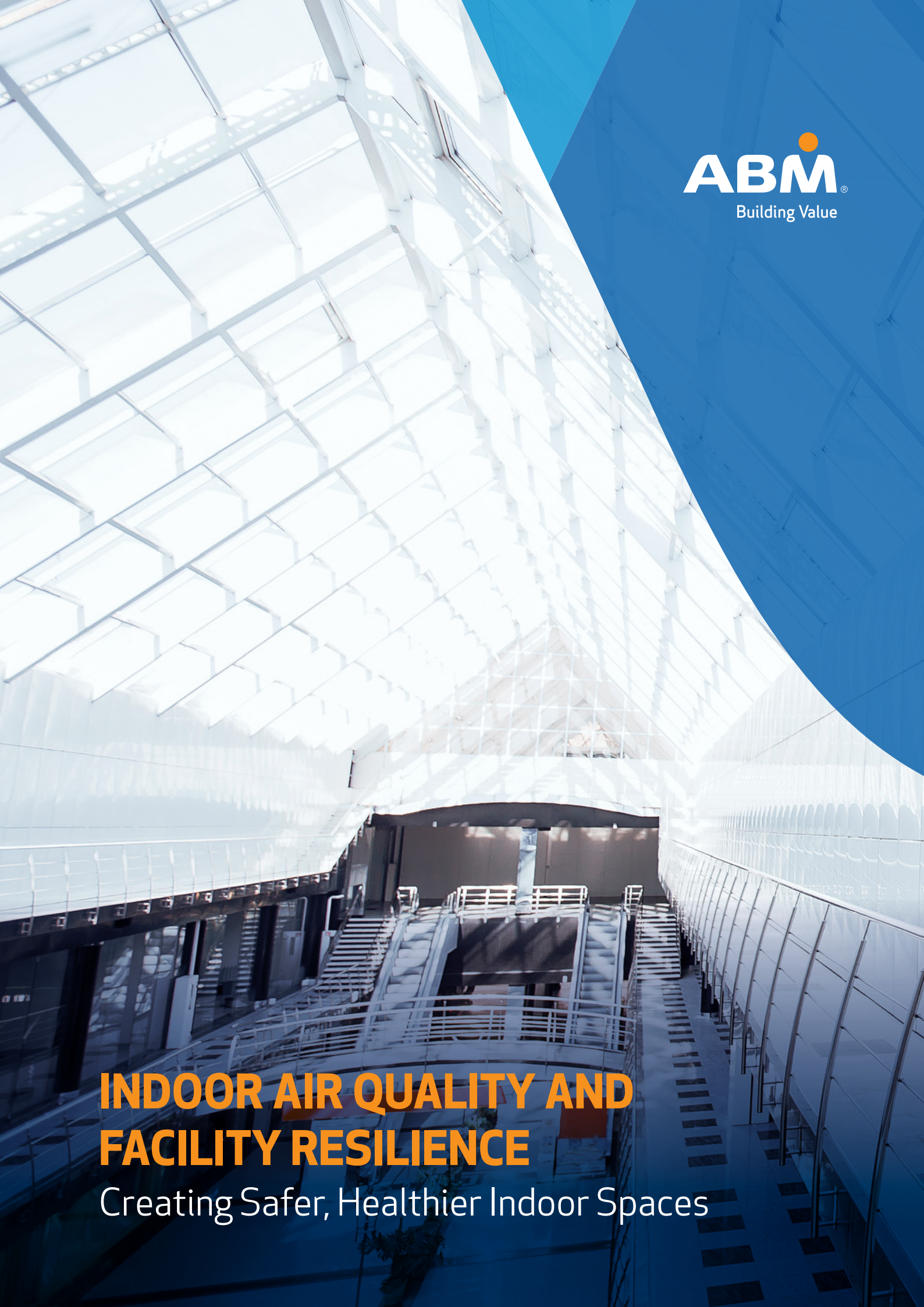


ABM®
Building Value

INDOOR AIR QUALITY AND FACILITY RESILIENCE

Creating Safer, Healthier Indoor Spaces

Background

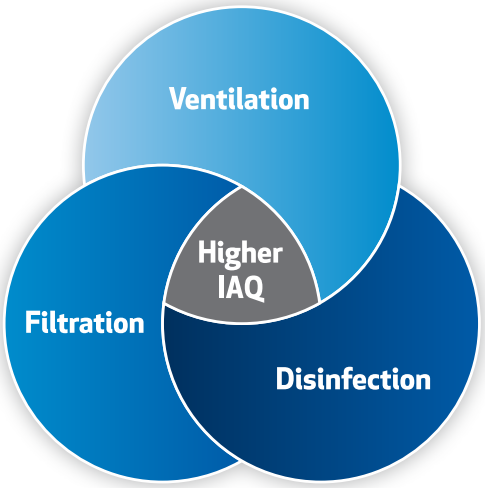
The COVID-19 pandemic dramatically disrupted life around the world, and most profoundly our interactions outside the home. Before people will be able to return in significant numbers to shared indoor environments like workplaces, schools, airports, and recreational spaces, both occupants and facility operators need to be confident those spaces are as safe as possible. Healthy air plays a central role in those safety calculations.

COVID-19 has undoubtedly heightened awareness of the importance of indoor air quality and is driving many changes. However, it is just one pathogen among many viruses, bacteria, particulates, volatile organic compounds (VOC), gases, and other contaminants that can impact and jeopardise human health. In addition to combating those various airborne and surface pathogens, better indoor air quality (IAQ) supports occupants' overall comfort and productivity.

Among the challenges for facility management is the evolving definition of healthy indoor air and a healthy building. Indeed, there is no universally accepted definition of "good" IAQ, nor a single measurement of it. IAQ reflects the complex interplay of a facility's systems and structures, the conditions outside, and the people inside. These factors and their interactions naturally vary enormously by facility. Even so, key indicators – including air-exchange rates and indoor humidity levels – allow us to evaluate facility wellness and establish baselines. Just as no two buildings are exactly alike, neither are ABM's action plans for improvement and remediation, which are tailored to every facility's unique conditions.

This white paper aims to provide an overview of IAQ risk factors, ABM's assessment process, and the best solutions for cleaner indoor air and reducing risk. The often overwhelming number of products that have been rushed into the marketplace in response to COVID-19 provide a cautionary tale. A number of these make bold promises yet are ineffective, unnecessary, and (in some cases) potentially dangerous. ABM only recommends methods and technologies that have been vetted by our Expert Advisory Council and that are safe and proven, as backed by evidence.

