# Typical Indoor Air Pollutants


The following four pages present information about several indoor air pollutants common to schools, in a format that allows for easy comparison. The pollutants presented include:

- Biological contaminants (mold, dust mites, pet dander, pollen, etc.)
- Carbon dioxide ($CO_2$)
- Carbon monoxide (CO)
- Dust
- Environmental tobacco smoke (ETS) or secondhand smoke
- Fine particulate matter (PM)
- Lead (Pb)
- Nitrogen oxides (NO, $NO_2$)
- Pesticides
- Radon (Rn)
- Other volatile organic compounds (VOCs) (formaldehyde, solvents, cleaning agents)

Each pollutant is described or analyzed across five categories:

- Description
- Sources
- Standards and guidelines for indoor air quality
- Health effects
- Control measures

| Indoor Air Pollutant | Description | Sources |
|---|---|---|
| **Biological contaminants** | Common biological contaminants include mold, dust mites, pet dander (skin flakes), droppings and body parts from cockroaches, rodents and other pests or insects, viruses, and bacteria. Many of these biological contaminants are small enough to be inhaled. | Biological contaminants are, or are produced by, living things. Biological contaminants are often found in areas that provide food and moisture. Damp or wet areas such as cooling coils, humidifiers, condensate pans, or unvented bathrooms can be moldy. Draperies, bedding, carpet, and other areas where dust collects may accumulate biological contaminants. |
| **Carbon dioxide ($CO_2$)** | Carbon dioxide ($CO_2$) is a colorless, odorless product of carbon combustion. | Human metabolic processes and all combustion processes of carbon fuels, like those in cars, buses, trucks, etc., are sources of $CO_2$. Exhaled air is usually the largest source of $CO_2$ in classrooms. |
| **Carbon monoxide (CO)** | Carbon monoxide (CO) is a colorless, odorless gas. It results from incomplete oxidation of carbon in combustion processes. | Common sources of CO in schools are improperly vented furnaces, malfunctioning gas ranges, or exhaust fumes that have been drawn back into the building. Worn or poorly adjusted and maintained combustion devices (e.g., boilers, furnaces), or a flue that is improperly sized, blocked, disconnected, or leaking, can be significant sources. Auto, truck, or bus exhaust from attached garages, nearby roads, or idling vehicles in parking areas can also be sources. |
| **Dust** | Dust is made up of particles in the air that settle on surfaces. Large particles settle quickly and can be eliminated or greatly reduced by the body's natural defense mechanisms. Small particles are more likely to be airborne and are capable of passing through the body's defenses and entering the lungs. | Many sources can produce dust including: soil, fleecy surfaces, pollen, lead-based paint, and burning of wood, oil, or coal. |
| **Environmental tobacco smoke (ETS), or secondhand smoke** | Tobacco smoke consists of solid particles, liquid droplets, vapors, and gases resulting from tobacco combustion. Over 4,000 specific chemicals have been identified in the particulate and associated gases. | Tobacco product combustion |

| Standards or Guidelines | Health Effects | Control Measures |
|---|---|---|
| There are currently no Federal government standards for biologicals in school indoor air environments. | Mold, dust mites, pet dander, and pest droppings or body parts can trigger asthma. Biological contaminants, including molds and pollens can cause allergic reactions for a significant portion of the population. Tuberculosis, measles, *Staphylococcus* infections, *Legionella* and influenza are known to be transmitted by air. | General good housekeeping and maintenance of heating and air conditioning equipment are very important. Adequate ventilation and good air distribution also help. The key to mold control is moisture control. If mold is a problem, get rid of excess water or moisture and clean up the mold. Maintaining the relative humidity between 30 and 60 percent will help control mold, dust mites, and cockroaches. Employ integrated pest management (IPM) to control insect and animal allergens. Cooling tower treatment procedures exist to reduce levels of *Legionella* and other organisms. |
| ASHRAE Standard 62-2001 recommends 700 ppm above the outdoor concentration as the upper limit for occupied classrooms (usually around 1,000 ppm). | $CO_2$ is an asphyxiate. At concentrations above 1.5 percent (15,000 ppm) some loss of mental acuity has been noted. (The recommended ASHRAE standard of 700 ppm above the outdoor concentration is to prevent body odor levels from being offensive.) | Ventilation with sufficient outdoor air controls $CO_2$ levels. Reduce vehicle and lawn and garden equipment idling and/or usage. |
| The OSHA standard for workers is no more than 50 ppm for 1 hour of exposure. NIOSH recommends no more than 35 ppm for 1 hour. The U.S. National Ambient Air Quality Standards for CO are 9 ppm for 8 hours and 35 ppm for 1 hour. The Consumer Product Safety Commission recommends levels not to exceed 15 ppm for 1 hour or 25 ppm for 8 hours. | CO is an asphyxiate. An accumulation of this gas may result in a variety of symptoms deriving from the compound's affinity for and combination with hemoglobin, forming carboxyhemoglobin (COHb) and disrupting oxygen transport. Tissues with the highest oxygen needs—myocardium, brain, and exercising muscle—are the first affected. Symptoms may mimic influenza and include fatigue, headache, dizziness, nausea and vomiting, cognitive impairment, and tachycardia. At high concentrations CO exposure can be FATAL. | Combustion equipment must be maintained to assure that there are no blockages and air and fuel mixtures must be properly adjusted to ensure more complete combustion. Vehicular use should be carefully managed adjacent to buildings and in vocational programs. Additional ventilation can be used as a temporary measure when high levels of CO are expected for short periods of time. |
| The EPA Ambient Air Quality standard for particles less than 10 microns is 50 $\mu g/m^3$ per hour for an annual average and 150 $\mu g/m^3$ for a 24-hour average. | Health effects vary depending upon the characteristics of the dust and any associated toxic materials. Dust particles may contain lead, pesticide residues, radon, or other toxic materials. Other particles may be irritants or carcinogens (e.g., asbestos). | Keep dust to a minimum with good housekeeping. Consider damp dusting and high-efficiency vacuum cleaners. Upgrade filters in ventilation systems to medium efficiency when possible and change frequently. Exhaust combustion appliances to the outside and clean and maintain flues and chimneys. When construction or remodeling is underway, special precautions should be used to separate work areas from occupied areas. |
| Many office buildings and areas of public assembly have banned smoking indoors or required specially designated smoking areas with dedicated ventilation systems be available. The "Pro-Children Act of 1994" prohibits smoking in Head Start facilities and in kindergarten, elementary, and secondary schools that receive Federal funding from the Department of Education, the Department of Agriculture, or the Department of Health and Human Services (except Medicare or Medicaid). | The effects of tobacco smoke on smokers include rhinitis/pharyngitis, nasal congestion, persistent cough, conjunctival irritation, headache, wheezing, and exacerbation of chronic respiratory conditions. Secondhand smoke has been classified as a "Group A" carcinogen by EPA and has multiple health effects on children. It has also been associated with the onset of asthma, increased severity of or difficulty in controlling asthma, frequent upper respiratory infections, persistent middle-ear effusion, snoring, repeated pneumonia, and bronchitis. | Smoke outside away from air intakes. Smoke only in rooms that are properly ventilated and exhausted to the outdoors. |

