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AIR (Indoor Air Quality)

INDOOR AIR QUALITY

Indoor air quality must be kept to the **best standards**, as prevention is better than cure.

What are some signs that the filter media is unsuitable / badly fitted for this environment?
- Dirty streaks on ceilings along diffusers facings
- Build-up of dust on surfaces

How can indoor air quality be improved?
During construction, designers should consider:

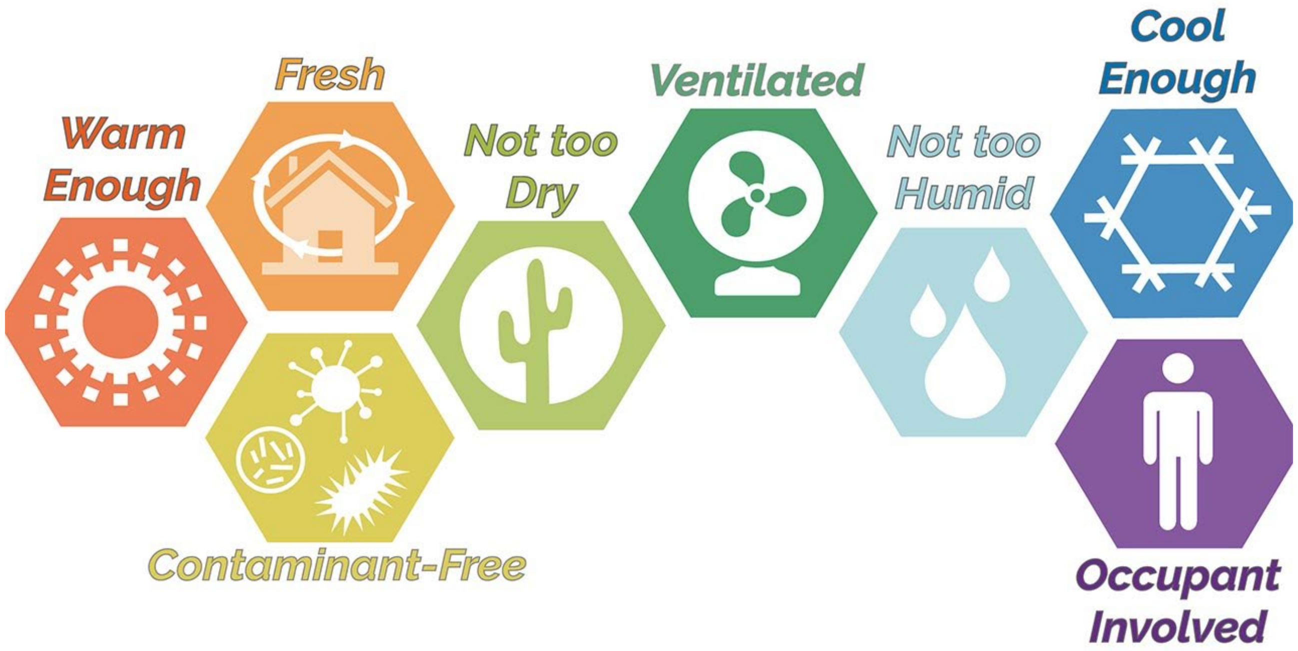
1. The different levels and types of pollutants
2. Filtration
   - This can also help the environment.
   - You need to be careful when selecting the filter
   - The filters need to be regularly maintenanced

COVID-19

Coronavirus has shown the importance of air conditioning in helping to prevent the spread of the virus inside buildings.

On a system with an average velocity of 5m/s, 50m of supply duct and 50m of return duct, it would take approx. 20-30 seconds to re-introduce the virus back into the room. The virus could multiple in a recirculated air environment.

Fan coil units could be fitted with UV-C germicidal lights but it would be expensive



The following diagrams show how air is distributed through different ventilation systems and how this can help spread diseases.

