



Delivering good indoor air quality through whole building



The importance of good indoor air quality



According to the World Health Organization (WHO) **“Air pollution from both outdoor and indoor sources represents the single largest environmental risk to health globally”**, and causes 7 million deaths a year, worldwide.

On average, people spend 90% of their lives indoors (and some, such as the elderly, even more). This has caused the level of indoor air pollutants to increase 2-5 higher than outdoor levels.

Some indoor air pollutants can be 100 times more damaging than outdoor equivalents which has made indoor air quality now a recognized key issue in to hospitals, schools and factories.

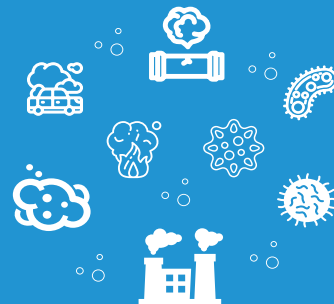
Indoor air pollution can lead to serious short and long-term health problems. There has also been growing evidence that air pollution impacts mental health

and may be a factor in conditions such as depression and bipolar disorder. It may also have a detrimental effect on children's learning ability, patient recovery and workforce productivity.

For building owners, poor indoor air quality (and poor indoor environments in general) can hit the bottom line: demands from leaseholders and tenants can result in having to carry out costly remedial works to both the building fabric and M&E systems (from lighting to climate control). This can lead to higher running costs and potentially affect market and rental values.

Did You

91% of people living in the cities do not breathe safe air



The causes of poor indoor air quality



Indoor air quality is defined as the quality of the air in and around a building, particularly in relation to the health and comfort of occupants. It is affected by complex and inter-linked factors, due to both outside and inside air pollution.

Sources of outdoor air pollution include road traffic, industrial processes, waste incineration and construction and demolition sites. Pollution includes particulate matter, NO₂, CO and pollen, all of which can be brought into a building through natural or mechanical ventilation and via infiltration through the building fabric.

But there are also pollution sources inside a building, including Volatile Organic Compounds (VOCs) given off by wall and floor coverings, furniture and appliances as they age and degrade; dust, damp and mould; emissions from office equipment and industrial machinery and, of course, occupants themselves, who breathe out CO₂ and can spread colds and viruses.

Whole building HVAC: striking a balance between good indoor air quality and energy efficiency

As energy efficiency standards in building design have risen in recent years, buildings have become more insulated and airtight. This can reduce fresh air circulation, leading to low oxygen levels and increased potential for allergies and odours, as well as the risk of condensation build-up.

The solution? Installing HVAC systems which control temperature, humidity and maintain air quality.

Main air pollution sources in buildings and how they affect IAQ



Indoor Sources

- Human or animal activity (dead skin, hair, CO₂, viruses and others)
- Cigarette smoke
- Dust
- Bacteria
- Mold
- Volatile Organic Compounds (VOCs - carbon-based compounds that easily evaporate)



Outdoor Sources

- Traffic and other combustion products
- Pollen
- Dust
- Ventilation
- Airflow patterns
- Air filtration systems



Ventilation

Fundamentally, ventilation aims to remove stale indoor air and replace it with 'fresh' outdoor air. HVAC systems are designed to extract water vapour, airborne pollutants and odours, controlling humidity and maintaining good indoor air quality, and to minimise the spread of these impurities to other areas of a building.

Systems must also provide 'purge ventilation' to help remove occasionally high concentrations of pollutants and water vapour caused, for example, by food cooking in a kitchen or an accidental water spill.

For larger buildings, ventilation can be supplied by air handling units linked to the indoor units, controlled centrally or by floor, room, or zone. For smaller buildings, heat recovery ventilation units can be integrated with the overall climate control system, to supply tempered fresh air to the indoor units.

Energy Efficiency

Whole building ventilation systems incorporating heat recovery deliver high levels of efficiency, using waste from heating/cooling to reuse in different areas of a building.

Manufacturers typically claim Seasonal Energy efficiency using (SEER) figures of 3 and 4 for heat recovery systems. However, it is possible, under certain conditions for a system's efficiency ratio to nearly double, when taking into consideration recovered energy. In practice, a SEER in excess of 6 should be possible to achieve on a fairly frequent basis.

Further energy savings can be achieved using features such as variable refrigerant temperature control. This varies the amount of refrigerant flowing through the system and alters the evaporating and condensing temperatures to match demand.

Dramatically less power is needed as a result and efficiency rises accordingly

Why not just open a window?

In the past, increasing fresh air supply was achieved by simply opening a window or a door. However, this can allow the ingress of outdoor pollution and simply may not be feasible in cold weather.

Additionally, windows in many modern buildings cannot be opened, to maintain energy efficiency, (and in taller buildings for safety reasons). Even if they can, opening windows or wedging open a door can have a detrimental effect on an HVAC system's ability to provide a comfortable indoor environment.

Designing ventilation building climate control

As with any element of HVAC, the design of ventilation, whether as a stand-alone system or as part of a whole building solution, must meet the requirements of the building's occupants.

The key factor in designing ventilation is that it must provide sufficient fresh air supply and extraction to minimise moisture build-up (and therefore control mould) and deal with bio-effluents (body odour), as well as to keep exposure to NO₂, CO and VOCs to a minimum.

"Ventilation and filtration provided by heating, ventilating, and air-conditioning (HVAC) systems can reduce the airborne concentration of SARS-CoV-2 and thus the risk of transmission through the air. Unconditioned spaces can cause thermal stress to people that may be directly life-threatening and that may also lower resistance to infection."

ASHRAE Statement on the operation of heating, ventilating, and air-conditioning systems to reduce SARS-CoV-2 transmission

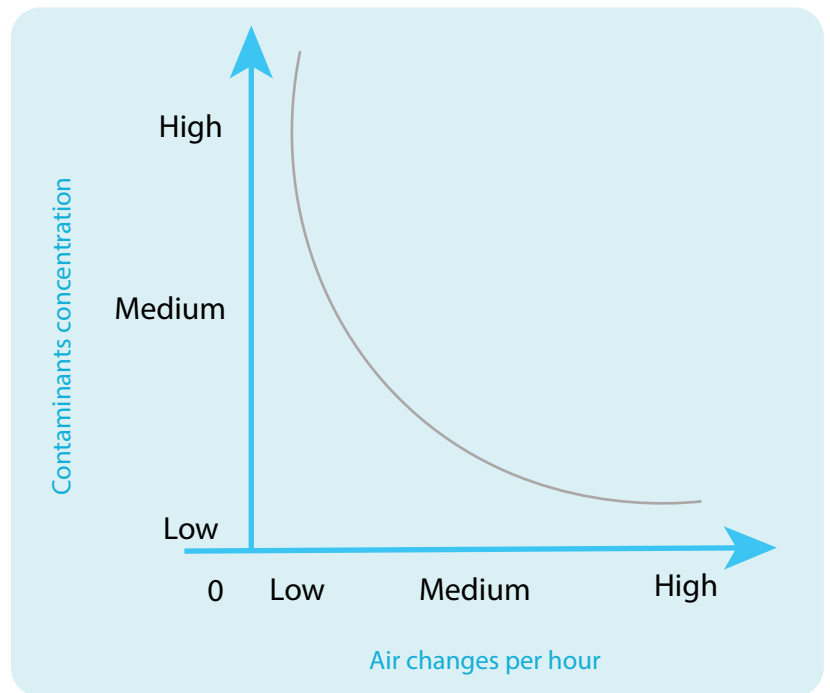


Utilizing ventilation

to reduce the risk of substandard indoor air quality

The dilution and filtration principle

The more air changes we have per hour and better filtration, the less contaminants we will have in the indoor air environment.



