Indoor Air Quality Parameters in Your School

Your school, in partnership with the Washington State Department of Health, is monitoring specific indoor air quality parameters to help ensure a healthy and comfortable learning environment.

This fact sheet describes the measurements being made and provides background information about the five indoor air quality parameters being measured.

The Environmental Protection Agency (EPA) has stated that "poor indoor air quality (IAQ) can impact the comfort and health of students and staff, which in turn, can affect concentration, attendance, and student performance."[1] Good indoor air quality is achieved by reducing or eliminating sources of indoor air contamination and providing sufficient fresh air through the school's heating and ventilation system.

The IAQ monitoring equipment measures a number of important basic IAQ parameters that provide information about room cleanliness, ventilation, and thermal comfort. The equipment measures the following indoor air quality parameters:

The Fluke 975 AirMeter™

- Carbon Dioxide
- Carbon Monoxide
- Relative Humidity
- Temperature

The Fluke 983 Particle Meter

- Particulates in six sizes: 0.3, 0.5, 1.0, 2.0, 5.0, and 10.0 micrometers

Carbon Dioxide (CO_2)

Carbon dioxide (CO_2) is a colorless, odorless gas. It is a product of carbon combustion and respiration by humans and animals. Exhaled air is the largest source of CO2 in classrooms.

CO_2 can be measured to evaluate whether adequate volumes of fresh outdoor air are being introduced into indoor air in offices, classrooms, etc. The outdoor level of carbon dioxide is typically 300 - 400 parts per million (ppm). The carbon dioxide level is usually greater inside a building than outside due to the release of CO_2 during normal human breathing. State ventilation codes since 1991 have required 15 cubic feet per minute per person of fresh outside air in classrooms in order to provide the proper dilution of CO_2. Measuring classroom CO_2 levels is a simple way of assessing whether the required dilution ventilation is being achieved. When a classroom is fully occupied and the ventilation system is operating, CO_2 levels should be below 1000-1100 ppm (700 ppm plus the outside CO_2 levels)*. Consistent levels of CO_2 above 1,200 ppm indicate that the ventilation system is not operating properly and not delivering the appropriate amount of fresh air. The lack of fresh dilution air can result in the build-up of other contaminants and an increase in odors. High CO_2 levels are also associated with sleepy and inattentive students.

* The American National Standards Institute/The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ANSI/ASHRAE) Standard 62.1-2007, p.32.

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless, toxic gas. It is a by-product of fossil fuel combustion. Incomplete oxidation during combustion in gas ranges, unvented gas or kerosene heaters, or worn or poorly adjusted and maintained combustion devices (such as boilers and furnaces), can be sources of CO. Exhaust flues that are improperly sized, blocked, disconnected, or leaking are also possible sources. Auto and bus exhaust contain many noxious gases and particulates, including CO.

Carbon monoxide poisoning can occur quickly. Normal background levels should be less than 5 ppm. The U.S. National Ambient Air Quality Standards (NAAQS) for CO are 9 ppm for 8 hours and 35 ppm for 1 hour. For healthy adults, exposure to CO levels greater than 50 ppm, for more than eight hours, are toxic. Exposure to levels of 70-100 ppm cause flu-like symptoms, such as headaches and respiratory irritation occur. With increased levels dizziness, drowsiness and vomiting can occur. Exposure to levels of 400 ppm and greater can result in unconsciousness and death. Children are more susceptible than adults and are affected at lower levels.

To help prevent CO poisoning from occurring, carbon monoxide detectors should be placed in rooms that contain fuel burning devices.

Temperature and Relative Humidity (Thermal Comfort)

Temperature (T) and Relative Humidity (RH) levels impact student and staff comfort.

Thermal comfort requirements vary for each individual due to factors such as clothing, activity level, age, and physiology. ANSI/ASHRAE Standard 55-2004 describes the temperature and humidity ranges that are comfortable for 80 percent of people engaged in largely sedentary activities. It was developed for adults in office environments and assumes “normal indoor clothing." Added layers of clothing reduce the rate of heat loss.

Temperature and relative humidity, a measure of the amount of water in the air, are interrelated for comfort. Generally, the recommended indoor relative humidity range for comfort is 30% to 60%. The recommended indoor temperature ranges for comfort are from 68-74 degrees Fahrenheit (F) in the winter and 74-79 degrees F in the summer.

Control of relative humidity also helps limit the growth of microorganisms. Maintaining relative humidity below 50% inhibits mold and mildew growth, dust mite infestations, and bacteria. If RH levels fall below 25%, building occupants can experience respiratory irritation and possibly dry, itchy eyes and skin.