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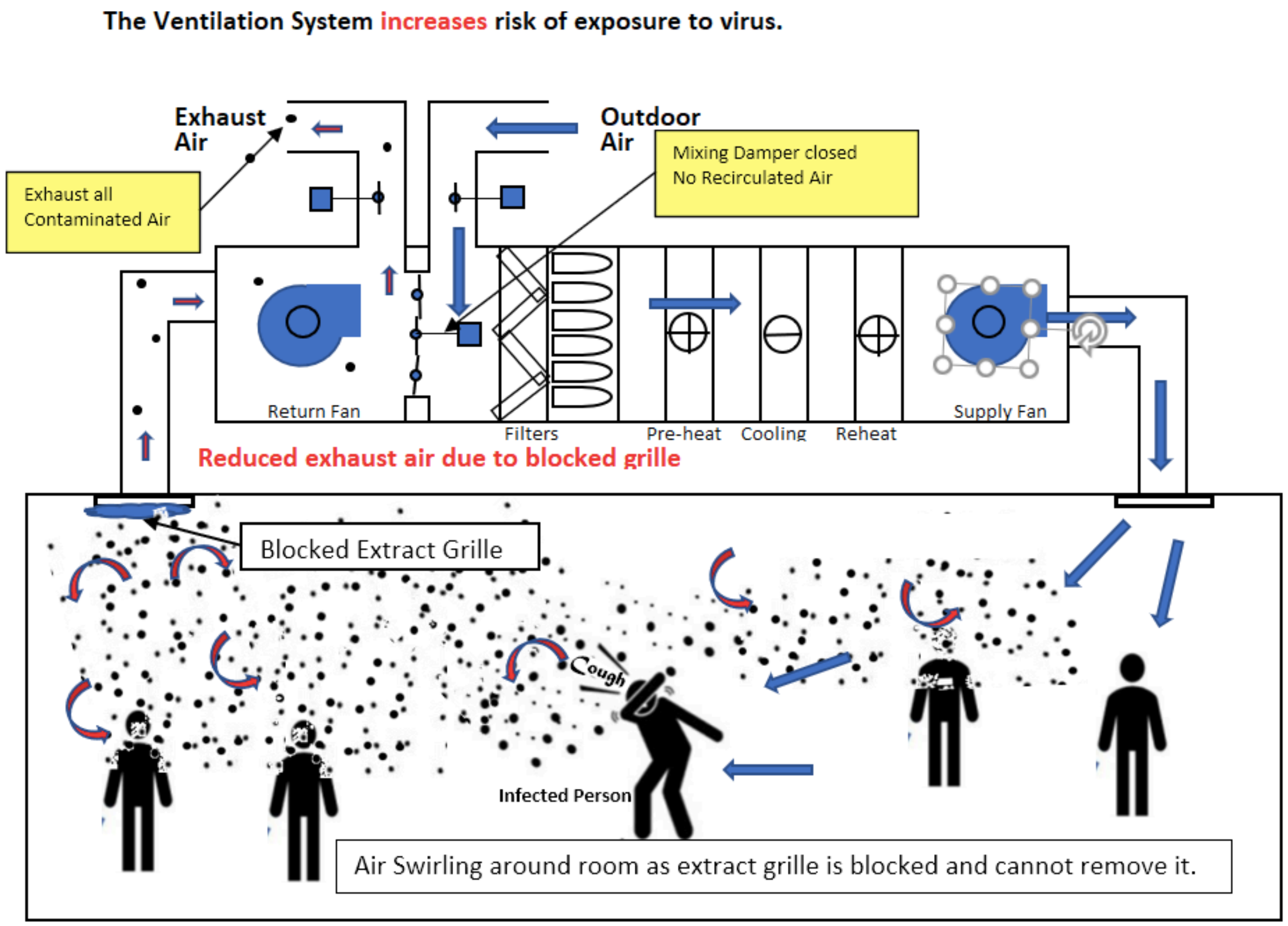
1. Effect of soiled extract/return air grilles



Why is there an increased risk of infection?

