



Breathing in Danger

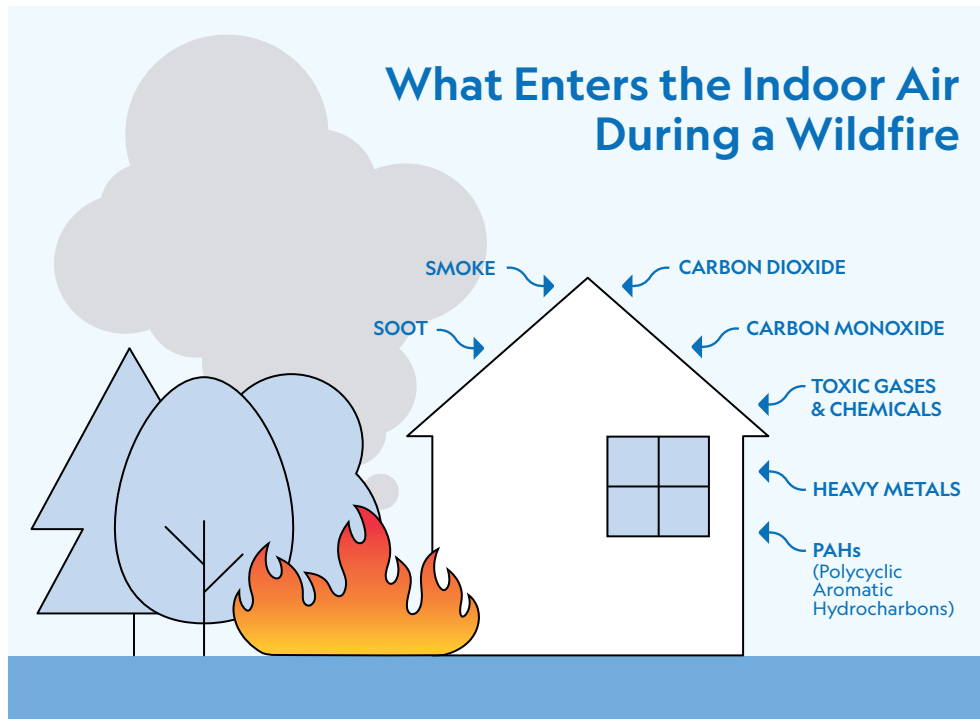
How Wildfire Smoke Compromises Indoor Air Quality and Your Health

Wildfires pose a serious threat to indoor air quality, which can lead to serious health issues, including respiratory problems, cardiovascular strain, and increased vulnerability to illness.

WELLAIR

Introduction

Wildfires have become increasingly prevalent, with tens of thousands of fires and millions of acres burned in North America each year. This growing crisis presents severe environmental challenges, with devastating consequences for ecosystems, infrastructure, and public health. One often-overlooked impact is how wildfire smoke infiltrates indoor environments, posing serious risks to indoor air quality (IAQ).



Wildfires release massive quantities of fine particulate matter (PM_{2.5}), carbon monoxide, and other toxic pollutants that can seep into homes, schools, and workplaces. This is particularly concerning for children, who breathe at a faster rate than adults and inhale more air relative to their body weight. As a result, they are more susceptible to harm from the toxic particles and gases present in wildfire smoke.

With adults typically breathing 25,000 times a day — inhaling over 2,000 gallons of air — exposure to these pollutants significantly threatens both immediate and long-term health. Understanding these risks and taking proactive measures to improve indoor air quality is crucial to protecting vulnerable populations and ensuring safer indoor environments during wildfire events.

Research from Stanford University¹ shows that wildfire smoke is up to 10 times more toxic than air pollution caused by burning fossil fuels, and there is no safe level of exposure. It's also important to note that cloth face masks commonly used during the COVID-19 pandemic offer little protection against the ultra-fine airborne particles and gases produced by wildfire smoke—these by-products pose the greatest risk to human health and well-being.

Wildfire smoke is about
10 times more toxic
than air pollution
from the burning of fossil
fuels and there is no safe
level of exposure.