| Indoor Air Pollutant | Description | Sources |
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| **Fine Particulate Matter ($PM_{2.5}$)** | Fine particulate matter ($PM_{2.5}$), or soot, is a component of diesel exhaust, and is less than 2.5 microns in diameter; in comparison, the average human hair is about 100 microns thick. It may consist as a tiny solid or liquid droplet containing a variety of compounds. | The main source of $PM_{2.5}$ is diesel engines in trucks, buses, and nonroad vehicles (e.g., marine, construction, agricultural, and locomotive). Diesel engines emit large quantities of harmful pollutants annually. |
| **Lead (Pb)** | Lead is a highly toxic metal. | Sources of lead include drinking water, food, contaminated soil and dust, and air. Lead-based paint is a common source of lead dust. |
| **Nitrogen oxides (NO, $NO_2$)** | The two most prevalent oxides of nitrogen are nitrogen dioxide ($NO_2$) and nitric oxide (NO). Both are toxic gases, and $NO_2$ is a highly reactive oxidant and corrosive. | The primary sources indoors are combustion processes, such as unvented combustion appliances (e.g., gas stoves, vented appliances with defective installations, welding, and tobacco smoke). Outdoor sources, such as vehicles and lawn and garden equipment, also contribute to nitrogen oxide levels. |

| Standards or Guidelines | Health Effects | Control Measures |
|---|---|---|
| There are currently no Federal government standards for $PM_{2.5}$ in school indoor air environments. EPA's National Ambient Air Quality Standards list 15 $\mu g/m^3$ as the annual limit and 65 $\mu g/m^3$ as the 24-hour limit for $PM_{2.5}$ in outdoor air. | Particulate matter is associated with a variety of serious health effects, including lung disease, asthma, and other respiratory problems. In general, children are especially sensitive to air pollution because they breathe 50 percent more air per pound of body weight than adults. Fine particulate matter, or $PM_{2.5}$, poses the greatest health risk, because it can pass through the nose and throat and become lodged in the lungs. These particles can aggravate existing respiratory conditions, such as asthma and bronchitis, and they have been directly associated with increased hospital admissions and emergency room visits for heart and lung disease, decreased lung function, and premature death. Short-term exposure may cause shortness of breath, eye and lung irritation, nausea, light-headedness, and possible allergy aggravations. | Effective technologies to reduce $PM_{2.5}$ include particulate filters and catalysts that can be installed on buses. An easy, no-cost, and effective way to control fine particulate matter is to minimize idling by buses, trucks, and other vehicles. |
| In 1978, the Consumer Product Safety Commission banned lead in paint. | Lead can cause serious damage to the brain, kidneys, nervous system, and red blood cells. Children are particularly vulnerable. Lead exposure in children can result in delays in physical development, lower IQ levels, shorter attention spans, and an increase in behavioral problems. | Preventive measures to reduce lead exposure in buildings painted before 1978 include: Cleaning play areas; frequently mopping floors and wiping window ledges and other smooth flat areas with damp cloths; keeping children away from areas where paint is chipped, peeling, or chalking; preventing children from chewing on window sills and other painted areas; and ensuring that toys are cleaned frequently and hands are washed before meals. |
| No standards have been agreed upon for nitrogen oxides in indoor air. ASHRAE and the U.S. EPA National Ambient Air Quality Standards list 0.053 ppm as the average 24-hour limit for $NO_2$ in outdoor air. | $NO_2$ acts mainly as an irritant affecting the mucosa of the eyes, nose, throat, and respiratory tract. Extremely high-dose exposure (as in a building fire) to $NO_2$ may result in pulmonary edema and diffuse lung injury. Continued exposure to high $NO_2$ levels can contribute to the development of acute or chronic bronchitis. Low-level $NO_2$ exposure may cause increased bronchial reactivity in some asthmatics, decreased lung function in patients with chronic obstructive pulmonary disease, and increased risk of respiratory infections, especially in young children. | Venting the $NO_2$ sources to the outdoors and assuring that combustion appliances are correctly installed, used, and maintained are the most effective measures to reduce exposures. Develop anti-idling procedures for all vehicles and nonroad engines (cars, buses, trucks, lawn and garden equipment, etc.). |