

Improving Ventilation and Indoor Air Quality During Wildfire Smoke Events



Recommendations for Schools and Buildings with Mechanical Ventilation

Overview

- Wildfire smoke is a complex mixture of particulate matter and gases, including carbon monoxide.
 - Particulate matter consists of solid particles and liquid droplets suspended in the air. Particles with diameters less than 10 microns (PM10) are upper respiratory track and eye irritants.
 - Smaller particles (PM2.5) 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 when 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 High Efficiency Particulate Air (HEPA) filters, particularly those with activated charcoal or other adsorbents, improves air quality even more.
- To reduce smoke particles in the building, damp mop with microfiber cloths and use 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, and vaping.

Maximizing a Building's Capacity to Improve Indoor Air Quality

- When outside air is in the Unhealthy for Sensitive Groups category for PM2.5 pollution (see the [Department of Ecology Washington Air Quality Monitoring Map](#)), close all windows and minimize use of outside doors. Close off outside air intakes unless there are Minimum Efficiency Reporting Value (MERV) 13 filters. MERV 13 filters will help to filter out smoke particles.
- Monitoring PM2.5 levels indoors throughout the building(s) of a facility during smoke events can help to identify areas with worse indoor air quality to inform mitigation strategies. See “Indoor PM2.5 Measurements in Schools” in [Wildfire Smoke Guidance for Canceling Events or Activities and Closing Schools \(PDF\)](#), for more information.
- 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.
- 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 1,000 parts per million (ppm) (Below ~700-800 ppm for dilution and better indoor air quality). A lower outdoor ventilation rate will reduce the amount of smoke drawn into the building but will also increase

CO₂ levels. Monitor CO₂ levels and if they rise above 2,000 ppm attempt to bring in more outside air – unless it is very smoky.

- Upgrading to MERV 13 filters is important. If the system does not have (or cannot accept) MERV 13 filters, portable HEPA filter air cleaners will help reduce smoke particulates.
- Public health officials may recommend monitoring for carbon monoxide (CO) in very smoky conditions. Use monitors that can detect CO at levels as low as 1 ppm. Low levels of CO can cause headaches, dizziness, fatigue, weakness, confusion, and nausea. The California ambient air CO standard of 9 ppm averaged over 8 hours, and 20 ppm averaged over 1 hour, which consider children's health, should be used. Learn more at [California Air Resources Board, Carbon Monoxide & Health](#).

Upgrading and Maintaining Filters on HVAC Units

Upgrading the filters on existing HVAC systems helps improve indoor air quality throughout the entire building and allows air intakes to stay open during moderate pollution events. The ideal filters to choose depends on the fan, which must be able to move enough air through it. Most public HVAC systems should accommodate the recommended MERV 13 filters. All filters are not created equal, and there is a high variation in air pressure drop for a given MERV rating. Generally, thicker filters have less air pressure drop than thinner filters, and more dust holding capacity. Because each building and its existing HVAC systems will be different, a professional engineer or HVAC specialist should be consulted to determine the best way to maximize the system's air filtration.

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

- Conduct a pre-wildfire season checkup to ensure all equipment will operate properly.
- Make sure the filter fits tightly in its seat to prevent air from bypassing the filter.
- Filters need to be checked and replaced more often during prolonged smoke events.
- Check the 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.
- Have multiple sets of higher efficiency filters for smoke events on hand, because they may not be available during smoke events due to increased demand.
- BAS (Building Automation Systems) may need to be programmed for a 'Smoke Event' mode that will place systems in minimum Outside Air mode during occupied hours and close Outside Air intakes during unoccupied hours. Consider operating the fan systems continuously during smoke event modes to help filter the air.
- Higher MERV filters (13+) do NOT remove 'smoke smell'. Some MERV 13 filters with high-density activated carbon are available that will reduce indoor 'smoke smell'.

Portable Air Cleaners

Portable high efficiency particulate air (HEPA) 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 nitrogen oxides (NO_x) and some volatile organic compounds (VOCs), such as benzene. These filters are more expensive and need more frequent replacement.

Portable HEPA air cleaners can supplement ventilation and are most critical in rooms with poorer ventilation or in isolation areas. Proper size, installation, and maintenance are critical for portable air cleaners to be effective.

Using and selecting portable HEPA air cleaners:

- Unit air ratings are based on the square footage of the room and the Clean Air Delivery Rate (CADR). The guide, [5 Step Guide to Checking Ventilation Rates in Classrooms from Schools For Health](#), provides a useful tool to calculate ventilation rates for indoor spaces.
- The equivalent of at least 5–6 air changes per hour is recommended.
- Consider the noise rating as some units can be quite loud. Consult with the manufacturer before purchasing. The Clean Air Delivery Rate is at the highest speed, which will be too loud for some environments. Choose one rated for a larger size room and run it on the low fan speed to reduce the noise or use two for the room.
- Units should be pointed so they do not blow air across occupants (e.g., from one individual to others) to help reduce the risk of airborne infectious disease transmission.
- Air filtration should be maximized in the space 2 hours before and after occupancy.
- Do not use additive technologies such as electrostatic precipitators, ionizers, or negative ion air purifiers because they can produce harmful by-products.
- Choose HEPA air cleaners that meet the UL 2998 standard of less than 5 ppb ozone.
- Do not use personal air purifiers.
- HEPA filters should be replaced regularly as recommended by the manufacturer. The unit should be vacuumed and cleaned on a regular schedule – this should be done outside. Filter disinfection is not needed or recommended.
- Portable Air Filters are also useful for reducing respiratory particles See the [Selection and Use of Portable Air Cleaners to Protect Workers from Exposure to SARS-CoV-2, NIH \(PDF\)](#) for more details.

More Resources

- [Smoke from Fires, Washington State Department of Health](#)
- [Wildfire Smoke Guide for Public Health Officials](#)
- [Wildfires and Indoor Air Quality, EPA](#)
- [Wildfires and Indoor Air Quality in Schools and Commercial Buildings, EPA](#)
- [Guide to Air Cleaners in the Home, EPA](#)
- [Air Cleaner Information for Consumers, California Air Resources Board](#)
- [Planning-Framework-for-Protecting-Commercial-Building-Occupants-from-Smoke-During-Wildfire-Events, ASHRAE \(PDF\)](#)

Contacts for School Environment and Indoor Air Quality Issues

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

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