Darryl DeAngelis
marketing@EBTRON.com

EBTRON Insight

Wildfires Have Renewed Focus on Indoor Air Quality and Building Operation Strategies

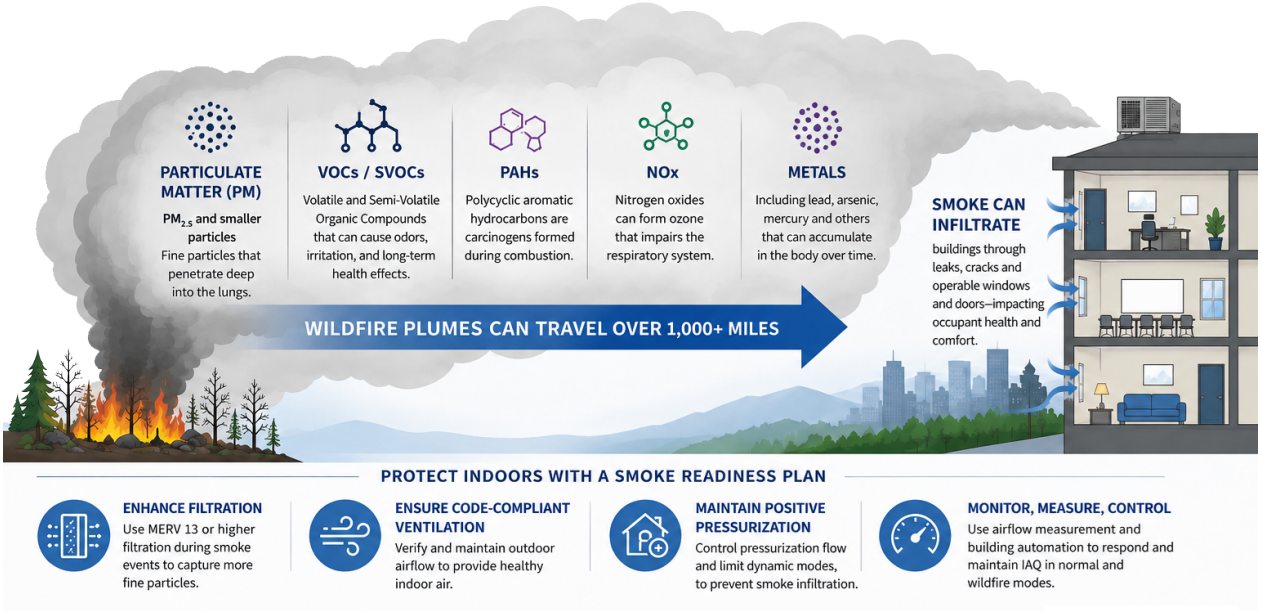
A record number of wildfires in Canada and the United States has sparked renewed focus on indoor air quality (IAQ) and building operation strategies. Building codes and ASHRAE's ventilation and IAQ standards, including Standards 62.1 and 62.2, emphasize three foundational strategies for maintaining indoor air quality: dilution (ventilation), air cleaning (filtration), and ensuring that air enters or leaves a building in a controlled and intended manner (building pressurization). These are essential to maintaining indoor contaminant levels generated by people, building materials, and components below acceptable thresholds.

ASHRAE Standard 62.1-2025[1] further reinforces the importance of responding to emergency outdoor air conditions such as wildfire smoke events. This standard requires emergency control modes for outdoor pollution events and references ASHRAE Guideline 44-2024[2]. Together, these documents reinforce the importance of designing and operating HVAC systems capable of transitioning between normal operation and emergency smoke mitigation strategies while maintaining acceptable indoor air quality and building pressurization. Guideline 44 provides design, commissioning, and operational guidance to help minimize the health impacts of wildfire smoke events on building occupants.

Understanding Wildfire Smoke and Indoor Risk

Wildfires generate gases and particulate matter (PM) that Air Quality Index (AQI)[3] systems measure, making AQI a useful indicator of when outdoor air quality is at risk. However, AQI doesn't measure every component of wildfire smoke. PM2.5 and smaller particles pose a considerable health risk because they can penetrate deep into the lungs. These particles can be filtered out with high-efficiency filtration. Wildfire smoke also contains gaseous components that require absorption technologies, such as activated carbon filtration, for removal. When wildfires spread into urban environments, smoke contaminants become even more diverse due to the combustion of building materials and synthetic products.

Due to the increase in wildfires and the significant smoke plumes that travel over long distances, many localities that may not experience wildfires may still be impacted by degraded outdoor air quality.



Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Green	Good	51 to 100	Air quality is acceptable. However, there maybe a risk for some people.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health affects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

Source: U.S. Environmental Protection Agency (EPA), Air Quality Index (AQI) Basics, adapted from 40 CFR Part 58, Appendix G, Uniform Air Quality Index (AQI) and Daily Reporting (Federal Register, August 12, 2025).[7]

AQI methodologies may differ by country[4]. Canada, for example, includes AQIH-Plus guidance specific to wildfire PM2.5 (fine particulate matter of 2.5 microns in size) exposure using short-term one-hour averaging due to the rapid increase in smoke-generated particulate levels[5]. Local AQI conditions are available through weather apps and local news sources.

Once outdoor air quality deteriorates, filtration becomes one of the primary strategies for reducing occupant exposure to wildfire smoke. The amount of PM removal depends on the mass removal efficiency of the filters used, and filter loading (how long the filter remains effective) is dependent on particle size and contaminant concentration. Given the frequency of wildfire smoke events, it is good practice to have a Smoke Readiness Plan[2,6] that can be implemented to protect occupants from both outdoor and indoor generated contaminants.

Preparing Buildings for Wildfire Smoke Events

Preparing and operating buildings during wildfire smoke events requires a combination of filtration, ventilation verification, operational control strategies, and building pressurization management. That is why it is essential to:

1. Verify HVAC System Operation and Maintenance

ASHRAE Standard 62.1-2025 Chapter 8, Operations and Maintenance, outlines requirements to maintain ventilation for indoor air quality in accordance with the minimum design requirements.[8] No system adjustments should be made prior to ensuring the ventilation system is operating as intended and maintenance has been performed.

• Table 8-1 outlines inspection, verification, and validation tasks and activity frequency that include: dynamic control operation, filter fit and function, sensor calibration, building pressurization, ventilation rates, and Testing, Adjusting and Balancing (TAB) requirements

• It references ASHRAE Standard 180, Standard Practice for Inspection and Maintenance of Commercial-Building HVAC Systems. This standard establishes minimum inspection and maintenance tasks and recommended frequency to keep equipment functioning efficiently to provide thermal comfort and IAQ.

2. Improve Filtration Strategies

Adequate filtration is essential to defend against harmful particulate matter during smoke events. Building owners and operators should:

• Determine if your HVAC system can handle an increase in filter efficiency. Be aware that equivalent MERV ratings from different manufacturers may have different pressure drops.[9] It is sometimes possible to increase the MERV rating without affecting system performance.

• Consider MERV 13 or higher filtration for supplemental outdoor air filtration during smoke events, as recommended by ASHRAE Guideline 44. Be aware that filters will load up faster during a wildfire event and will require more frequent changes.

• Consider absorption filtration for VOCs, PAHs, and Ozone removal

• Verify that existing filtration systems have correct MERV ratings and fit well without bypass air gaps. Effectiveness of filter can be significantly impacted when there are air gaps.[10]

• Add high efficiency in-room portable air cleaners as needed.

• Prior to wildfire season, inspect outdoor air intakes and identify temporary or permanent filtration upgrades, filter rack requirements, sealing materials, and spare filters needed to support smoke event operation.

• If you are in a location that experiences wildfires on a regular basis or designing a new system and incorporating emergency control modes, investigate the possibility of permanent alternate airflow path with enhanced filtration, fan and airflow enhancements, and new control strategies.

3. Ventilation Verification and Validation

• ASHRAE 62.1-2025 Appendix M7 Ventilation for Existing Buildings and Appendix N Ventilation Rate Check Table provide quick verification methods to check ventilation.[11]

• ASHRAE Guideline 44 recommends installed airflow measurement solutions and validation of airflow rates by an Accredited TAB professional. Note: A TAB measurement is only valid for a moment in time; systems are impacted by the environment and degrade over time. Permanently installed airflow measurement can maintain ventilation and pressurization during all normal dynamic modes and wildfire smoke mode.

• ASHRAE 62.1 Emergency Control Mode requires maintaining ventilation at the standard minimum; however, to limit the amount of smoke in the building, a reduction may be necessary. This should start with limiting the amount of exhaust to ensure that when ventilation is reduced, positive pressurization is maintained.

4. Maintain Positive Building Pressurization.

Maintaining positive building pressurization helps reduce smoke infiltration into occupied spaces. Building operators should:

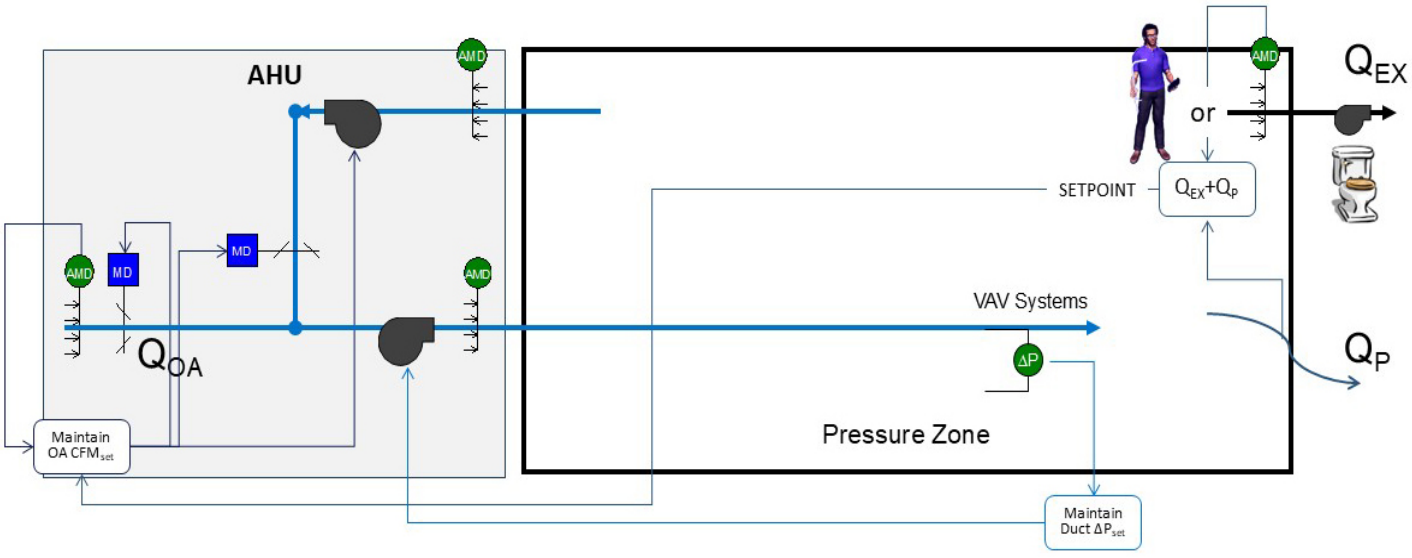
• Ensure windows and doors are properly closed. Inadequate sealing may impact pressurization control and allow infiltration. Ineffective door closures or extreme over-pressurization can keep doors from sealing properly.

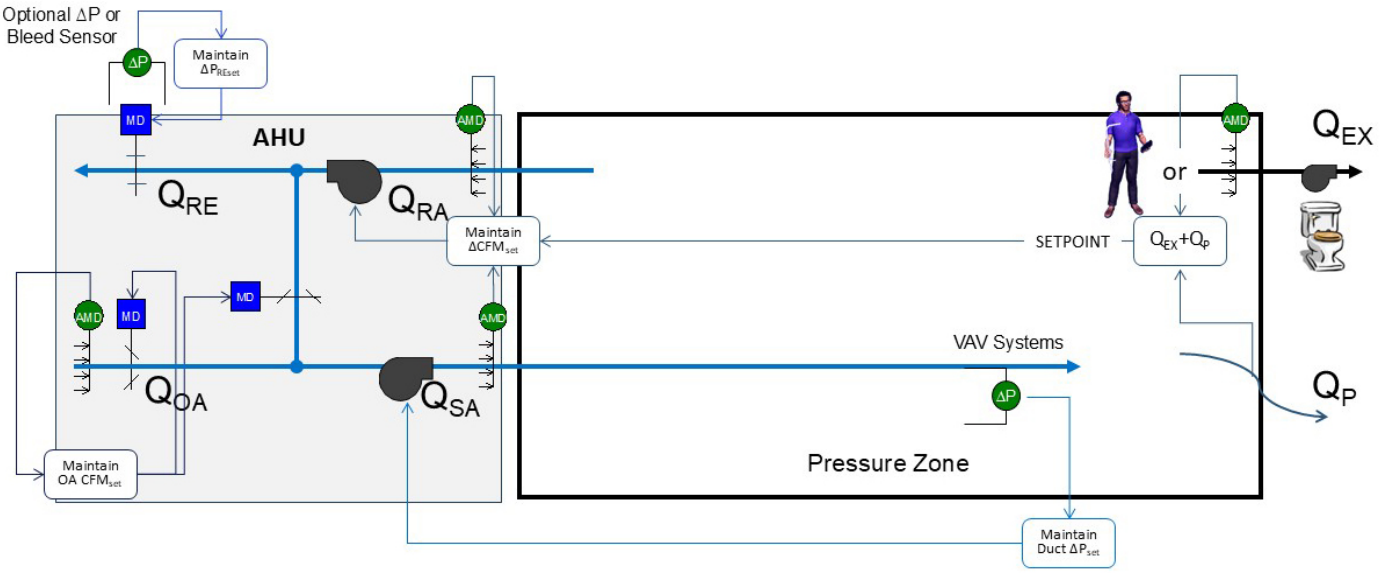
• Control the pressurization flow by ensuring the ventilation rates exceed exhaust and relief rates during all operating modes.