Example of the impact of ventilation on indoor air quality

World Health Organization
Air quality guideline values for particulate matter (PM)

Fine particulate matter (PM_{2.5})

- 10 µg/m³ annual mean
- 25 µg/m³ 24-hour mean

Coarse particulate matter (PM_{2.5-10})

- 20 µg/m³ annual mean
- 50 µg/m³ 24-hour mean

Average one-day indoor concentrations of PM10 µg/m³

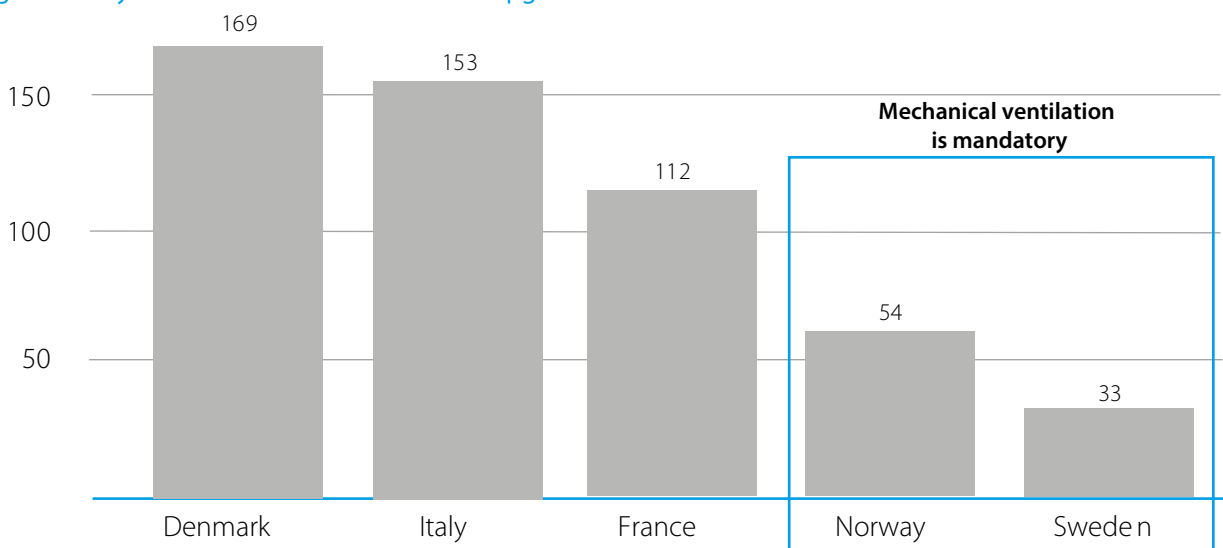


Chart: Pietro Consalvo

Source: Health Effects of School Environment (HESE)



Homes

Required ventilation rates for homes are based on the number of bedrooms, from 13 l/s for a one bedroom home, to 29 l/s for a five bedroom property (assuming that two people occupy the main bedroom and one person occupies each of the others). The minimum ventilation rate must not be less than 0.3 l/m² of the internal floor area (all storeys).



Offices

The total air supply and extraction is 10 l/s/person, based on the assumption that the building has an air permeability of 3 m³/(h.m³). This is within the range achieved by most modern, well-designed buildings and is negligible infiltration, compared with the ventilation system capacity. Intermittent extract ventilation is required for specific areas, including WCs and urinals, printing /photocopying rooms, showers and food and beverage preparation areas. Purge ventilation is also required in each one.



Hospitals and healthcare

Obviously, some healthcare environment, such as operating theatres, critical care areas and isolation units, have particular ventilation requirements to prevent the spread of infection and of odours and hazardous materials. For example, air recirculation systems are normally used in clean rooms and ultra-clean operating theatres, where the extracted air is significantly cleaner than the outside supply.



Locating ventilation intakes and exhaust outlets

Ventilation intakes must be placed as far away as possible from the main sources of local air pollution. For HVAC systems, this typically means on the roof (unless there are higher-level sources). Alternatively, intakes can be placed on walls, in courtyards and in atria. Regardless of position, it is important to avoid cross-contamination be placed as far a way as possible, preferably on the roof or at a high level, and downwind of intakes where there is a prevailing wind direction. They should not discharge into courtyards or enclosed spaces and it is recommended that they discharge vertically, to avoid downwash.

Controlling ventilation

Automatic systems are fitted with CO₂ sensors, which slow down, or switch off the unit if CO₂ levels drop below a customer-defined level, typically linked to how many people are in the room. If CO₂ levels are perceived to be too high, air quality is maintained by VAV (variable air volume). Ventilation can also be controlled using the same infrared sensors used to adjust temperature in climate control systems that detect room occupancy.

Systems also need to be flexible enough to enable some ventilation units to be switched off (or reduce flow rates) - for example during rush hour - with the system relying on units remote from the pollution source or using recirculated air for a time.

Dealing with noise

Ventilation can be noisy and annoying for both occupants and for people outside a building, so noise should be minimised wherever possible. This can be achieved through design - i.e. by placing units carefully - or by choosing indoor and outdoor units with very low sound power levels and sound insulation - or introducing attenuation.



Filters

Filtration is another important element of ventilation. All HVAC units will be fitted with filters, primarily to keep them free of dust, to ensure good operation and to maintain energy efficiency.

Filters are also fitted to remove particulate matter (PM) from supply air and, in some cases to remove particles where there is a risk of pollution entering the outside atmosphere. Filter selection is based on the widely-accepted thresholds for PM, published by the World Health Organisation in its Air Quality Guidelines - Global update 2005. The recommended annual limits are:

> Annual mean for $PM_{2.5}$ < 10 $\mu\text{g}/\text{m}^3$

> Annual mean for PM_{10} < 20 $\mu\text{g}/\text{m}^3$

General filters capture larger, heavier particles, such as dust; filters remove smaller particles - typically the size of bacteria; while HEPA and ULPA filters are used in specialist environments, such as clean rooms and ultra-clean operating theatres.

Efficiency	Size range (μm)
ePM10	0.3-10
ePM2.5	0.3-2.5
ePM1	0.3-1

Eurovent 4/23 Selection for EN ISO 16890 Rated air filter classes for general ventilation applications (2018) gives guidelines on selecting air filters based on the minimum filtration efficiency, depending on outdoor and supply air categories, for a range of buildings, including homes, offices, shopping centres and hospitals. It also gives comparisons between the filter grades in EN 779 and ISO 16890.

Measuring Real Life ISO 16890



International Standards Organization

Issues a new standard for filter testing and rating



The precise definition of PM₁₀, PM_{2,5} and PM₁ is quite complex and not simple to measure. Public authorities, like the US EPA or the German Federal Environmental Agency (Umweltbundesamt), increasingly use in their publications the simpler denotation of PM₁₀ as being the particle size fraction less or equal to 10 µm. Since this deviation to the above-mentioned complex "official" definition does not have a significant impact on a filter elements particle removal efficiency, the ISO 16890 documents refer to this simplified definition of PM₁₀, PM_{2,5} and PM₁.

