducts such as carbon monoxide and nitrogen dioxide.

Radon is a tasteless, colorless gas that is emitted during the natural decay of uranium in rock, soil and water—is found in many homes throughout the country. According to the EPA, the radioactive particles contained in radon gas contribute to between 7,000 and 30,000 lung cancer deaths each year.

Asbestos is a mineral fiber that was commonly used in building and construction materials because of its strength, flexibility and heat resistance. Although many used of asbestos were banned under the Clean Air Act and the Toxic Substances Control Act after it was found to cause lung cancer and other lung diseases, it is still found in older buildings and houses across the nation. Asbestos fibers become dangerous only when released into the air, usually when asbestos-containing materials are disturbed during renovation or demolition.

Environmental tobacco smoke (ETS), also known as second-hand smoke, is one of the most widespread and easily preventable indoor contaminants. ETS is known to cause lung cancer in nonsmokers, increase the severity and frequency of asthma episodes, and increase the risk of children developing serious lung diseases.

Volatile organic compounds include a number of household products, including paints, paint strippers, glue, cleansers, solvents, automotive products and wood preservatives like formaldehyde and are often found in indoor air. Some of these compounds cause eye, nose and throat irritation; damage internal organs; and are the suspected causes of some cancers.

Pesticides are widely used throughout many households and can be tracked inside after outdoor use. Pesticides can irritate the skin, eyes and throat; damage the central nervous system; and increase the risk of cancer.

The nature and degree of indoor air quality problems varies between office buildings, homes, and schools because the activities and type of ventilation vary between structures.

Nearly 50 percent of schools have been found to have

INDOOR AIR QUALITY STATS

- The average American adult spends 90 percent of his or her time indoors, where air can be significantly more polluted than it is outdoors.
- The U.S. Occupational Safety and Health Administration (OSHA) estimates that 30 percent of the workers in non-industrial buildings—including offices, schools, and hospitals—are exposed to poor indoor air quality.
- The EPA estimates that medical costs, lost productivity and increased sick leave cost businesses and government more than \$60 billion dollars per year.
- Children also are affected because their smaller developing bodies often are more susceptible to pollutants, and they spend an increasing amount of time indoors.

problems linked to poor indoor air quality. Schools tend to have particular problems because renovation and retrofitting is commonly performed so the buildings can accommodate more students. Unfortunately, ventilation rates generally have not been adapted to meet these demands. In addition, limited budgets often do not provide for proper maintenance of ventilation systems. Schools also contain a variety of pollutant sources, including art, biology and chemistry supplies; shop areas; gymnasiums; and cleaning solvents and pesticides. The EPA and many state governments have focused on improving indoor air quality in schools since children spend much of their day in the classroom and tend to be more susceptible than adults to a variety of indoor air pollutants.

FEDERAL REGULATION

Relatively few indoor air quality regulations exist for a number of reasons: indoor air pollution is mostly invisible, it comes from a variety of sources, and air quality problems vary from building to building. Many of the symptoms caused by indoor air pollution are not easy to pinpoint and may occur at extremely low pollutant levels that are difficult to measure, making it difficult to determine what contaminant to regulate and at what level.

It is important to note that literally hundreds of different chemicals can be detected in most indoor air, and that detecting many types of pollutants depends on advanced instrumentation that can detect pollutant levels as low as one part per trillion—the equivalent of one drop of water in 50 Olympic-sized swimming pools.

OSHA created indoor air standards that are designed to protect workers in industrial occupational environments. However, these standards may not be appropriate for homes, offices or elementary schools.

Growing consciousness about indoor air quality problems in non-industrial settings has prompted the federal government to take a variety of actions. OSHA's April 1994 proposal to adopt standards on indoor air quality generated the largest public response the agency had ever seen; more than 100,000 comments had been received when the comment period closed in August 1995. OSHA continues to study the issue, but no target date has been established for a final determination. OSHA published guidelines in 1999 to help in investigating, preventing and remediating indoor air problems.

The EPA has dealt with the problem by publishing a series of voluntary guidance documents to assist building owners and others in maintaining good indoor air quality. It also developed a program called "Tools for Schools," which helps schools set up programs to identify and correct indoor air quality problems.