– Stanford University

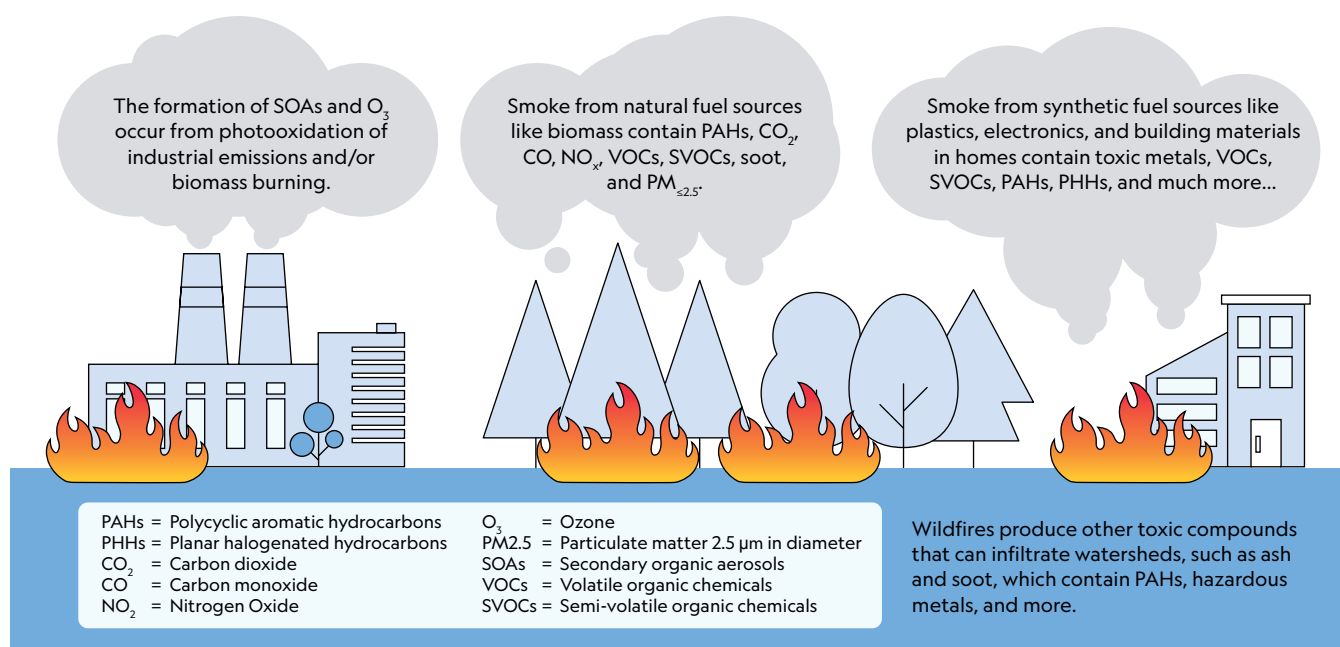
Wildfires and Indoor Air Quality

Longevity and Spread of Airborne Threats

Wildfire seasons are becoming longer and even year-round in some areas. We expect to see some trends that will affect smoke pollution in the years ahead: increased frequency, size, and intensity of wildfires, and increased use of prescribed burns to reduce wildfire risk.

Airborne pollutants from wildfires can remain suspended in the atmosphere for days, weeks or even months (ASHRAE 44-2024²), depending on weather conditions and particle size. Fine particulate matter (PM_{2.5}), in particular, can travel hundreds or thousands of miles from the wildfire source. This widespread dispersal means that areas located far from an active wildfire can still experience significant air quality degradation. **Without effective mitigation, these pollutants accumulate indoors, creating a persistent health hazard even after the wildfire has subsided.**

Key Pollutants from Wildfires



Wildfires release a complex mix of pollutants into the atmosphere, which impact ambient air quality, and can subsequently infiltrate indoor environments. Many pollutants in wildfire smoke are already regulated by the EPA as pollutants (e.g., PM_{2.5}, CO, NO_x, phenols, cresols, acrolein, and acetaldehyde). At least five chemical groups in smoke have been classified as human carcinogens by the International Agency for Research on Cancer (IARC).