More than Logic - ISO 16890 Measures Reality!

The world's leading health-related organizations consider PM₁₀, PM_{2,5} and PM₁ the dust fractions as the most important and dangerous for humans. Their official documentation to the public always refers to these PM levels.

It is more than logic that filter test methods and classifications follow this approach to demonstrate filtration performance towards the most harmful fine dusts.



ISO coarse – filters allocated to this range capture less than 50% of PM₁₀ particles.



PM₁₀ – Refers to the particle size fraction in the range from 0,3 µm up to 10 µm.



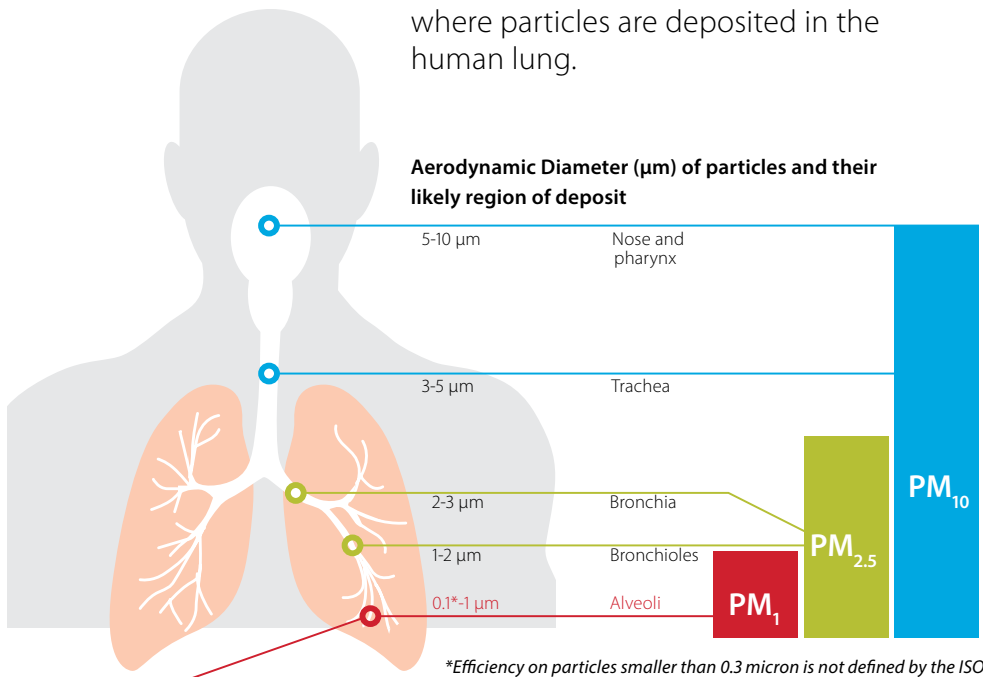
PM_{2,5} – Refers to the particle size fraction in the range from 0,3 µm up to 2,5 µm.



PM₁ – Refers to the particle size fraction in the range from 0,3 µm up to 1 µm.



ISO 16890 classifications are based on where particles are deposited in the human lung.



PM₁ - The smaller, the more dangerous!

A variety of studies are focusing on the health effects of PM₁ particles.

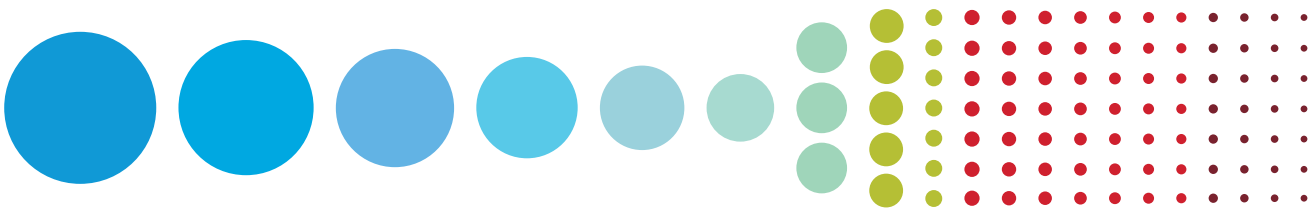
Particles smaller or equal to 1 micron in diameter are small enough to find their way through the cell membranes of the alveoli and into the human blood stream.

Fine particles in the air measuring between 0.25 to 0.5 microns in diameter have a closer relationship to the human health, specially and increased risk of cardiovascular diseases.

Smaller particles in the body can harm the regulation of the human nervous system.

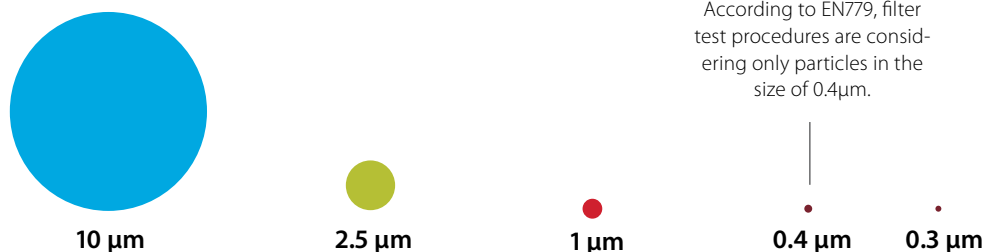
Due to their harmfulness, permanence, and frequency, particles smaller or equal to 1 μm need the most attention!

The lighter and smaller a particle is, the longer it stays in the air.



Particles smaller than 1 micron contribute only a few % to the mass, at the same time contributing to over 90% of the numbers.