Public health experts, business owners, and consumers all increasingly view high-quality indoor air as an imperative. Taking measurable steps toward improving your facility's IAQ now will position it for our emergence from the current pandemic. Incorporating air-quality protections such as ventilation, filtration, and disinfection will support your facility's resiliency, viability, and value over the long term.



WHAT'S IN THE AIR, ANYWAY?

Indoor Air Quality fundamentally refers to the types and concentrations of airborne contaminants found in buildings. We can organise them into four main categories.

Particulate Matter

Particulates are formed by a mix of tiny particles and liquid aerosols. This broad category encompasses fibers, metals, soils, and dusts, as well as viral and bacterial pathogens (and the dusts and aerosols that may contain them), and fungi (or mold spores). Their health effects can range from mild lung irritation to life-threatening illness.

SOURCES

outside contaminants

people | interior furnishings | building materials | smoke | exhaust fumes

Important to Know

The presence of viral pathogens is the hardest to measure and research is ongoing into COVID-19 transmission measurement strategies. ABM is closely monitoring the latest developments and is adhering to and following the latest recommendations from the U.S. Centers for Disease Control and Prevention (CDC) and U.S. National Institutes of Health (NIH).

SOLUTIONS

Filtration and disinfection technologies for both air and surfaces

Volatile Organic Compounds (VOCs)

VOCs are a large class of chemicals that can be emitted as vapor or come in a gaseous form. Some VOCs can cause lung irritation, making the interior environment uncomfortable for occupants, while others can have result in severe long-term effects, such as cancer.

SOURCES

building materials | furnishings | paint | carpeting | process chemicals

Important to Know

Concentrations of some VOCs can be up to 10 times higher indoors compared to outdoors.

SOLUTIONS

Elimination, substitution of a chemical or product, and/or engineering controls such as improved ventilation

Carbon Dioxide

Carbon dioxide (CO_2) is a colorless, odorless gas that is naturally present in air. Inside a facility, it is primarily produced by people through their exhalations. Interior CO_2 levels reflect human (or animal) density and the facility's ventilation. If a building is crowded or the ventilation system is inadequate (or not working properly), then carbon dioxide concentrations will be elevated. At unsafe, higher levels, people inside may experience drowsiness, headaches, dizziness, difficulty breathing, sweating, increased heart rate, and increased blood pressure.