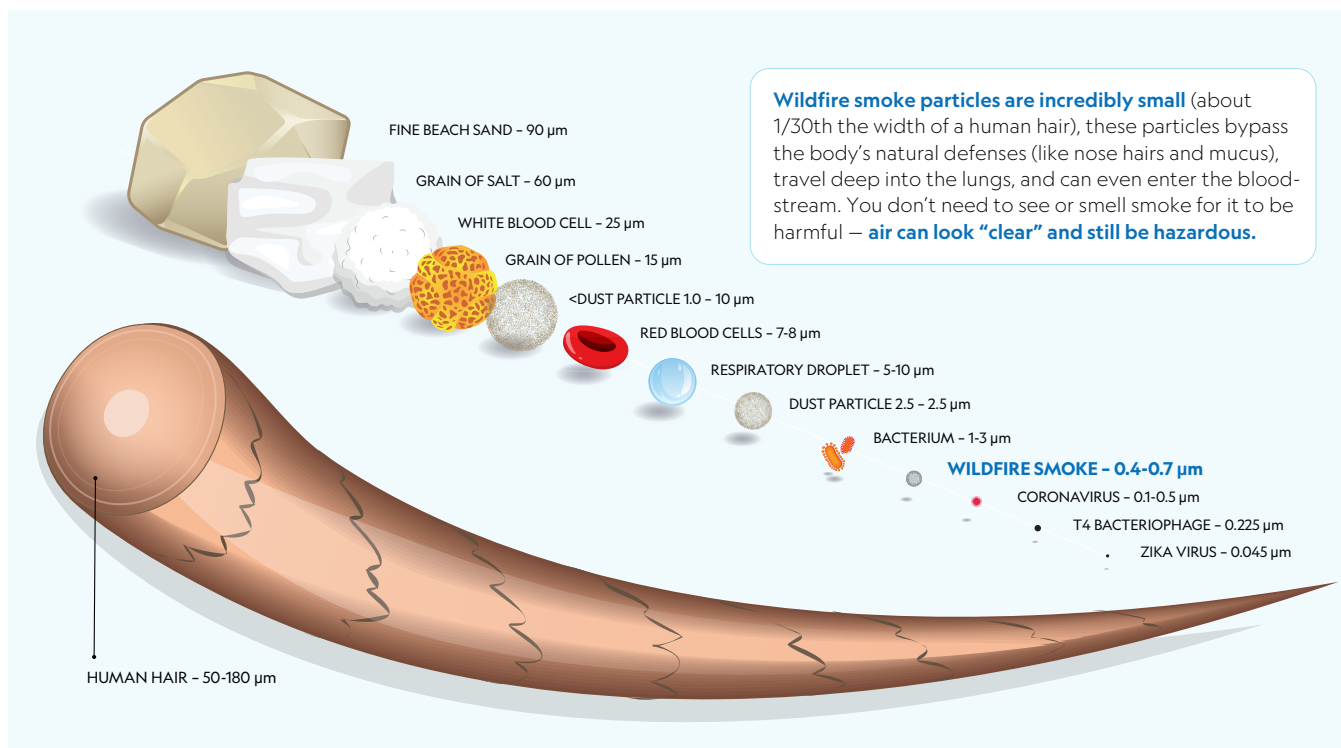


At least five chemical groups in smoke have been classified as human carcinogens.

Pollutant	Health Impacts	Details
 Fine Particulate Matter (PM2.5)	- Short-term respiratory and cardiovascular issues - Long-term damage to every organ	Tiny particles (<2.5 µm) penetrate deep into lungs and bloodstream. Includes black carbon (soot). PM2.5 levels can spike over 50x typical levels during wildfires (ASHRAE 44-2024).
 Carbon Monoxide (CO)	- Dizziness and confusion - Potentially fatal outcomes	Colorless, odorless gas that limits oxygen delivery, quickly leading to life-threatening conditions without early detection.
 Volatile Organic Compounds (VOCs) & Gases	- Respiratory irritation - Long-term health risks	Harmful gases like nitrogen oxides (NO _x), sulfur dioxide (SO ₂), benzene, toluene, formaldehyde, acetaldehyde, acrolein, and ozone (O ₃) that worsen respiratory and systemic health.
 Toxic Particles and Chemicals	- Neurological damage - Cancer risk - Organ toxicity	Heavy metals (lead, copper, zinc, tin, mercury, arsenic) and carcinogens like PAHs. Smoke can become even more toxic over time through chemical reactions with sunlight.

A Relative Size of Particles

A particle needs to be 10 microns (µm) or less before it can be inhaled into your respiratory tract. But how small are these particles? The illustration below shows some relative sizes of familiar particles.



Pathways of Indoor Air Contamination

During wildfire events, outdoor pollutants infiltrate indoor environments through:

- Windows and doors
- Buildings not airtight: gaps in windows and doors, porous materials in structure
- Poorly sealed HVAC systems
- Outdoor air passing through low level filtration within the HVAC system, for example MERV 8 filters used in homes and offices will allow >70% of PM_{2.5} to penetrate (Source: ASHRAE 44-2024)
- Emissions from contaminated clothing from occupants

Health Implications of Compromised Indoor Air Quality

“The first and most important is that PM_{2.5} can penetrate deep into the human lungs, where the particles cause local irritation and systemic inflammation that can affect other organ systems. Short-term and long-term exposure to ambient PM_{2.5} has been conclusively linked to a wide range of acute and chronic health effects by a large body of scientific research.

Some of this evidence suggests that the respiratory effects of wildland fire smoke PM_{2.5} may be greater than those of PM_{2.5} from other sources, even at the same concentrations. It is not yet clear whether these differences are due to differences in the PM_{2.5} composition and toxicity between sources or unmeasured copollutants in wildland fire smoke.”

ASHRAE 44-2024

Exposure to toxic wildfire smoke can have serious health impacts, especially for vulnerable groups like children, older adults, and those with respiratory conditions. Wildfire smoke contains fine particulate matter (PM_{2.5}), carbon monoxide, and volatile organic compounds (VOCs), which can irritate the eyes, nose, and throat while also triggering asthma attacks, heart problems, and reduced lung function. Prolonged exposure can worsen chronic illnesses, increase respiratory infections, and raise the risk of cardiovascular events. Inhaling fine particles allows toxins to enter the bloodstream, causing inflammation that may lead to fatigue, headaches, and impaired cognitive function. Over time, repeated exposure can contribute to lung disease, heart conditions, and even increase the risk of developing cancer.

Protecting indoor air quality during wildfire events is crucial for reducing exposure and safeguarding health.