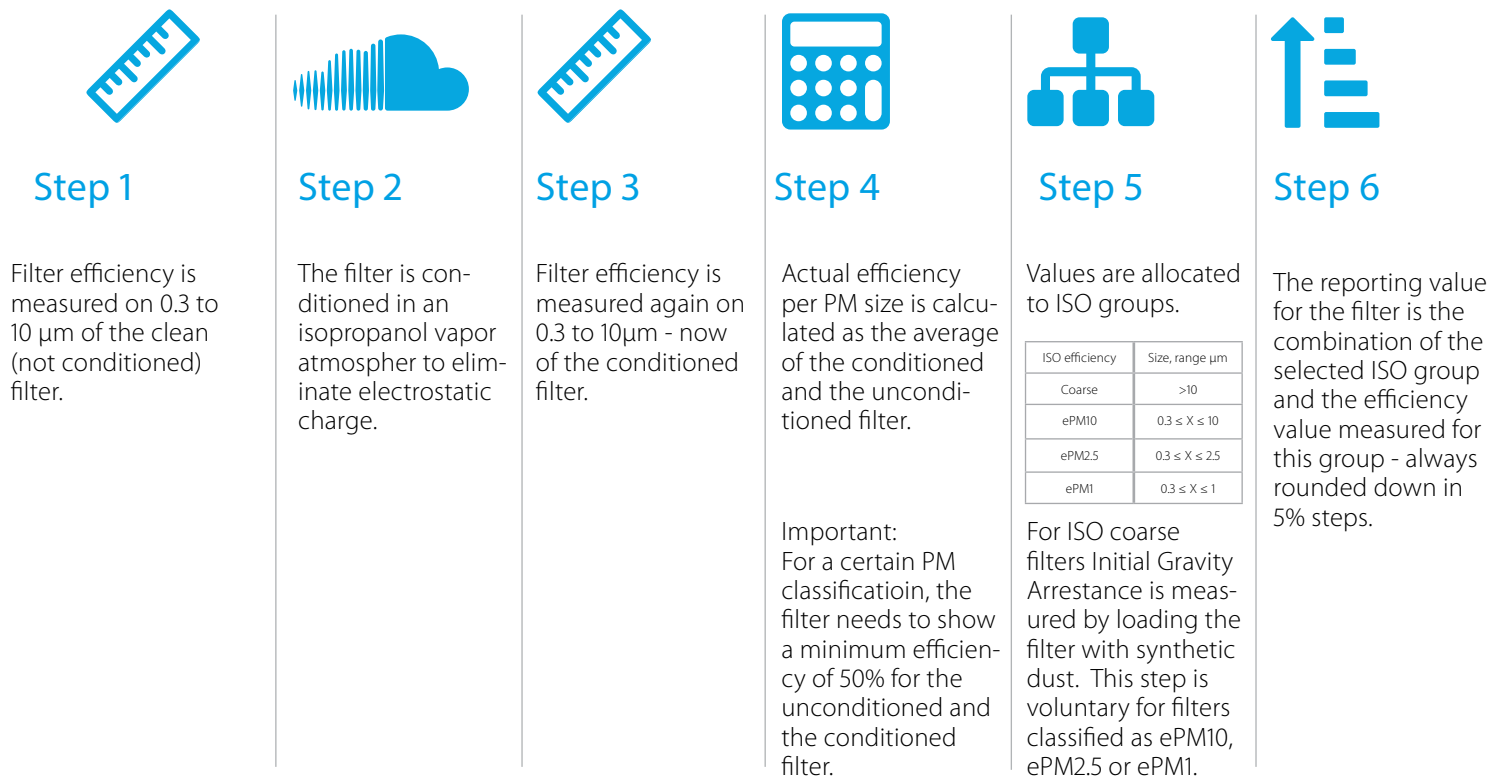
The main difference between EN779 and the ISO 16890



According to EN779, filter test procedures are considering only particles in the size of 0.4 μm .

According to ISO 16890, filter test procedures are considering the range from 10 μm to 0.3 μm .

ISO 16890 Testing and Classification Procedure



Example:

A filter shows the following average efficiency values:

Efficiency Class	Value
ISO ePM ₁₀	89%
ISO ePM _{2.5}	63%
ISO ePM ₁	49%

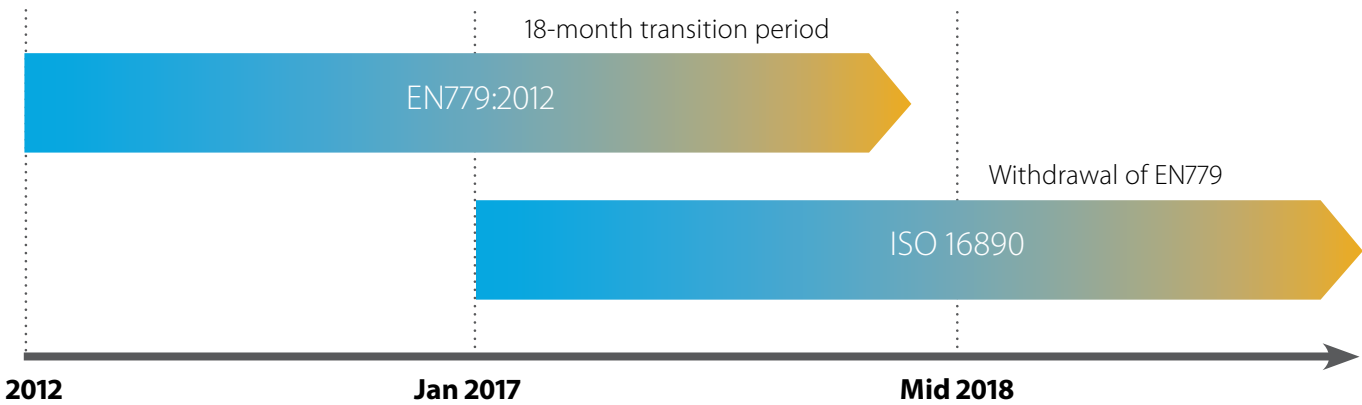
- › Minimum efficiency of 50% is achieved for ISO ePM10 and ISO ePM2.5 - but only 49% for ISO ePM1, which is not fulfilled.
- › Possible ISO groups are therefore ISO ePM2.5 and ISO ePM10
- › If for example, ISO ePM2.5 group is selected, value of 63% is rounded down to 60%.

As a result, the filter is classified as:

Classification
ISO ePM _{2.5} 60%

Meaning this filter is able to capture 60% of the particles smaller or equal to 2.5 micron!

ISO 16890 Timeline



Installing, commissioning and servicing of ventilation to maintain good indoor air quality

Installation and commissioning

It is crucial that HVAC systems are installed according to manufacturers' recommendations and commissioned changes on site – varying piping length, for example –

Using (and supervising) an installer approved to install a particular manufacturer's systems is key, as is choosing a company with experience of similar installations.

Maintenance and cleaning of ventilation

Regular maintenance of ventilation is obviously important and should form part of the overall servicing regime for a building's HVAC system. However, cleanliness is of particular importance when dealing with ventilation, as dust and dirt can

Maintenance should include checking the intake and exhausts for any signs of dirt build-up, pollution or contamination, damage from weather and animals, as well as inspections of ductwork and the indoor units.

Dust should be removed from ductwork, particularly change of direction in the ducting. Filters should also be cleaned and replaced as necessary. Indoor units should also be cleaned and the dust boxes of those fitted with auto-cleaning systems emptied.

COVID-19

As coronavirus (COVID-19) restrictions become part of our daily reality, concerns have been raised about the role of HVAC in the risk of spreading airborne viruses.

First and foremost, building owners and managers should follow government guidelines. But, as with any airborne contaminants, the risk of potential spread of viruses can be mitigated by ventilation and proper and effective filtration, along with regular cleaning and maintenance of systems.

It is essential that air conditioning systems in buildings where confirmed cases of coronavirus have been diagnosed are cleaned and sterilised according to best practice; it is equally important to do so in buildings with no confirmed cases, as a preventative measure, not only now but as part of ongoing maintenance.

While in urban areas, where air pollution is likely to be higher, this may mean more pollution ingress to a building, the view is that mitigating the risk of coronavirus is more important during the pandemic.

This means extending ventilation operation times (and, where possible, keeping ventilation running 24/7), increasing ventilation rates when the building is occupied and only reducing them during 'off-peak times such as at night or at weekends.

However, it says there is no need to change filters more regularly; nor is additional cleaning thought to help reduce the risk of room-to-room transmission – normal maintenance procedures can be used, with adequate PPE for service engineers and appropriate safety procedures in place, including switching off systems during filter changes.

Certifications



The Eurovent program certifies the air handling systems for Mechanical and Performance characteristics including the following : Casing Strength (CS), Casing air leakage (CAL), Filter bypass leakage (FBL), Thermal transmittance of the casing (TT), Thermal bridging factor (TBF), Acoustical insulation of casing, Air flow, Available static pressure, power input, airborne sound power level, cooling capacity, heat recovery, pressure loss on water side, etc.