- Reduced air change rate
- Reduced or no extraction through the grille
- Increased number of contaminated droplets in contact with people / on surfaces and work stations
- Longer exposure time to virus and bacteria

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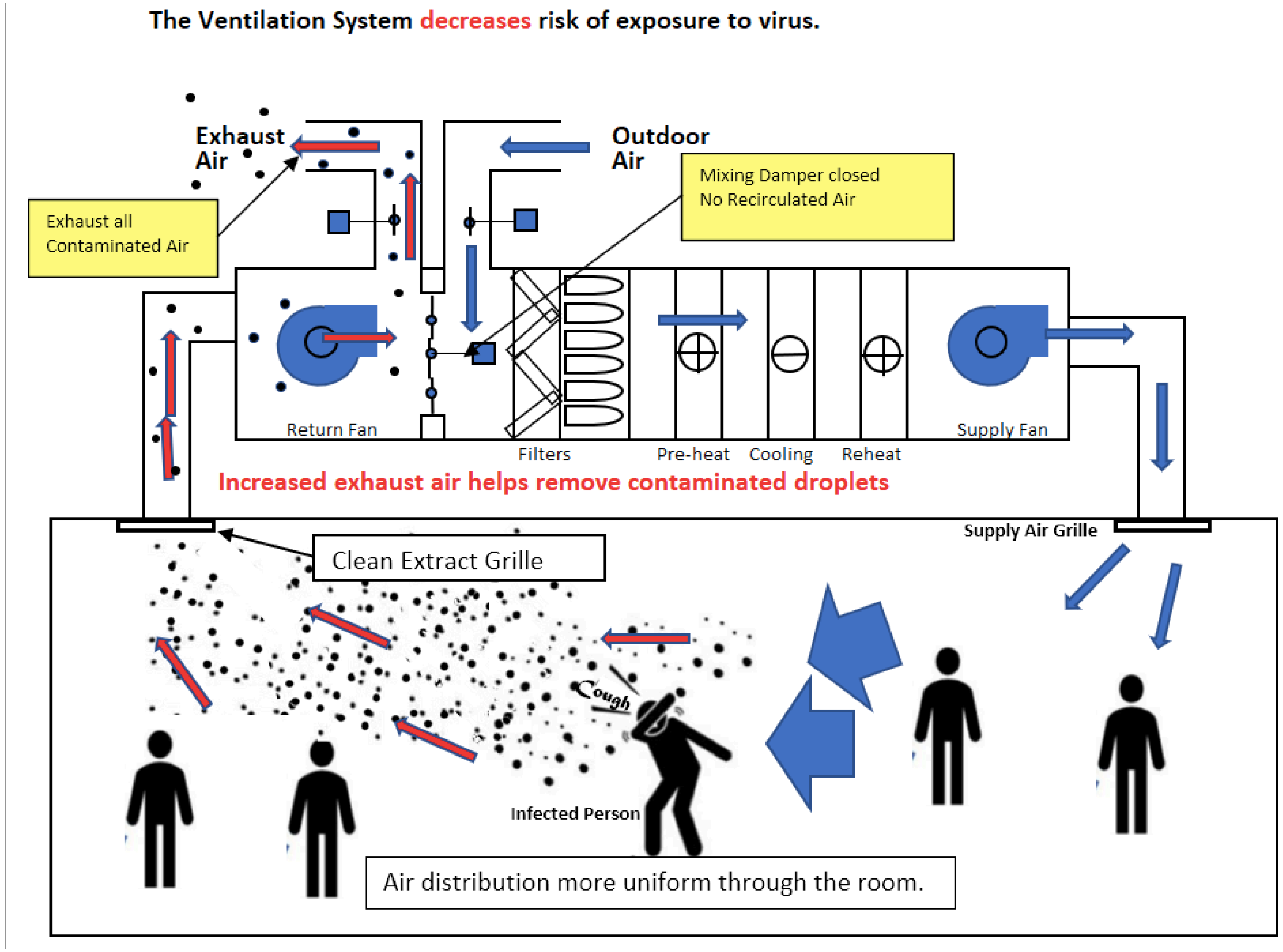
2. Effect Of Clean Extract/Return Air Grilles



Why is there a reduced risk of infection?