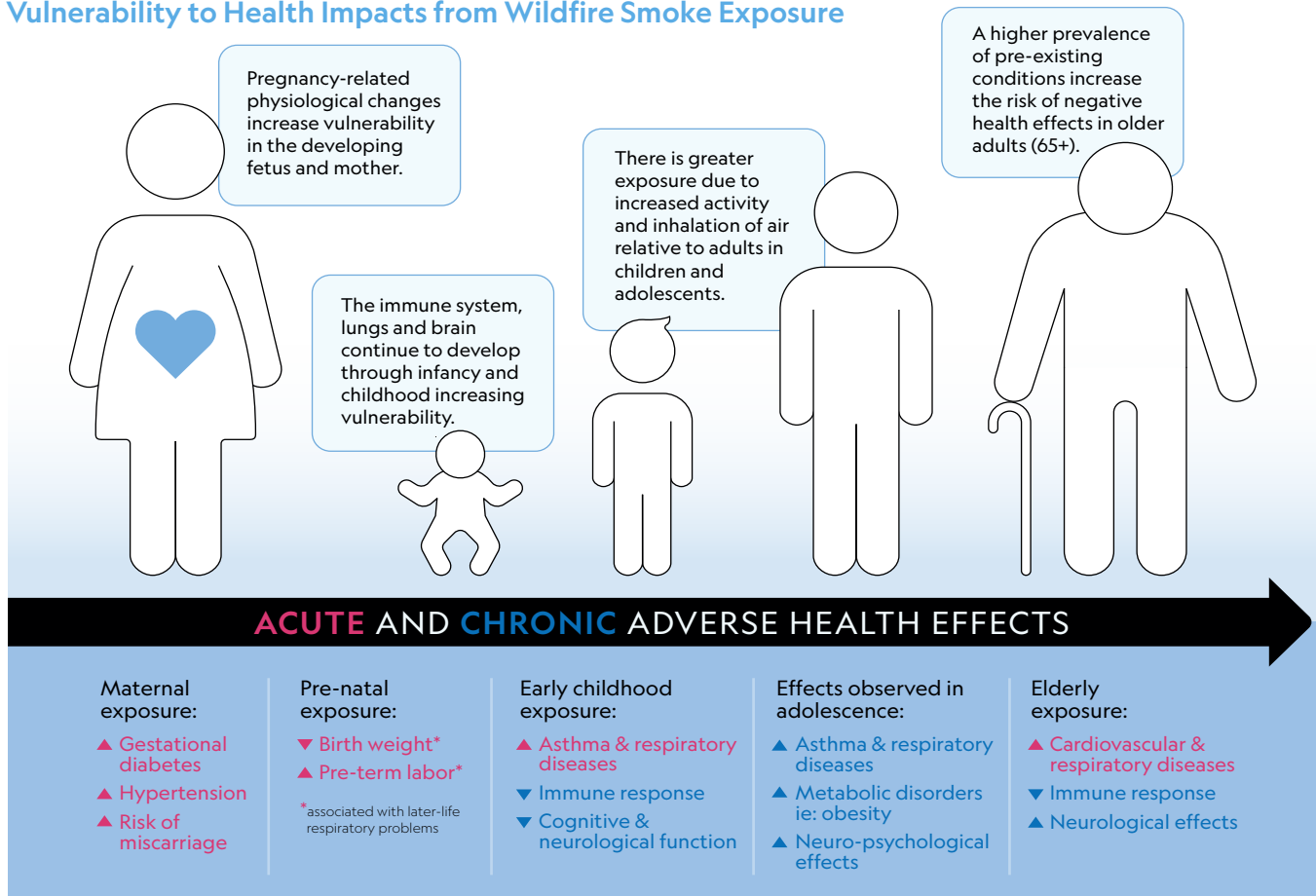
Vulnerable Populations

The health impacts of wildfire-related air pollution are particularly severe for:

- **Children:** Due to developing respiratory systems and higher breathing rates
- **Elderly Individuals:** With pre-existing conditions like chronic obstructive pulmonary disease (COPD) or heart disease

- **Pregnant Women:** Increased risk of adverse birth outcomes
- **Individuals with Respiratory or Cardiovascular Conditions:** Exacerbated symptoms and higher likelihood of hospitalization
- **Outdoor workers and socially disadvantaged groups:** Higher exposure levels

Vulnerability to Health Impacts from Wildfire Smoke Exposure



Health Effects of Wildfire Smoke

Exposure to wildfire smoke can have both immediate and long-term effects on your health and well-being.