Particulates

Particulate matter (PM) is a complex mixture of extremely small particles. People are exposed to PM from both naturally occurring processes and human activities. Major sources of PM include cars, trucks, construction equipment, coal-fired power plants, and wood burning. Common airborne particles in schools include pollens, dust, mold spores, human skin flakes, fibers, building materials, tire wear, and diesel soot.

The size of particles is directly linked to their potential for causing health problems. The size of PM in the air ranges from approximately 0.005 micrometers (μm) to 100 μm in diameter. The two size categories of particulates that are of particular concern for respiratory health are:

- Particles between 2.5 micrometers and 10 micrometers in diameter, "inhalable coarse particles," such as those found near roadways and dusty industries.

- Particles that are 2.5 micrometers in diameter or smaller ($PM_{2.5}$), “fine particles," such as those found in smoke and haze. The main source of $PM_{2.5}$ is diesel engines in trucks, buses, and non-road vehicles (e.g., marine, construction, agricultural, and locomotive).Fine particles are easily inhaled deep into the lungs where they may accumulate, react, be cleared or absorbed. Because of their small size, fine particles tend to remain in the air for long periods of time, travel long distances, and concentrations will vary changing wind patterns and atmospheric conditions.

Health effects that have been associated with various types of PM exposure include respiratory, eye, and skin irritation, asthma, and possibly cardiac disease. Children may be especially vulnerable to exposure to PM and other air contaminants because they breathe more air per pound of body weight relative to adults.

To reduce particulate concentrations in schools:

- Clean regularly and thoroughly.
- Reduce sources of particulates, including clutter. Use closed storage boxes as much as possible.
- Eliminate upholstered furniture.
- Reduce the number of stuffed animals. Regularly wash the ones that are needed.
- Collect and remove dust with damp microfiber cloths.
- Use high efficiency vacuum cleaners and/or vacuum bags.
- Exhaust combustion appliances to the outside.
- Clean and maintain flues and chimneys.
- Use mechanical exhaust with high volume copiers.
- Maintain HVAC filtration systems.
- Use the highest grade HVAC filters practical for the air handling systems. They should fit tightly and be changed as needed.
- Take precautions to separate work areas from occupied areas during construction or remodeling.
- Avoid contamination of air handling systems by construction debris or rain/snow.
- Ensure that vehicle exhaust is not drawn into buildings. Enforce no-idling policies for buses, cars, and delivery trucks.

The Fluke 983 particle counter “counts” the number of particles in six different sizes in the air, from 0.3 to 10 micrometers in diameter. The values obtained by the particle counter cannot be compared to a standard since no standards exist for indoor particles.

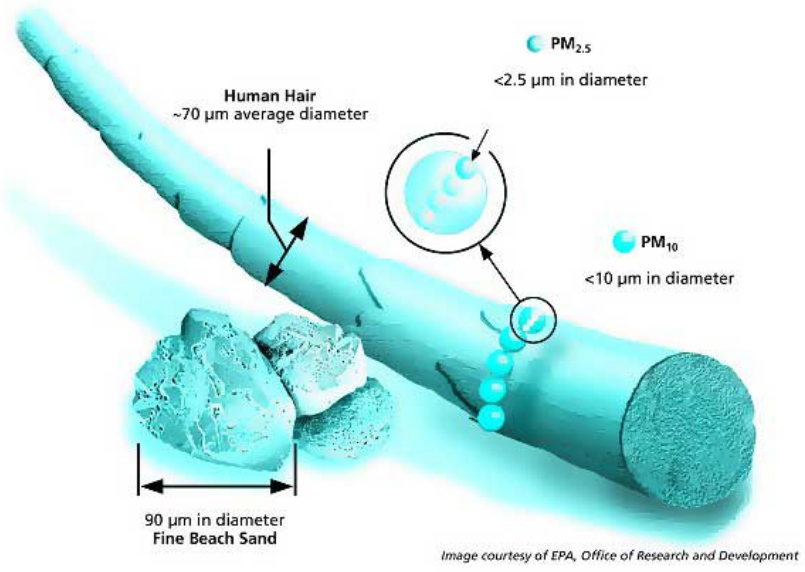
However, indoor particulate data *can* be used to:

- Obtain baseline information.

- Assess cleaning effectiveness by comparing readings taken before and after vacuuming, dusting, carpet cleaning etc.
- Assess the effectiveness of the building's filtration system.
- Assess particle size and particle count variations between rooms/areas to provide clues about potential particulate sources.

The information obtained from the particle readings will help increase our knowledge and understanding of particle loading, particle size distribution, and particle exposures in schools.

Additional information can be found at EPA's Particulate Matter Web site, www.epa.gov/oar/particlepollution/



Size of $PM_{2.5}$ and PM_{10} particles relative to human hair and beach sand

[1]IAQ Tools for Schools Program, www.epa.gov/iaq/schools/index.html