

Improving Ventilation and Indoor Air Quality during Wildfire Smoke Events



Recommendations for Schools and Buildings with Mechanical Ventilation

Overview

- Smoke is a complex mixture of carbon dioxide (CO₂), water vapor, carbon monoxide (CO), hydrocarbons, other organic chemicals, nitrogen oxides (NO_x), trace minerals, and particulate matter.
 - Particulate matter consists of solid particles and liquid droplets suspended in the air. Particles with diameters less than 10 microns (PM₁₀) are upper respiratory tract and eye irritants.
 - Smaller particles (PM_{2.5}) are the greatest health concern – they can be inhaled deep into the lungs, and can affect respiratory and heart health.
 - Carbon monoxide, a colorless, odorless gas produced by incomplete combustion, is a particular health concern and levels are highest during the smoldering stages of a fire.
- Outdoor (ambient) air pollutants, including smoke, enter and leave buildings in three primary ways:
 1. Mechanical ventilation systems, which actively draw in outdoor air through intake vents and distribute it throughout the building.
 2. Natural ventilation (opening of doors or windows).
 3. Infiltration, the passive entry of unfiltered outdoor air through small cracks and gaps in the building shell.
- Tightly closed buildings reduce exposure to outdoor air pollution. Upgrading the filter efficiency of the heating, ventilating, and air-conditioning (HVAC) system and changing filters frequently during smoke events greatly improves indoor air quality. Supplementing with HEPA filters, particularly those with activated charcoal or other adsorbents, improves air quality even more.
- During long-term smoke events, take advantage of periods of improved air quality (such as during rain or shifts in wind) to use natural ventilation to flush-out the building.
- To reduce smoke particles in the building and their off-gassing, damp mop with microfiber cloths and use high efficiency (HEPA) vacuums or vacuums with high efficiency filter bags.
- Reduce all sources of indoor air pollutants, including use of aerosols, fragrances, gas, propane or wood-burning stoves, smoking, etc.

Maximizing a Building's Capacity to Improve Indoor Air Quality

- When outside air is in the hazardous category (see the [Department of Ecology Washington Air Quality Advisory Map](#)), close all windows and minimize use of outside doors.
- Under normal operations, mechanical ventilation air intake systems can supply approximately 15 -20 cubic feet per minute of outside air per person to flush out pollutants and keep CO₂ levels below about 1000 - 1100 parts per million (ppm).
- Close air intakes when outside air is in the unhealthy category. Indoor CO₂ levels will probably rise.
- If possible, monitor CO₂ levels. The eight-hour Washington Division of Occupational Safety and Health permissible limit for CO₂ is 5000 ppm ([WAC 296-841-20025](#)). If CO₂ reaches this level, the building will be uncomfortable. At about 4000 ppm, open air intakes to bring in outside air, preferably filtered.
- If recommended by public health officials, use CO monitors with meters that can detect CO at levels as low as 1 ppm. Most hardware store CO alarms only detect potentially life-threatening levels of CO, not long-term, low-level exposures that still affect health.
 - California considered children when they set the current ambient air CO standard of 9 ppm CO averaged over 8 hours, and 20 ppm averaged over 1 hour. See [California's Evaluation of Air Quality Standards and Protection of Children \(PDF\)](#). Low levels of CO can cause headache, dizziness, fatigue, weakness, confusion, and nausea.

Upgrading Filters on HVAC Units

Upgrading the filters on existing HVAC systems helps improve indoor air quality and allows air intakes to stay open during moderate pollution events. The filters chosen depend on the fan, which has to be able to move enough air through it. Most public HVAC systems should accommodate at least Minimum Efficiency Reporting Value (MERV) 8 filters. Selecting a filter with the deepest pleat your system can accommodate (two inches or more) reduces the air resistance across the filter and improves filtration. Research shows even medium efficiency filters can improve indoor air quality; have your HVAC technician evaluate if a higher MERV filter can be used. Filters need to be checked and replaced more often during prolonged smoke events.

Proper installation, operation, and maintenance are critical for effective use of air filters:

- Make sure the filter fits tightly in its seat to prevent air from bypassing the filter.
- Check filter for dust and debris buildup at least every month during heavy use – more often in heavy smoke conditions. Clean or replace the filter as necessary.
- To prolong the life of a high-efficiency filter, discuss with your HVAC technician installing a low-efficiency pre-filter upstream to prevent rapid overloading of the filter.

Portable Air Cleaners

Portable high efficiency HEPA air cleaners can supplement the work of the HVAC system by removing fine particulates. HEPA filters with activated charcoal or alumina, especially those impregnated with potassium permanganate or zeolite will adsorb gases in the smoke, including NO_x and some of the volatile organic compounds (VOCs) such as benzene. These filters are more expensive and need more frequent replacement.

Do not use ozone generators, personal air purifiers, or electrostatic precipitators and ionizers that produce ozone. Ozone is a respiratory irritant that can aggravate asthma and other lung diseases. Consult the [California Air Resources Board Consumers' Air Cleaner Portal](#) for information on devices certified to avoid ozone exposures.

Proper size, installation, and maintenance are critical for portable air cleaners to be effective.

- Air cleaners should filter at least two or three times the room volume per hour.
- The package should indicate the unit's airflow rate, the room size it is suitable for, its particle removal efficiency, and perhaps its Clean Air Delivery Rate (CADR), a rating that combines efficiency and airflow.
- The [Association of Home Appliance Manufacturers \(AHAM\)](#) maintains a certification program for air cleaners. The AHAM seal on the box lists three CADR numbers; the higher the numbers, the faster the unit filters the air. Choose a unit with the highest number.
- [Consumer Reports](#) has evaluated air cleaning devices and produced a buying guide.
- Put the unit(s) away from doors, windows, and foot traffic; but not close to walls or corners, so the air can easily reach the unit.

More Resources

- [Wildfire Smoke, Washington State Department of Health](#)
- [Wildfire Smoke Guide for Public Health Officials \(PDF\)](#)
- [Indoor Air Quality: Air Cleaners, EPA](#)

Contact for School Environment and Indoor Air Quality Issues

- www.doh.wa.gov/SchoolEnvironmentContact - Washington State Department of Health