Short-Term Minor Effects

You may experience:

- Irritation of the eyes, nose, and throat
- Headaches and fatigue
- Coughing, wheezing, and phlegm
- A faster heart rate
- Worsening asthma symptoms, including difficulty breathing

Short-Term Serious Effects

Even brief exposure to fine particles (PM_{2.5}) in wildfire smoke can lead to:

- Increased blood pressure

- Reduced heart rate variability
- Heart attacks, strokes, or unstable angina
- Out-of-hospital cardiac arrest
- In extreme cases, death

Long-Term Health Risks

Repeated or prolonged exposure to wildfire smoke is linked to:

- Chronic respiratory issues like bronchitis, asthma, and COPD
- Reduced lung function
- Cardiovascular and kidney disease
- Diabetes
- Increased risk of cancer
- Cognitive decline, including dementia
- Weakened immune function, making it harder to fight off infections
- Brain inflammation

Mental Health Impacts

Research shows a strong link between wildfire exposure and mental health challenges, including:

- Increased anxiety, stress, and depression
- Sleep disturbances
- Mood disorders

These effects can be especially severe for vulnerable populations, leading to more ER visits, hospital stays, and—in some cases—fatalities.



Productivity Impacts of Wildfire Smoke

Wildfire smoke doesn't just affect health—it can also reduce productivity across a range of indoor environments due to the presence of fine particles (PM) and harmful gases.

Office Workers

Poor indoor air quality can cause fatigue, difficulty concentrating, and more sick days, all of which reduce overall workplace performance.

Students

Exposure to wildfire pollutants can impair cognitive function and increase absenteeism, negatively impacting academic performance and learning outcomes.

Healthcare Workers

Extended exposure to poor air can make it harder to focus and perform critical tasks, especially in high-pressure emergency situations.

Retail and Service Workers

Respiratory discomfort and added stress from poor air quality can lower job satisfaction and diminish the quality of customer interactions.

These productivity losses underscore the broader economic and societal impacts of poor indoor air quality during wildfire events.

The Novaerus Defend 1050 – The Ultimate Air Purification Mitigation Strategy

Wildfires pose some of the most severe airborne threats to indoor environments, requiring more advanced solutions than typical consumer or light commercial products. The Novaerus Defend 1050 is a portable air disinfection and cleaning system that is FDA-cleared as a Class II medical device. It is used in a variety of settings—including hospitals, clinics, and laboratories—to help mitigate the most extreme airborne risks to human health.

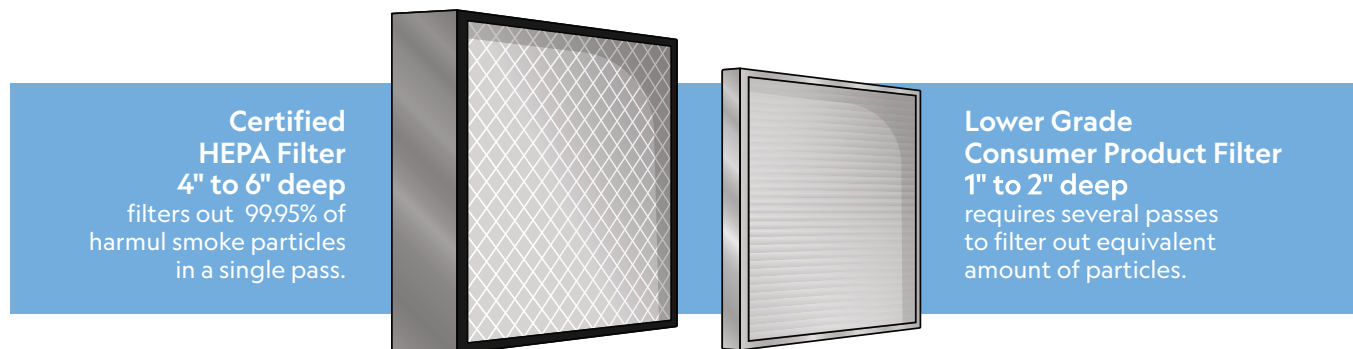


Features and Benefits

Triple Stage Medical Grade Filtration

- **Certified HEPA:** This is one of the few portable air purifiers in the world equipped with a filter that has been officially certified as HEPA. A certified HEPA filter is typically 4 to 6 inches deep, delivering the high level of performance required to capture 99.95% of all particles in a single pass through the device. In contrast, lower-grade consumer products with filters only 1 to 2 inches deep rely on multiple passes to achieve similar results. The key advantage of a certified HEPA filter is its ability to reduce exposure to ultrafine particulates, which pose the most serious health risks. It also helps mitigate smoke damage and reduce persistent smoke-related odors in the home.

Novaerus HEPA vs. Other HEPA-like Filter



- **Largest Carbon Filter:** The Defend 1050 has the largest carbon filter of any portable air purifier. The volume of carbon inside the device is equivalent in size to 100 football fields once fully unraveled from 3D into 2D. This ensures that the device has capacity to trap the extreme high levels of gases and odors associated with wildfires.
- **Pre-filter:** The Defend 1050 has a pre-filter that is equivalent to a MERV 9-10 filter, designed to filter larger particulate matter.
- **NanoStrike™ Technology:** Provides added benefit of inactivating viruses, bacteria and mold in the air to provide a comprehensive solution for health, wellbeing and productivity of indoor occupants.