LEED (Leadership in Energy and Environmental Design) is the most widely used green building rating system in the world. Available for virtually all building types, LEED provides a framework for healthy, highly efficient, and cost-saving green buildings. LEED certification contributes to the comfort and well-being of building occupants by establishing minimum standards for indoor air quality (IAQ).

Standards



ANSI/ASHRAE Standards 62.1 and 62.2 are the recognized standards for ventilation system design and acceptable indoor air quality (IAQ). Expanded and revised for 2019, both standards specify minimum ventilation rates and other measures in order to minimize adverse health effects for occupants.

Regulations



Section 401.01 requests Minimum Ventilation requirements for adequate Indoor Air Quality. All new and existing air-conditioned buildings must be mechanically, or mixed mode ventilated and must comply with the minimum requirements of ASHRAE Standard 62.



The livable indoors section introduces many aspects that are important in the design of a building interior such as: Indoor Air Quality Management practices during construction and after occupation; Ventilation quality during normal building operation; Material selection to reduce harmful emissions.

Standards and Regulations

World Health Organisation Air quality guidelines (2005)

Widely accepted as the key air quality guidance for policy makers on reducing the effects on health of air pollution, this document includes guideline values for the four most common air pollutants: particulate matter, ozone, nitrogen dioxide and sulphur dioxide.

https://www.euro.who.int/__data/assets/pdf_file/0005/78638/E90038.pdf

WHO guidelines for indoor air quality – selected pollutants 2010

This document provides guideline values and exposure thresholds for the protection of public health from risks due to a number of chemicals commonly present in indoor air.

https://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf

EN ISO 16980 Air filters for general ventilation (2016)

ISO 16980 is the guidance for designing filtration in ventilation systems. It superseded BS EN 779:2012. Particulate air filters for general ventilation. Determination of the filtration performance in 2018.

<https://www.iso.org/obp/ui/#iso:std:iso:16890:-1:ed-1:v1:en>

EN 16798-1:2019 Energy performance of buildings – Ventilation for buildings – Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics – Module M1-6.

This standard is part of a series, EN 16798, covering the main aspects of building ventilation, from the point of view of energy performance. This standard provides parameters that need to be considered in designing heating, cooling, ventilation and lighting systems to make the energy-method.

Eurovent 4/23 Selection of EN ISO 16890 ventilation applications (2018)

This document provides guidelines on selecting air filters, outlining the differences between EN779 and EN ISO 16980 filter classifications. It gives recommendations for selecting the minimum filtration efficiency based on outdoor air and supply air in a range of buildings, including homes, offices, shopping centers and hospitals.

<https://eurovent.eu/sites/default/files/field/file/Euro-vent%20REC%204-23%20-%20Selection%20of%20EN%20ISO%20r%20classes%20-%202017.pdf> 16890520rated%20air%20filter

Non-Residential (NRVU) units are classified under the directive with airflows from 280 l/s onwards.

Bidirectional (BVU) units are those producing supply and extract fans.

All BVU products must incorporate heat recovery in the form of Thermal Wheel,

Air recirculation (Mixing) is only permissible if the fresh air content is 10% or less of the total ventilation rate without a separate heat recovery device.

The Specific Fan Power (SFP) is a ratio of power consumed to the amount of air moved by a ventilation system i.e. W/l/s or kW/m³/s. SFP is greatly influenced by system resistance and reducing by design is an effective method of achieving the requirements of Part L2A. existing building.

Central System – A supply and extract system serving the whole or major parts of a building.

Zonal System – A system which serves a group of rooms forming part of a building

(i.e. a zone where ducting is required).

Local Unit – An unducted ventilation unit serving a single area.

Improving air quality

with innovative solutions

From small heat recovery systems to large air handling units, Daikin provides a variety of ventilation solutions to deliver a fresh, healthy and comfortable environment for residential, commercial and industrial spaces.

Comfort

- ✓ Breathing clean air is one of the joys of life and is certainly a major health benefit. Clean air delivered at the right humidity and in the right place is a perfect foundation for optimal comfort.
- ✓ Daikin's new technologies filter out particles, allergens and unpleasant odours to deliver clean air for you to breathe and in doing so, optimizing your comfort levels and reducing health risks.

Energy Efficiency

- ✓ It would not be a Daikin product if it had anything less than the highest level of energy efficiency. Like all our products, our systems are highly-efficient.

Reliability

- ✓ Daikin products are renowned for their reliability. You can also rely on our service to match.



Indoor Air Quality Solutions

Residential



1. Air Purifier (Streamer)

Daikin's stand-alone streamer technology air purifiers supply fresh air and minimise asthma and allergy symptoms by removing dust particles and pollen from the air, as well as reducing odours and filtering out airborne bacteria and viruses. Air is cleaned as it passed through a pre-filter, plasma ionizer, electrostatic dust collection ionizer, electrostatic dust collection filter, a titanium apatite filter and a deodorising catalyst filter.

A=41m ²	330CMH
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2. AstroPure (Advanced HEPA Filtration)

AstroPure is a stand-alone complete air purification system to recirculate and clean the air in a controlled environment. It combines particulate, gas-phase and HEPA filters to remove airborne particles, gaseous contaminants, viruses, bacteria, fungus and molds to provide total clean air solution.

AstroPure is the best solution for prevention of spread of viruses and can be used as a stand-alone unit in any space where people gather like offices, malls, hotels (conference rooms, restaurants and suites), airports (lounges, immigration area), schools (classrooms, canteen, indoor sports areas), hospitals (common areas, consultation rooms, isolation rooms, ICUs), dental clinics, movie theaters, convention halls and tech parks.

A=25m ²	450CMH
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3. PurAir 350C Ceiling Mounted Unit

Three-stage of high-performance filters can efficiently remove indoor airborne particles, harmful gases, bacteria and viruses.