Important to Know

Carbon dioxide is typically used as a marker or stand-in for other airborne contaminants that can build up in facilities when evaluating ventilation systems.

SOURCES

primarily people

SOLUTIONS

Ensure that HVAC systems are designed to comply with minimum ventilation requirements and verify that these systems are operating as designed. For systems equipped with variable (controllable) outside air dampers and CO_2 sensors, a demand-controlled ventilation (DCV) sequence can be added that will measure and remove CO_2 by dilution with variable amounts of fresh air.

Carbon Monoxide

Carbon monoxide (CO) is a colorless, practically odorless, and tasteless gas that results from incomplete oxidation of carbon in combustion processes. Carbon monoxide is a very serious health hazard. At low concentrations, it can cause fatigue in healthy people and chest pain in people with heart disease. At high concentrations, it can impair vision and coordination and cause headaches, dizziness, confusion, nausea, and even death.

Important to Know

Carbon monoxide can build up slowly over time. Facilities with equipment and systems that could be leaking CO into the indoor environment should periodically test for CO intrusion or accumulation in ventilation shafts, plenums, and other areas associated with these potentially leaky sources.

SOURCES

gas-powered equipment

vehicle exhaust

heaters

stoves

boilers

furnaces

leaking or improperly vented chimneys and flues

SOLUTIONS

Hazard mitigation through first identifying and controlling sources, then improving ventilation

ABM's Holistic Analysis

ABM begins with a building assessment of facility risk factors, including but not limited to the pandemic. This data-driven analysis determines the most critical needs as they relate to indoor air quality and guides the next steps.

Our Expert Risk Assessment and Solution Prioritisation Process

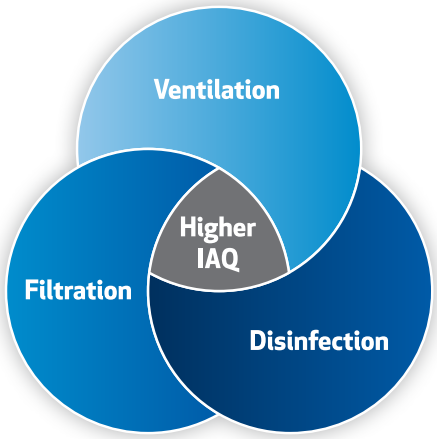
Using our proprietary Healthy Building Risk Assessment, developed alongside our Expert Advisory Council, we can assess and identify IAQ challenges and recommend effective and cost-effective solutions.

First, your facility's exposure risk is categorised. Using our proprietary Healthy Building Risk Assessment, your facility's overall risk level is identified (low, medium, high, or very high).

Then, the highest priorities to each facility are identified. The most important and effective strategies for your facility's specific risk level are determined.

Lastly, targeted solutions based on risk level are developed for maintenance, lighting, and HVAC systems. A report of fact-based recommendations help you form a comprehensive strategy for reopening and operating more safely.

There are three widely accepted ways to managing IAQ: **ventilation** (or dilution) to reduce the concentration of airborne contaminants inside; **air cleaning and disinfection** to remove or destroy these contaminants; and **source control through filtration** to prevent contaminants from getting into the facility in the first place. In combination, these approaches together help mitigate or minimise the factors that can impact IAQ.



In nearly all facilities, a comprehensive, multifaceted plan is needed to make meaningful improvements, with the goal of reducing overall risk. These efforts should complement each other as part of an overall safety strategy. The key is finding the right combination of technologies and procedures that align with the building's requirements, and at the same time are feasible, efficient, and ultimately sustainable for the organisation.