Benefits

- **Cleanroom Level Performance:** The Defend 1050 delivers ISO 8 cleanroom-level performance. This means the Defend 1050 can reduce ultra-fine particles and pathogens, in the 0.5 microns range, by a factor of up to **1,000 times** compared to ambient air, far exceeding MERV-filtered HVAC systems and commercial air purifiers. The performance gap is not a marginal improvement (e.g., 50%) but rather an **order-of-magnitude enhancement (10X-100X)**.

- **Air Cleaning Performance:** The device moves a large volume of air—up to 541 cubic feet per minute—which means it can clean the air in a room very quickly. Because it uses a certified HEPA filter, it maintains a high level of particle removal even at this maximum airflow. This makes it especially effective when you need rapid air cleaning, such as during a smoke event or to reduce airborne threats quickly.
- **Accretive to HVAC Ventilation:** The Defend 1050 can supplement the HVAC system boosting equivalent air changes per hour (eACH) to rapidly purge airborne threats. In spaces of approximately 800 ft² it can provide over 5 eACH or in space of around 2,000 ft² it can deliver 2 eACH.
- **Highest Safety Levels:** The Defend 1050 has UL 2998 which means there is zero ozone produced. It does not create gaseous by-products or particulates during operation.
- **Durability:** As a medical device the Defend 1050 requires the highest rated materials and components to ensure consistency in performance over a long period of time. For example, the certified HEPA filter ensures high dust loading capacity which means it typically **does not need to be replaced for several years in normal operating conditions, whereas a consumer product would need the particulate filter replaced within 3-to-6 months.**
- **Scalability:** Suitable for various indoor settings, from homes to offices, and schools to healthcare facilities.

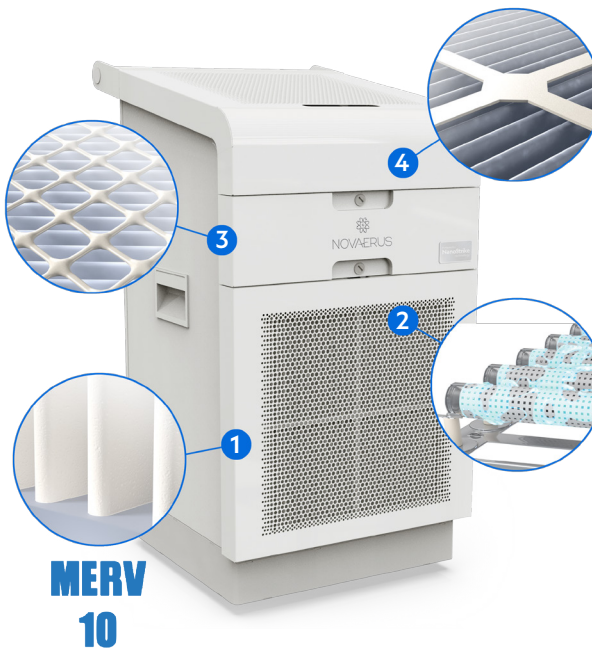
How Defend 1050 Works

Stage 3

A Camfil® HEPA H13 filter traps bacterial debris and particles as fine as 0.12µm.

Stage 1

Powerful multi-speed fan pulls indoor air through a Camfil® pre-filter, capturing large particles, protecting the internal NanoStrike™ coils and extending the life of the HEPA filter.



Stage 4

A Camfil® G4 carbon/molecular filter neutralizes VOCs, gases, odors and impurities.

Stage 2

Six NanoStrike™ coils provide a powerful strike, made up of multiple concurrent inactivation processes, that work to burst airborne pathogen cells, rapidly inactivating them, ensuring they are no longer a threat of infection.

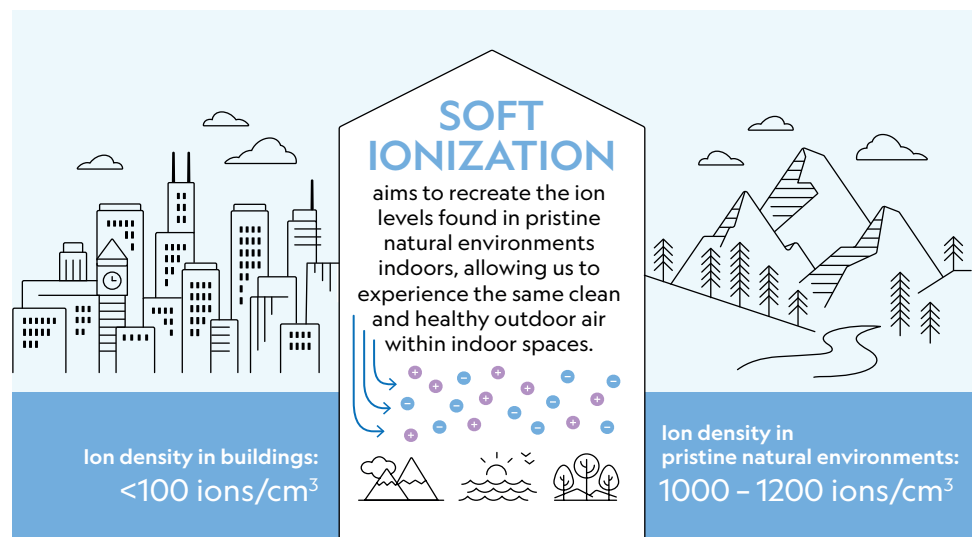
Plasma Air Soft Ionization: A Cost-Effective Solution for Wildfire Smoke in Buildings and Homes