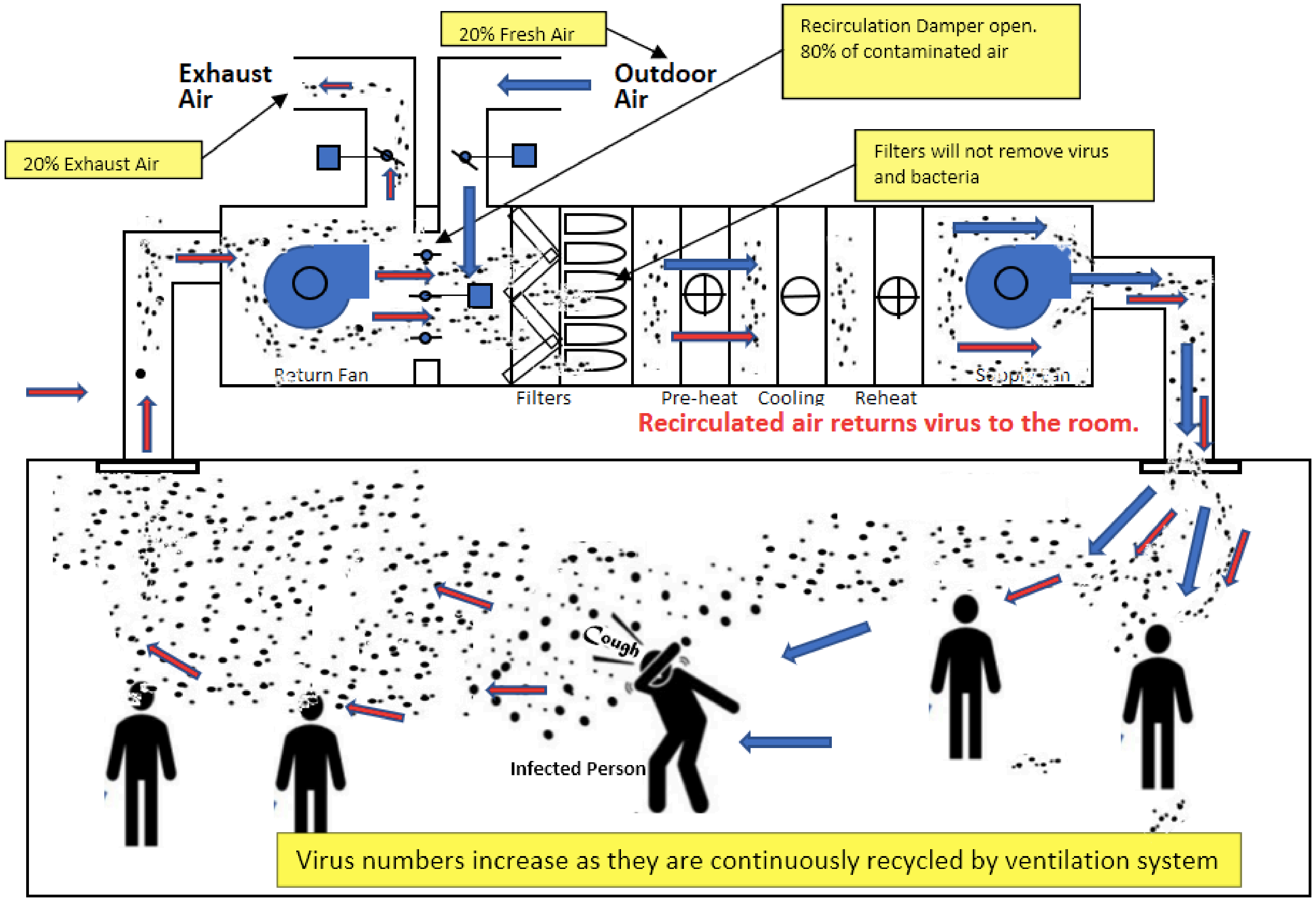
- The air distribution is more uniform
- The extract grille is removing contaminated air
- The air flow rates are according to system design
- The contaminated droplets are taken away from people
- Reduced number of contaminated droplets on surfaces and work stations
- Minimum exposure time to virus and bacteria

3. Effect of 100% Recirculation in a Building

TheVentilation System increases risk of exposure to virus.

Why is there an increased risk of infection?