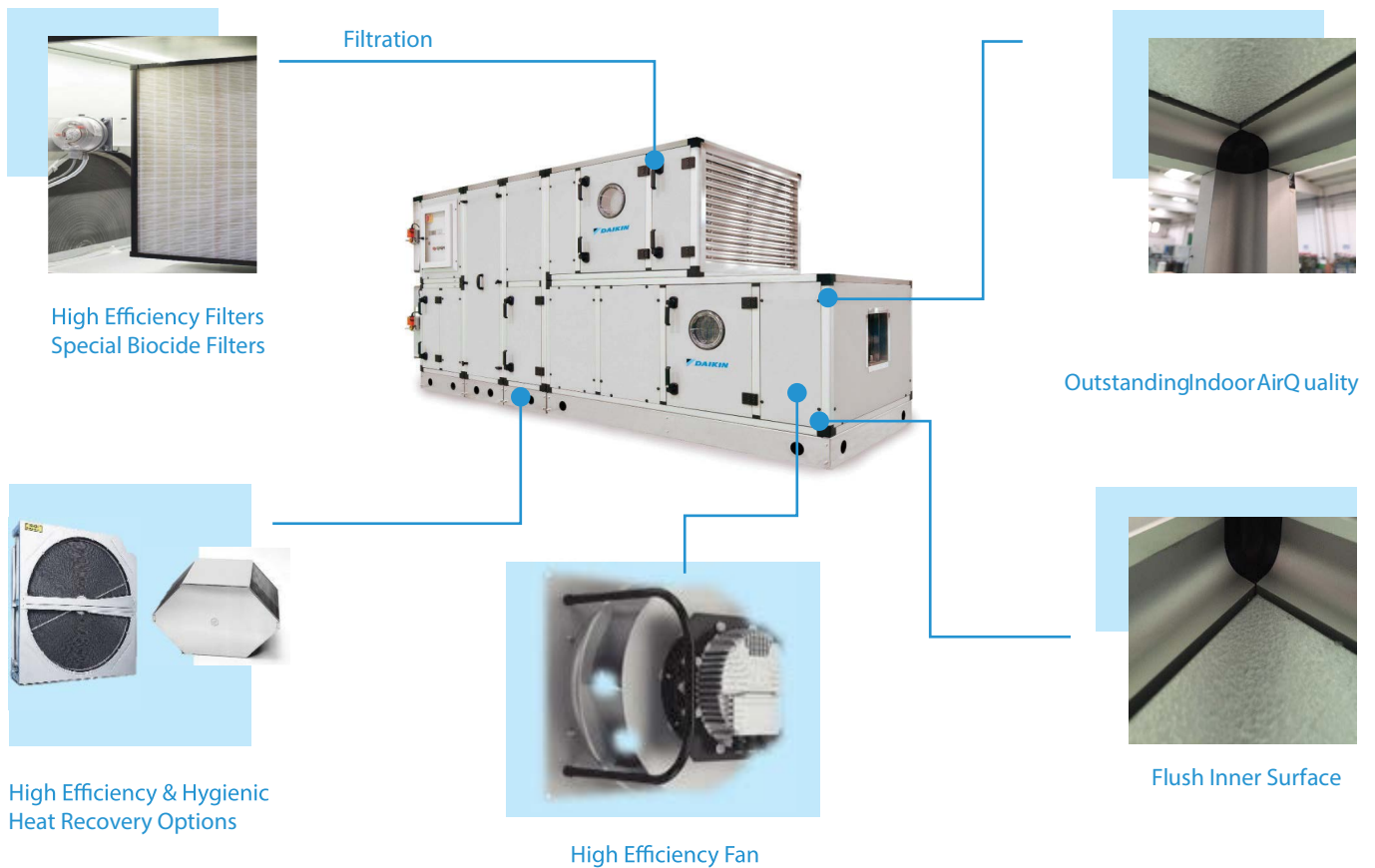
- > The compact design of machine-integrated with three-stages of high-performance filters can efficiently remove indoor fine particles, harmful gases, bacteria and viruses.
- >
- > The first-stage coarse panel filter is used to effectively remove indoor large particles, dust and hair.
- >
- > The second-stage gas-phase filter can effectively remove indoor 1VOC, odors, harmful gases such as formaldehyde.
- >
- > Third-stage HEPA filter can remove indoor fine particles such as PM2.5, PM1 and bacteria and virus.
- >
- > Easy-to-replace air duct adapters at both ends for on-site installation.

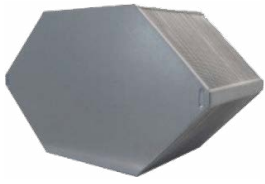
A=111m ²	2550CMH
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Air Handling Units

Daikin offers a wide range of air handling units for medium-sized to large-scale applications. The standard range of different-sized units can be customized to fit available space, or systems can be tailored to meet a building's needs. AHUs are available with different options to improve and set new standard in "Indoor Air Quality" like biocide filters with different efficiency levels classified according to the ISO 16890 New Semi-absolute filter ePM1 95%. A counterflow plate heat exchanger with the anti-bacterial coating in addition to the standard offering of the rounded profile, along with completely flush step panels guarantee excellent IAQ through AHU casing design as well.





1. New counterflow heat exchanger

- › No or Negligible cross contamination
- › Hygienic feature with optional Antibacterial coating
- › Highest heat recovery efficiency compared to similar crossflow heat exchanger



2. ePM1 Gold Filter

- › High Efficiency - ePM1 efficiency 95% (ISO 16890)
- › Low Initial Pressure Drop

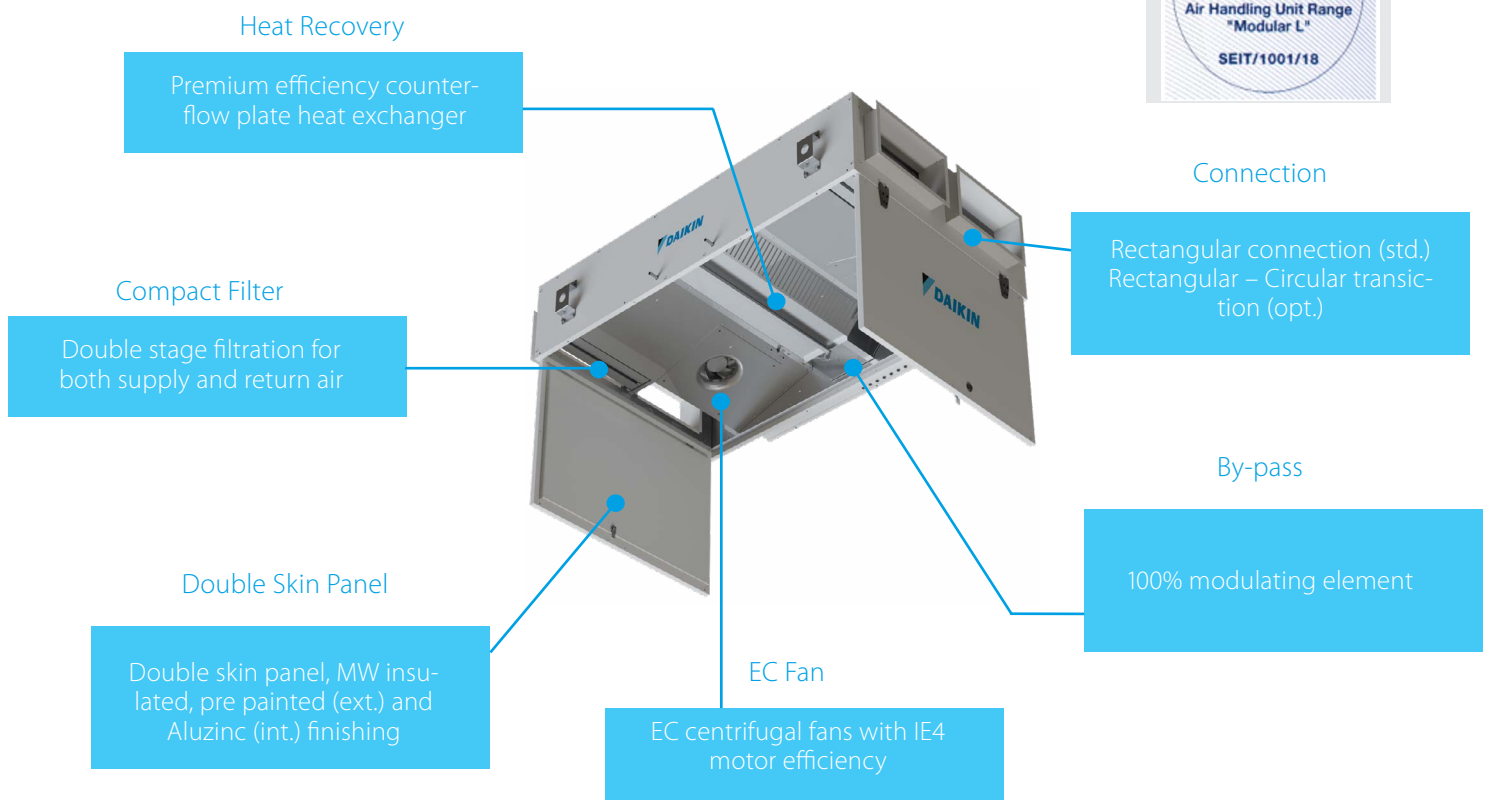


3. Biocide Filter

- › Antimicrobial treated air filter media
- › Bio Rigid Pocket - ISO16890:ePM1_50-65,ePM1_70 80,ePM1>=85
- › Bio Panel - ISO 16890: ePM1_50-65
- › Antimicrobial treatment tested and compliant to the Biocidal Products Regulation No 528/2012/EU