Wildfire Smoke Mitigation with Soft Ionization:

Plasma Air's soft ionization technology offers an effective defense against the harmful indoor pollutants caused by wildfire smoke. By releasing positive and negative oxygen ions—similar to those found in clean, natural outdoor environments—this active technology goes beyond passive filtration. The ions

travel through the HVAC system, continuously seeking out and neutralizing airborne contaminants, including the fine particulate matter found in wildfire smoke, before they can be inhaled by occupants.

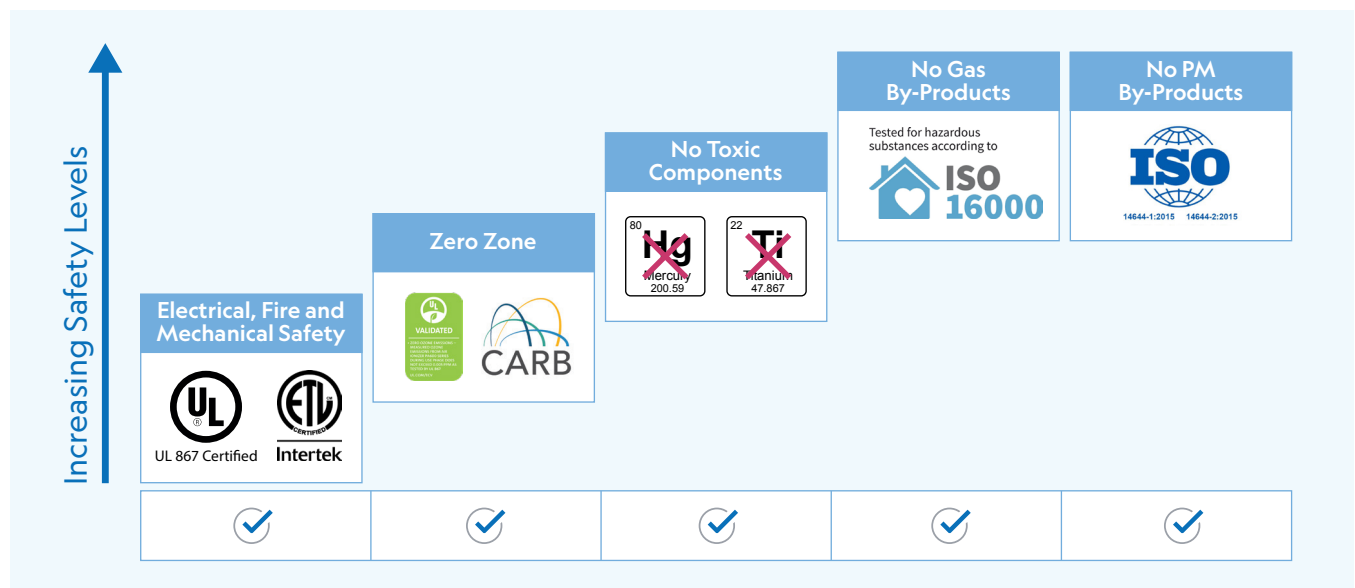
When integrated with ventilation and filtration, Plasma Air's soft ionization delivers a powerful, cost-efficient approach to mitigating wildfire smoke indoors, making it an essential part of a multi-layered air purification strategy.



Features and Benefits

- **Whole Building Air Purification:** Leverage HVAC system to purify air in every room 24x7 in the most cost-effective way with the added benefit of no disruptive noise.
- **Highest Safety Levels:** All products have UL 2998 which means there is zero ozone produced. The devices also have been tested against ISO 16000 to ensure there are no gaseous by-products created, such as formaldehyde. The products have also been proven to not create any by-products, such as Particulate Matter (PM), during the inactivation process.