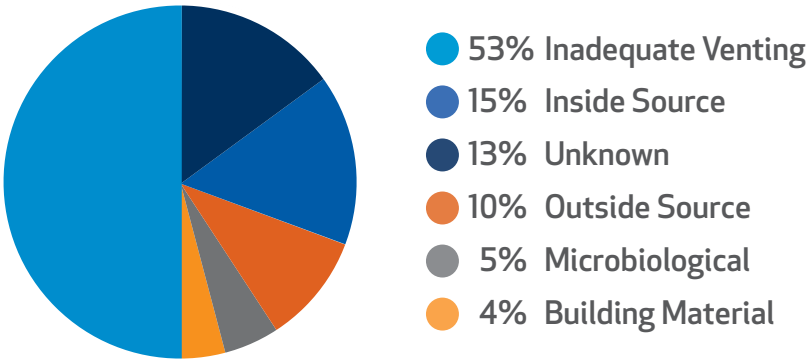
Sectors like healthcare, high tech manufacturing, and pharmaceuticals have been at the forefront of IAQ innovations and leading air-quality technologies have been adapted from them. Before looking to those solutions, we start with the basics.

HVAC AND VENTILATION

A healthy building is a well-ventilated one. A pre-coronavirus study of sick buildings by the National Institute for Occupational Safety and Health (NIOSH), a division of the CDC (the U.S. public health agency) the Centers for Disease Control and Prevention, cited inadequate ventilation as the single biggest probable cause of Sick Building Syndrome (see chart below).

What Makes Buildings "Sick"

NIOSH Indoor-Air investigations Point to Inadequate Venting



Source: Environmental Protection Agency, "VOC Impact on IAQ," November 6, 2017.
https://www.epa.gov/indoor-air-quality-iaq/volatile-organic-compounds-impact-indoor-air-quality

Ventilation means regular air outdoor exchanges (exhausting indoor air out and bringing fresh air in). Everyone is familiar with the sensation of a stuffy room or the unpleasantness of lingering strong odours. Ensuring proper ventilation rates is one of the best methods for maintaining good IAQ. Those rates are based on the primary function of the space, the number of occupants, and the square footage.

Maximum ventilation is equivalent to circulating 100% outdoor air (recognising that conditions outside don't always allow, which we address later in this white paper) and the resulting dilution effect is compelling. It often brings low-hazard source materials below the regulatory limits and reduces the likelihood of transmitting a pathogen. And while 100% outside air is more expensive to condition, the benefits to IAQ may outweigh the higher associated costs.

It's recommended that the indoor ambient temperature ranges from 20.3 to 23.9 degrees Celsius in the winter and 22.2 to 26.9 degrees Celsius in the summer. Indoor air humidity should be kept between 30% and 60% both for occupants' comfort and to inhibit biological growth.

The humidity levels can be adjusted depending on critical programming and the need to avoid static build-up. Keeping relative humidity at the higher end of the recommended range has been shown to help reduce transmission of COVID-19, making HVAC controls an important tool in controlling pathogens.

Two critical functions of HVAC controls are scheduling the HVAC system's operation and the ability to control outside air. Simple controls like a stand-alone thermostat will give the system the feedback it needs to make a space comfortable, but not necessarily energy efficient. If a unit's fresh air supply is controlled, and the fan is set to "ON" rather than "AUTO" when the facility is occupied, then adequate fresh outdoor air will be brought into the building even with the simplest of systems.

Larger HVAC systems may be equipped with smarter controls systems, such as direct digital controls that operators can interact with on a computer or a mobile app. These controls often have the added benefit of being able to adjust the positions of outside air dampers and also may allow for the introduction of additional ventilation, as conditions and equipment capabilities permit. On very humid days, for example, the controls will reduce the percentage of outdoor air by closing the damper to a minimum set-point, ensuring that the indoor humidity and temperature stay within comfortable limits. Similarly, on very cold days, the damper is adjusted to prevent the freezing of any coils inside the air handling unit. In all other situations, the controls should be configured to strike a balance between increased fresh air and the limits of the system's heating or cooling capability.

Current guidelines recommend that ventilation systems operate both two hours before and two hours after the building's normal occupancy hours. Those extra two hours pre and post-occupancy will eliminate 95% of indoor contaminants in buildings, even in those designed to satisfy only the minimum ventilation standards.

FILTRATION

As an integral part of the HVAC system, air filtration is essential to supporting IAQ.

All centralised HVAC system filters are rated according to a minimum efficiency reporting value (MERV). Higher numbers mean more and smaller particulates are removed. The typical commercial system is designed and installed with MERV 6 or 8 filters.

Systems capable of supporting highly efficient particle filtration (HEPA) filters provide even greater protection to building occupants by capturing more types of airborne substances. HEPA is standard in healthcare settings, for example. For targeted needs such as those of an enclosed room, single-space, high-efficiency filtration units can be highly effective in reducing or lowering concentrations of infectious aerosols, provided they are appropriately selected and deployed. They are available as portable and ceiling-mounted units.