D-AHU Modular L

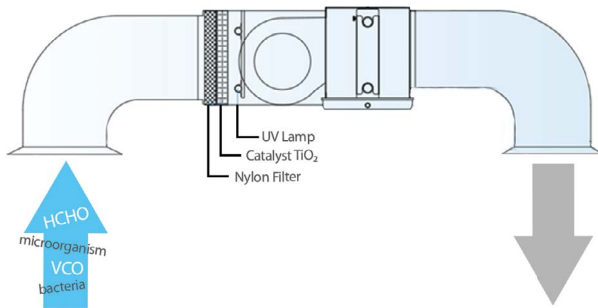
6 Standard sizes Covering airflow up to 3500 m3/h



Fan Coil Units

1. Photo-Catalytic Oxidation Technology

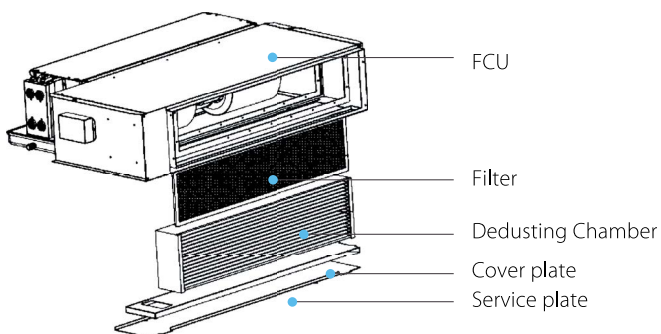
Unit Configuration



- › Photo-catalytic oxidation (PCO) utilizes ultraviolet radiation to create highly reactive hydroxyl radicals and super-oxide ions on the surface of a metal oxide catalyst
- › Biological contaminants coming in to contact with the hydroxyl radicals are oxidized and decomposed
- › Volatile organic compounds (VOCs) are converted to simpler chemicals, carbon dioxide and water

Applicable Models: FWW-VC/C/F/H/DA
Power Supply: 240-220V/1Ph/50Hz & 60 Hz

2. Electrostatic Filter



- › Washable metal mesh pre-filter which traps large dust particles
- › Remaining particles, as small as 0.01 microns pass through ionizing section where the particulate receives an electrical charge
- › Charged particles then pass through a dedusting chamber made up of a series of equally spaced parallel plates
- › Each alternate plate is charged with the same polarity as the particles, which repel. While the interleaving plates are grounded, which attract and collect.

Applicable Models: FWW-VC
Power Supply: 240-220V/1Ph/50Hz

3. PM2.5 90% Filter



- › Anti-microbial treated media
- › High dust-holding capacity
- › Low depth and light weight
- › PM 2.5 90%

PCO Retrofit Kit Option
available for existing installation

Advantages

- Remove the existing filter and mount the PCO retrofit kit on the return flange
- Minor modification on the unit wiring

Start-up checklist for HVAC Systems

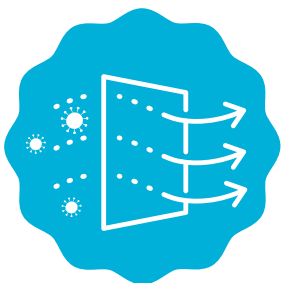
prior to occupancy



Ensure the safest air quality for your space

- Maintain proper indoor air temperature and humidity to maintain human comfort, reduce potential for spread of airborne pathogens and limit potential for mold growth in building structure and finishes (refer to ASHRAE 55 recommended temperature ranges of 68-78 degrees F dry bulb depending on operating condition and other factors, recommend limiting maximum RH to 60%). Consider consulting with a local professional engineer to determine appropriate minimum RH levels based on local climate conditions, type of construction and age of the building under consideration. Recommend minimum RH of 40% if appropriate for building. Consider the addition of humidification equipment only when reviewed by a design professional to verify minimum RH set points will not adversely impact building or occupants by contributing to condensation and possible biological growth in building envelope.
- Trend and monitor temperature and humidity levels in each space to the extent possible and within the capability of BAS, portable data loggers and handheld instruments.
- Verify proper separation between outdoor air intakes and exhaust discharge outlets to prevent/limit re-entrainment of potentially contaminated exhaust air (generally minimum of 10-foot separation - comply with local code requirements).

- Consider having airflows and building pressurization measured / balanced by a qualified Testing, Adjusting and Balancing (TAB) service provider.
- Consider having airflows and system capacities reviewed by design professionals to determine if additional ventilation can be provided without adversely impacting equipment performance and building Indoor Environmental Quality (IEQ).
- Measure building pressure relative to the outdoors. Adjust building air flows to prevent negative air pressure differential.
- Verify coil velocities and coil and unit discharge air temperatures required to maintain desired indoor conditions and to avoid moisture carry over from cooling coils.
- Review outdoor airflow rates compared to the most current version of ASHRAE Standard 62.1 or current state-adopted code requirements.



Filtration in all mechanical equipments

- Verify that all filters are installed correctly.
- Develop standards for frequency of filter replacement and type of filters to be utilized.
- Select filtration levels (MERV ratings) that are maximized for equipment capabilities, use MERV 13 if equipment allows, while assuring the pressure drop is less than the fans capability.



If Demand-Controlled Ventilation (DCV) systems using Carbon Dioxide (CO₂) sensors are installed, operate systems to maintain maximum CO₂ concentrations of 800-1,000 Parts Per Million (ppm) in occupied spaces:

- Trend and monitor levels continuously if controls system is capable of doing so (use portable data loggers and handheld Instruments and document readings where needed to demonstrate compliance with District or Campus requirements)
- Consider adjusting to maximize outdoor air or disabling operation of DCV if it will not adversely impact operation of overall system (Temporary recommendation while operating under infectious disease crisis).

If Demand-Controlled Ventilation (DCV) systems using Carbon Dioxide (CO₂) sensors are installed, operate systems to maintain maximum CO₂ concentrations of 800-1,000 Parts Per Million (ppm) in occupied spaces:

- Mechanical systems should operate in occupied mode for minimum period of one week prior to students returning (may be completed at same time as teachers start returning to building) while assuring the outside pers are open.

Preparing for your Re-opening

Air filtration refresh



Your building requires safety checks prior to reopening after a period of downtime. To aid you in your preparation, we compiled a list of steps that you can follow to feel confident in the cleanliness of your building. Clean and sterilize all floors, counters, and even the air according to suggestions from the CDC's COVID-19 Resources for Businesses and Employers.