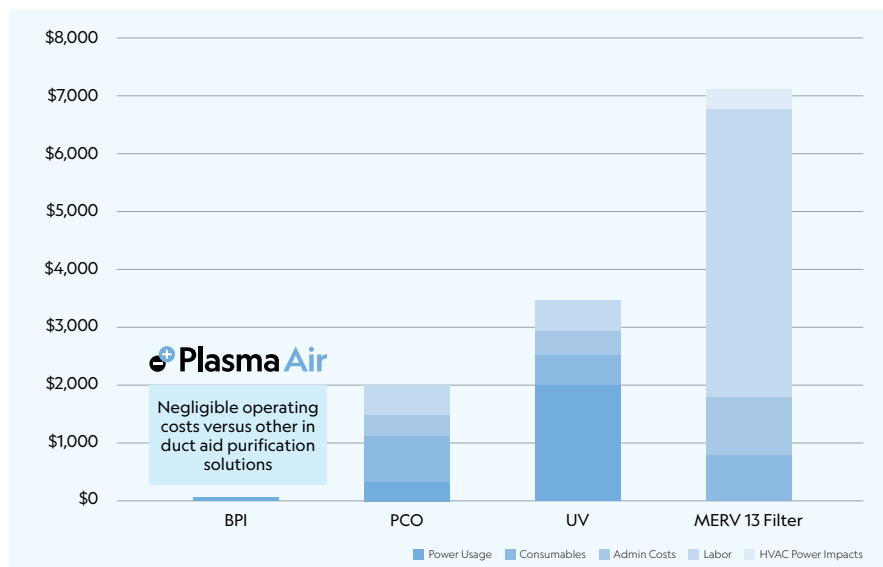
Highest Safety Levels of Any Air Purification Technology



- **Highly Effective in Reducing Smoke:** Soft ionization produces positively and negatively charged ions that attach to airborne particles such as wildfire smoke. These charged particles then cluster together, becoming larger and heavier, making them easier to remove from the air. The increased

size and weight facilitate their filtration by air purifiers, ventilation systems, or settling on surfaces. The particulate matter agglomerates and either falls to surfaces, due to gravity, or is made easier to capture by filters during air recirculation through HVAC.

- **Reduce the Gases and Odors Associated with Smoke:** Soft Ionization will help remove the smoke and soot based odors within indoor environments while also helping to reduce some of the gases that are by-products of wild fires.
- **Lowest Total Cost of Ownership:** All soft ionization products have extremely low power consumption. The products all have long operational life-cycles and require no consumables. There are self-cleaning variants of the products that ensure the products can operate for their entire life span without the need for servicing. All this, combined with a fast and easy installation, delivers lowest total cost of ownership of any air purification solution.



10 Year operating cost comparison chart

- **Eco-Friendly:** Lowest power consumption of any air purification solution, no pressure drop to impact HVAC power consumption, no consumables and either low or zero service requirements – depending on whether self-cleaning variants are used – these products have the lowest carbon footprint within the air purification industry.

The Most Sustainable Air Purification Technology



- Ultra low power consumption of devices (< 5W – most Plasma Air products)
- Negligible pressure drop in HVAC system (unlike filters)
- Can save 30%+ of energy in buildings via IAQP (ASHRAE 62.1)
- Reduce outside air in HVAC, thereby reducing ongoing heating and cooling energy costs
- No consumables, thereby reducing industrial energy, emissions, transport, etc.
- Minimal / no servicing, reducing contractor fuel & emissions from call outs

- **Range of Benefits All Year Round:** Soft ionization can inactivate pathogens in the air reducing risk of COVID, flu and colds spreading in offices, schools, and homes. By reducing PM within the air, it helps reduce asthma and allergy episodes and helps to reduce risk from long term exposure to ultra fine particles.

Plasma Air Solutions



Conclusion

As wildfires continue to increase in frequency and intensity, protecting indoor air quality has never been more critical. The toxic pollutants released during these events pose serious risks to respiratory health, cognitive function, and overall well-being. While traditional HVAC filters and consumer-grade air purifiers may offer some relief, they are often insufficient in addressing the extreme airborne threats that wildfire smoke presents.

WellAir's advanced air purification solutions — including the Novaerus Defend 1050 and Plasma Air HVAC solutions — provide powerful protection against wildfire-related pollutants. The Novaerus Defend 1050's certified HEPA filter efficiently traps hazardous fine particulate matter (PM2.5), while its large carbon filter effectively absorbs harmful gases and odors. Combined with NanoStrike technology for airborne pathogen inactivation, the Defend 1050 offers comprehensive mitigation for indoor environments. Meanwhile, Plasma Air's HVAC-integrated solutions continuously reduce airborne contaminants, enhancing overall IAQ protection throughout entire buildings.

By investing in these proven solutions, building owners, facility managers, and homeowners can create safer, healthier indoor environments — even during severe wildfire events. When smoke fills the air outside, WellAir's technology provides peace of mind inside.

"In recent years, the incidence of wildland fires has increased in both the number of fires per year and the severity and duration of each event. In some cases, smoke events have lasted several weeks to months. The smoke produced from wildland fires can have a significant negative impact on ambient air quality, both local and distant, which in turn can negatively impact health."

ASHRAE Guideline 44-2024
Protecting Building Occupants from Smoke
During Wildfire and Prescribed Burn Events

Endnotes

- 1 <https://news.stanford.edu/stories/2025/01/assessing-wildfire-health-risks>
- 2 <https://www.ashrae.org/about/news/2024/ashrae-releases-new-guidance-to-mitigate-the-impact-of-smoke-on-indoor-air-quality>