A MOLDY DILEMMA

One indoor air pollutant that has recently found notoriety is mold. *Time*, *Newsweek*, CNN, and numerous newspapers have run numerous stories on toxic mold and its threat to the health and housing. One of the biggest stories focused a couple who became ill with headaches, respiratory problems and memory loss after purchasing a new \$6.5 million mansion in Dripping Springs, Texas. Investigators found that much of the house was contaminated with a toxic mold and the house was condemned and bulldozed. The owners subsequently won a \$32 million lawsuit against the insurance company, which was accused of not fixing the plumbing leaks that caused the damage. This case and others have raised public consciousness, leading to a dramatic increase in the number of mold-related claims submitted to insurers over the past few years. Insurers are scrambling to address the problem, some stating they can not address the increase in claims without raising rates or excluding mold coverage.

Nationwide, states have introduced legislation to deal with the issue. Approaches include setting up advisory and research panels to discover more about the risks of mold, creating public health standards for mold, and requiring that sellers and lessees disclose known mold hazards to buyers and lessors.

STATE ACTIVITY

The types of state indoor air quality legislation vary broadly. Examples include setting up commissions to study and assess health risks of indoor air quality; educating residents about the hazards of various indoor air pollutants; notifying of parents before pesticides are used in schools; requiring sellers of property to disclose environmental hazards such as radon or asbestos; improving school indoor air quality; and establishing state programs or offices to deal with indoor air quality issues. A few states, such as New Hampshire, have set standards for specific pollutants such as carbon dioxide and formaldehyde.

During the past few years, a number of bills have been introduced, including Texas House Bill 2007. This bill, which passed the House in May 2001, requires indoor air quality testing and compliance with mandatory indoor air quality guidelines in newly constructed schools or those undergoing major renovation. The Texas Department of Health would write the guidelines.

California currently is considering Senate Bill 732, which provides uniform standards for mold, requires education efforts, and requires mold disclosure on commercial and residential property transactions.

In Maryland, Governor Glendening signed Senate Bill 283, which establishes a task force on indoor air quality.

The task force will provide a report by July 2002 that will examine the nature, location and health risks posed to workers by toxic molds, spores and other substances located in the heating, ventilation and air-conditioning systems of office buildings.

One of the most common topics of legislation has been indoor air quality in schools. The reasons for this involve the previously discussed susceptibility of schools to indoor air problems and the fact that schools are usually government owned buildings, making them easier to regulate than private homes or businesses.

49 states and DC have clean indoor air provisions restricting smoking in public places, such as offices, restaurants, and government buildings. Such laws have improved indoor air quality by reducing exposure to secondhand smoke, which contains many harmful and irritating chemicals.

The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) developed Standard 62-1989 (*Ventilation for Acceptable Indoor Air Quality*), a continuously evolving standard that establishes the "standard of care" for the design of commercial, institutional and residential buildings. Building codes in many states refer to Standard 62 as part of their definition of minimum ventilation requirements.

Indoor air quality is a complex and constantly evolving issue. Many who work at state agencies and private environmental firms hope that OSHA or EPA arrive at some sort of indoor quality standards. At this point, however, it appears that the research base is not deep enough to support exposure standards for many indoor air pollutants. Nonetheless, states have a variety of reasons for requiring standards and will continue to deal with indoor air quality issues, setting their own standards as the need arises.

WEB LINKS AND RESOURCES

American Lung Association has a wide range of information on air quality in workplaces, homes, and schools. http://www.lungusa.org/air/air_indoor_index.html

Environmental Protection Agency (EPA) has a large amount of material on Indoor Air Quality, including details on ways to reduce indoor air quality problems in homes, schools, and large buildings. Information ranges from an introduction to indoor air quality to specific details on many indoor pollutants. <http://www.epa.gov/iaq/>

Centers for Disease Control and Prevention (CDC) has indoor air quality information related to mold, carbon monoxide, and asthma. <http://www.cdc.gov/nceh/airpollution/>

Environmental Law Institute has a number of indoor air quality policy publications, including the 2002 report: *Healthier Schools: A Review of State Policies For Improving Indoor Air Quality*. <http://www.eli.org>

National Conference of State Legislatures has policy and science information on indoor air quality and environmental health issues, including searchable legislation and statute databases. <http://www.ncsl.org/programs/esnr/toxics.htm>

NOTES

1. Stacy L. Daniels and Michael T. Fox, "Engineering Design for Indoor Environments: Perception vs. Reality" Midland, MI NSF International Conference on Indoor Air Health, May 1999, Denver

The *Environmental Health Series* is produced by staff from the Environmental Health Project at the National Conference of State Legislatures in Denver. The Centers for Disease Control and Prevention (CDC) reviews each issue for accuracy and scientific integrity. For more information, visit <http://www.ncsl.org/programs/esnr/toxics.htm> or call (303) 830-2200.

This issue of the *Environmental Health Series* was researched and written by Glen Andersen.