Prior to running your HVAC system at normal capacity again, replace existinig air filters with clean filters. Safety First - Before replacing dirty air filters, first be sure to wear gloves, a mask, and safety glasses. As you slowly remove the current air filters, take care not to dislodge any of the dust and debris, which can otherwise re-enter the airstream inside your building. Bag Disposal – Now that you have removed the dirty air filters, place them into bags and seal these bags as further protection against the collected dust and particles harming people who are exposed to them.

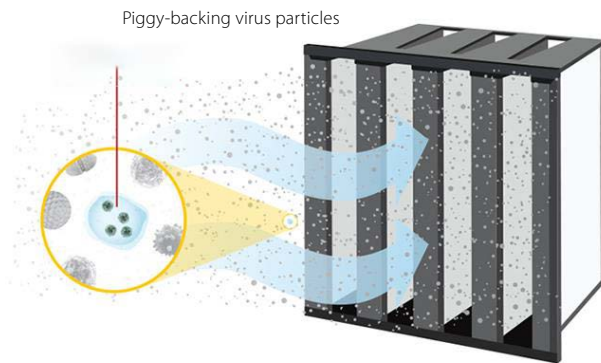
Clean air filter installation

Place clean air filters inside the HVAC unit with the air flow arrow pointing toward the blower motor. You will find this air flow arrow on the frame of your air filter. View these additional tips and suggestions on filtration and disinfection. f your HVAC system from ASHRAE (American Society for Heating, Refrigeration, and Air-Conditioning Engineers). Before reopening your business, ramp up your HVAC system to normal levels, allowing air to circulate for a couple of hours before people enter the building.

Importance of air filtration

As noted above, healthy building experts suggest replacing current air filters as part of this preparation process. In many cases, they urge businesses to upgrade their filter efficiency to capture even more small particles,

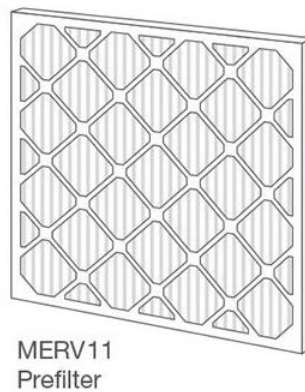
Pathogen-carrying particles



Tiny virus particles generally piggyback on comparatively larger dust particles or droplets as they travel through a building. In general, virus particles tend to hitch a ride on particles and droplets in the size range of 0.3 to 1.0 microns. Fortunately, air filters with a rating of MERV 16 or higher capture a minimum of 95% of airborne particles in this size range.

The case for upgrading

Even better, a combination of high-efficiency air filters captures nearly all of the particles in this size range, eliminating typical virus-carrying particles from airstreams inside buildings. For example, a MERV 11 prefilter in conjunction with a MERV 16 secondary filter removes 98.66% of particles in the 0.3-1.0 micron size range in one pass. By contrast, if you rely on lower efficiency filters such as a MERV 8 prefilter with a MERV 14 secondary filter, it would take three passes through the filters to remove the same percentage particles.



Particles efficiency vs energy efficiency

Generally you can expect that an upgrade in particle efficiency will cause a decrease in energy efficiency. Besides translating to a higher energy bill, you could also be faced with additional wear and tear on your HVAC equipment. However, thanks to innovative filter design and media options, you can usually find a way to upgrade your particle efficiency without breaking the bank or causing undue damage to your HVAC equipment.

Service Solutions

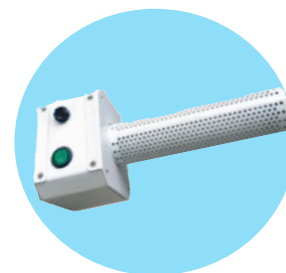
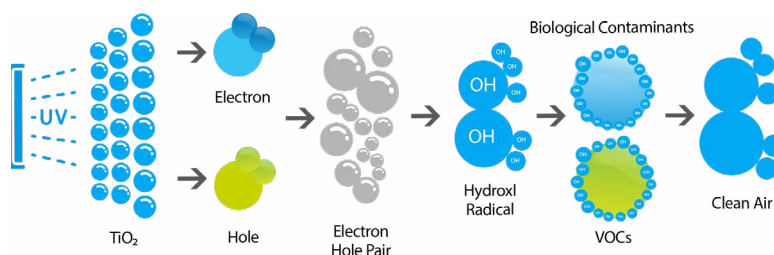
for indoor air quality

1. Duct Insertion PCO Solution

Daikin offers Duct insertion Photocatalyst Oxidizer (PCO) sterilization to kill bacteria and viruses in the air, other harmful organic substances such as formaldehyde, benzene etc. in

Photo-catalytic oxidation (PCO) utilizes ultraviolet radiation to create highly reactive hydroxyl radicals and super-oxide ions on the surface of a metal oxide catalyst:

- › Biological contaminants coming in to contact with the hydroxyl radicals are oxidized and decomposed.
- › Volatile organic compounds (VOCs) are converted to simpler chemicals, carbondioxide and water.

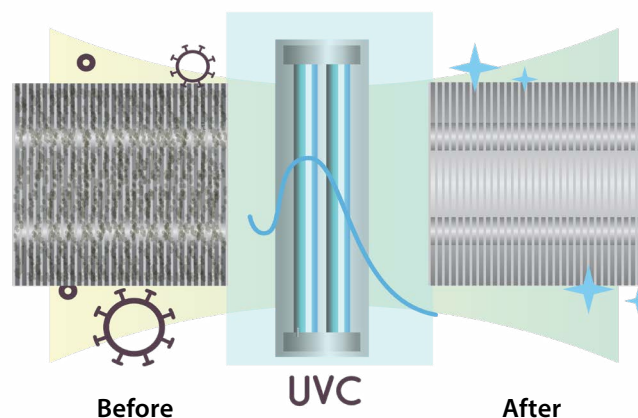


2. UVC Lights Solution

Daikin utilizes UVC lights that help eliminate a variety of harmful bacteria and mold and prevents organic build up on the surfaces of the AC system's coil and ducts to produce more sterile air.

UVC uses ultraviolet light to inactivate microorganisms, mainly by cross-linking thymidine nucleotides in the DNA and uracinnucleotides in the RNA which block replication.

UVC systems are relatively fast and easy to use, leave no chemical residues and do not expose workers to harmful substances.



3. IAQ Kit for VRV

Daikin offers the IAQ Kit, pre-designed for Daikin's VRV / DX indoor units with the intention of enhancing Indoor Air Quality for space occupants. The kit consists of a pre-selected and factory-designed box consisting of a MERV8 filter and an Ultraviolet UV-C light.

The solution comes with an optional duct insertion Photocatalyst Oxidizer (PCO).



MERV 8 Filter

UVC

3. Coil Cleaning Service

Conditions often exist for the growth of microbiological contaminants in AHU cooling coils. Contaminants such as bacteria, mold and fungi can colonise on the cooling coil fins creating toxic allergenic organic fragments known collectively as Macromolecular Organic Dust. This has been linked with various health complaints in buildings, triggering a "sick building syndrome". Daikin's Service team are equipped to mobilise and provide an intensive coil cleaning service for Air Handling Units suited to customer's needs.

Daikin's Service team also provides anti-mold and anti-bacterial spray for DX / VRV units indoor units that reduces stains and odor from mold in indoor units and slime in drain pans by its sterilizing, antibacterial, anti-mold, and deodorizing effects. This is typically used on clean heat exchangers (after replacement or cleaning).



Indoor Air Quality

We are committed to creating revolutionary technologies to give you the purest air.



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