All of these more powerful filters require greater air pressure to work as designed. Some HVAC systems may not have the capacity to accommodate the necessary pressure loads. It is important to undertake a thorough design review before making any changes.

Ongoing preventative maintenance is also crucial to IAQ. Regularly checking for leaks, changing filters, cleaning, servicing and replacing parts all go a long way toward supporting optimal HVAC operation while reducing energy consumption and extending the life of the system.

DISINFECTION TECHNOLOGIES

Innovative ways to disinfect air and surfaces can be powerful tools in your regimen for a healthier, safer building. But even cutting-edge technology is useless if it is improperly installed, operated incorrectly, or is simply the wrong choice.

Ultra-Violet C Light

Ultra-violet (UV)-C light, which can inactivate harmful microorganisms, is among the most recognised and effective technologies for air and surface disinfection.

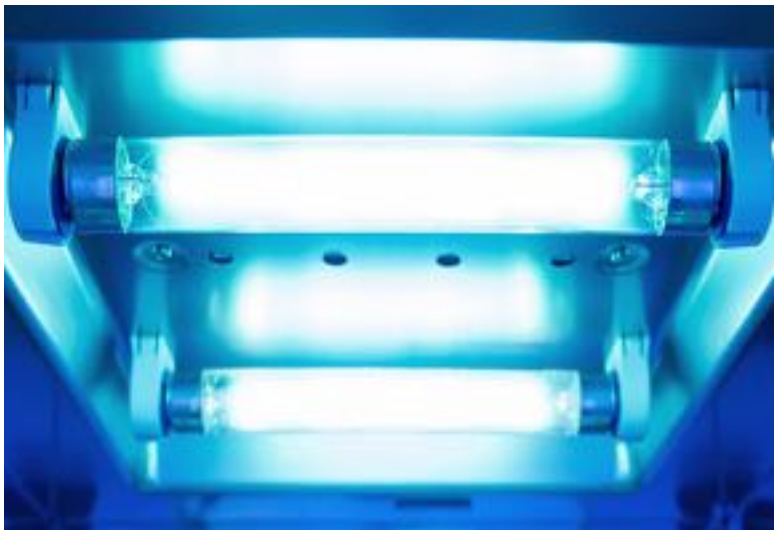
The options include:

- **Upper Room UV-C** has the longest track record. Special fixtures irradiate the air in a room at 7 feet or above, so it can be safely used in rooms that are occupied. This technology has successfully controlled the spread of airborne pathogens in places like hospitals, prisons, and government buildings.
- **Fixed-air handing unit UV-C** directs a light fixture on HVAC drain pans, supply ducts and cooling coils where pathogens may flourish. A 360-degree application that also targets the recirculating air delivers the best outcomes.
- **Installed UV lighting:** Far UV is the latest innovation in this arena. It uses a 222-nanometer light source that is known to be safer for the skin and eyes. Like other UV-C options, its application must incorporate important operational safeguards. This technology is especially promising for downlighting, but it requires critical knowledge of the room contents and occupancy patterns to effectively inactivate pathogens.

Be aware that all the current UV-C applications require specialised training and installation as well as scrupulous attention to safety features, application procedures, and controls. Improperly deployed, UV-C can cause damage to skin and eyes.

The use of UV-C or UV GI mobile devices such as movable towers, counter-top devices, and cabinets is growing. "No-touch" (automated) mobile UV-C devices have been shown to reduce bacterial contamination of surfaces after manual cleaning. When using these devices, scrupulously following safety protocols, like having UV shielding between the UV energy source and the operator and preventing facility occupants from entering the room when disinfection is underway, is critical.

ABM currently does not recommend any type of UV-C wand or handheld device.



Emerging Technologies

Needlepoint Bipolar Ionization

This exciting technology relies on nature's air-cleaning agents: electrically charged oxygen ions. When generated inside the HVAC system, these ions group fine particles into filterable clusters (a process called agglomeration), break down harmful VOCs, and inactivate microorganisms. They have demonstrated effectiveness on a broad range of airborne contaminants as well as unpleasant odors.