• Disable Demand Control Ventilation (DCV) and Economizer Operation to limit dynamic modes of operation during wildfire events, as these can make pressure tracking more challenging.

ASHRAE Guideline 44 recommends operating buildings at approximately 0.02 to 0.07 in. w.g. (5 to 17 Pa) positive pressure relative to outdoors or maintaining outdoor airflow approximately 10% greater than exhaust airflow during smoke events. The guideline also recommends implementing airflow measurements devices (AMD) in outdoor air and exhaust air streams to provide enhanced monitoring and control of building pressurization during both normal and emergency operations. Tracking supply and exhaust airflows to control pressurization flow helps maintain desired pressurization while minimizing smoke infiltration. Systems with relief at the air handling unit (AHU) may maintain pressurization flow using AMDs in the supply and return and building exhaust. Note: If toilet exhaust are not a complex variable speed setup, they can be set by TAB in lieu of installed AMD.

Many energy saving strategies dynamically modify fan speeds, outdoor air ventilation rates, economizer damper positions, and exhaust airflow operation. These are often mandated by code and may be factory installed, utility incentive based, or other control implementations. They include unoccupied or partial occupancy sensor control strategies, pressure reset strategies, cooling load reduction strategies, and variable speed turn down requirements. These are all dynamic modes





that make building pressurization control more challenging. During a wildfire smoke event, the control mode should try to limit or override dynamic control strategies where practicable to maintain stable building pressurization and reduce smoke infiltration.

Smoke Readiness Planning

ASHRAE Journal identified Smoke Readiness Planning as an important operational strategy for commercial buildings. One recommendation stated in the Smoke Readiness Plan: "Optimize System Airflows; Assess and maintain adequate airflows that are protective of human health and equipment health during smoke events. Prior to wildfire season, determine an outdoor air intake level that controls odor, temperature, indoor contaminant levels and maintains a positive building pressure consistent with the building and HVAC system design."[12]

Ventilation, filtration, and pressure control are foundational to maintaining a healthy building during normal operation and become even more critical during outdoor smoke events. Integrating airflow measurement devices into building automation systems allow ventilation rates to be automatically or manually adjusted to the necessary airflow rates as conditions change between normal and emergency modes. Guideline 44 has a dedicated section for returning the building to normal operations. Once inspection and cleaning have taken place, installed airflow measurement devices would assist in validating damper operation, minimum ventilation, and dynamic modes of operation are working as intended.

Proper outdoor air ventilation and building pressurization are necessary for controlling indoor contaminant concentrations. Uncontrolled or imbalanced airflow can allow unwanted air to enter a building through walls, windows, doors, mechanical rooms, janitor closets, restrooms, locker rooms, basements, or other leakage pathways where the air has not been filtered or conditioned. Installed airflow measurement solutions help verify ventilation and pressurization strategies are performing as intended and can identify airflow deviations that may indicate when filters are becoming loaded and require replacement.

Maintenance remains critical for effective operation in all modes. Testing and inspection protocols help maintain IAQ during normal operation while keeping systems ready for future smoke events. HVAC systems should also be inspected following wildfire smoke events to determine if cleaning is needed, as exposure may impact the operation of components and cause the system to function improperly or inefficiently, impacting normal mode IAQ.

Wildfire smoke events may also leave residual contaminants and VOCs on indoor surfaces that can later be released into occupied spaces. Post-event inspection and cleaning procedures should be considered part of a Smoke Readiness Plan. Guideline 44, returning to normal operation, suggest steps to inspect and clean HVAC components. This is essential to ensure proper operation and eliminate contaminants that could impact air quality.

If You Don't Measure It, You Can't Control It.

When designing or upgrading an HVAC system, measurement, control, and fault detection strategies should be treated as foundational system elements. Future HVAC system designs should consider adding filtration efficiency and control strategies capable of initiating smoke event operating modes. These approaches enable systems to operate efficiently during normal mode and allow for additional fan capacity and the control logic needed during wildfire events. Airflow measurement and control costs are minimal compared to the long-term operational health and energy impacts associated with inadequate ventilation, ineffective filtration, and uncontrolled building pressurization.

ABOUT THE AUTHOR

Darryl DeAngelis is Director of Business Development for EBTRON and has more than 40 years of experience in the HVAC industry. He holds four patents related to HVAC and building systems technologies and is Co-Vice Chair of the Ventilation and Acceptable Indoor Air Quality, ASHRAE Standard Standing Project Committee 62.1. An active ASHRAE member for more than two decades, Darryl is the former Chair of ASHRAE Technical Committee 7.7 Testing and Balancing and has contributed to numerous standards, guidelines, and technical resources focused on indoor air quality, ventilation, energy efficiency, and building performance. He also serves as a voting member of ASTM International and represents EBTRON on ASHB's Board of Directors.

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