Large industrial facilities and buildings located in areas where the outdoor air quality is poor are among the biggest existing users of this air-purifying technology. Think of going inside an airport terminal and never smelling jet fuel. Some ionization technologies may create dangerous ozone particles, so it is important to choose the technologies that have been vetted for occupant safety.

HVAC Dry Hydrogen Peroxide Generation

Unlike aqueous hydrogen peroxide technologies, dry hydrogen peroxide technology is an ion generating process placed inside HVAC ductwork and uses a catalytic converter to react with a multi-wavelength ultraviolet light to illuminate a target surface. The target surface is a honeycomb matrix treated with a proprietary photocatalytic coating. It then converts water and oxygen molecules found naturally in the humidity of the air into safe but effective levels of hydroxyl radicals (OH-), oxygen ions (O_2-) and hydrogen peroxide (H_2O_2).

These devices come in a variety of sizes and a combination of these units can be used to cover a facility. Depending on the unit, the device will cover 37, 92, 232, or 464 square metres. The self-contained unit is installed by drilling a small hole into the side of the HVAC duct, inserting and securing the unit, plugging it in, and turning it on.

Photo-Hydro-Ionization (PHI)/ Hydro-Peroxide Generation

Similar to the dry hydrogen peroxide technology, PHI units disinfect the air traveling through HVAC systems by projecting a broad spectrum HE/UV light onto a quad metallic catalyst target in a low ozone and moist atmosphere. This process causes a unique oxidation reaction that produces friendly oxidizers called ionized hydroperoxides. These are naturally occurring disinfection agents that are then circulated throughout spaces via the fan. As long as the fans continue to circulate indoor air, the PHI circulates its neutralising ionized hydroperoxides, providing continuous air disinfection.

SOURCE CONTROL

People are at the front line of controlling airborne pathogens because they are potential carriers – and their actions and choices can help control and eliminate exposure. Although most guidance issued in 2020 focused on COVID-19, these recommendations apply equally to colds, flus, strep, gastrointestinal infections like norovirus, and other communicable illnesses.

- Require the use of hand sanitiser, masks, and social distancing practices as occupants enter and occupy all buildings, at all times
- Send all potentially positive infection cases home immediately upon discovery
- Evaluate the infected individual's work area
- Clean and disinfect all affected work areas, keeping in mind that disinfectants likely contribute to the airborne VOC concentration, at least initially.

In other recommendations, use building materials, furnishings, appliances, and consumer products with low VOC contaminant emissions and ones that can be easily and thoroughly disinfected as needed.

Design, operate, and maintain building envelope structures, HVAC systems, and plumbing systems to reduce the likelihood of moisture problems. Address leaks or other water intrusions immediately.

HIGHER EXPECTATIONS FOR INDOOR AIR QUALITY: ARE YOU DOING ENOUGH?

At ABM, we believe that every IAQ solution should be implemented only as part of a comprehensive mitigation plan for one simple reason: No single process or control can be 100% effective in preventing the airborne spread of pathogens and contaminants indoors. However, the right combination of methods, procedures, and protocols, designed and calibrated to work in harmony, can and does dramatically lower risks and improve conditions indoors.

The pandemic is profoundly shifting expectations for facility health and safety risk for all types of facilities. The broader public better appreciates the risks from contaminants and pathogens in the air. This pandemic has heightened awareness of the role of healthy buildings on human health even among those familiar with challenges like norovirus, Legionnaire's disease, and asbestos.

Most buildings can be turned into safer, healthier places. Although the roll-out of COVID-19 vaccines may reduce the need for certain measures in the near term, we have been assured that the likelihood of future epidemics and pandemics will necessitate improved IAQ going forward. Therefore, we anticipate that many measures for healthier indoor air will become permanent fixtures that occupants will expect, with lasting implications for resilient facility management.

Visit EnhancedFacility.co.uk to learn more or call 0207 089 6600.

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About ABM

ABM (NYSE: ABM) is a leading provider of facility services in the United States and various international locations. ABM's comprehensive capabilities include janitorial, electrical & lighting, energy solutions, facilities engineering, HVAC & mechanical, landscape & turf, mission critical solutions, and parking, provided through stand-alone or integrated solutions. ABM provides custom facility solutions in urban, suburban and rural areas to properties of all sizes — from schools and commercial buildings to hospitals, data centers, manufacturing plants and airports. ABM Industries Incorporated, which operates through its subsidiaries, was founded in 1909. For more information, visit ABM.com.