- 80% of air containing the virus is reintroduced to the room
- The filters aren't removing virus and bacteria
- Increased number of contaminated droplets in contact with people / on surfaces and work stations
- Longer exposure time to virus and bacteria
- Contact with the infected person is not necessary to be exposed to the virus



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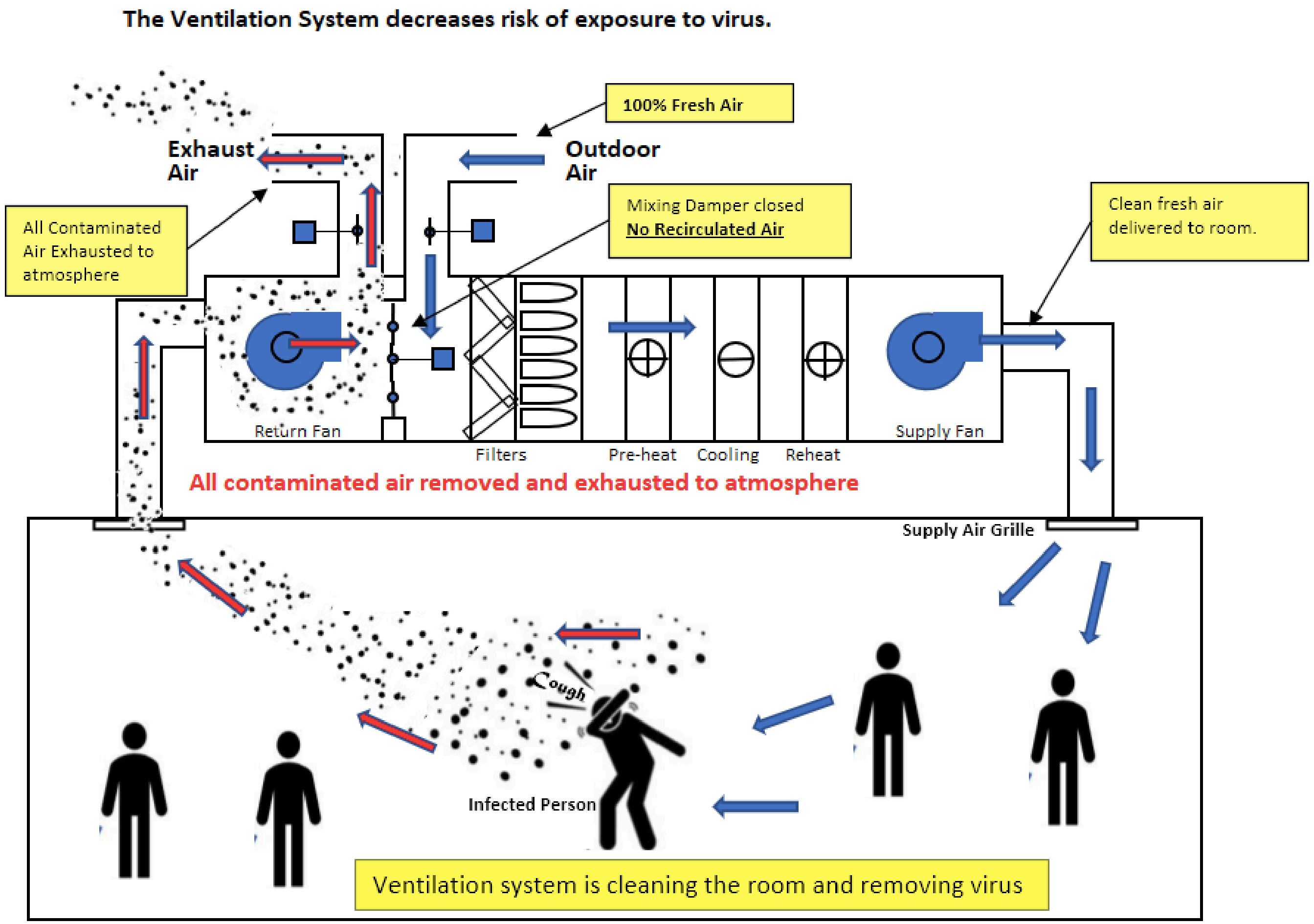
4. Effect of 100% Fresh Air in a Building

Why is there a reduced risk of infection?

- The ventilation system is cleaning the air in the room
- Most / all of the contaminated air is being removed
- 100% fresh air is coming into the room
- Contaminated droplets are taken away from people by the airflow
- Reduced number of contaminated droplets on surfaces and workstations
- Minimum exposure time to virus and bacteria



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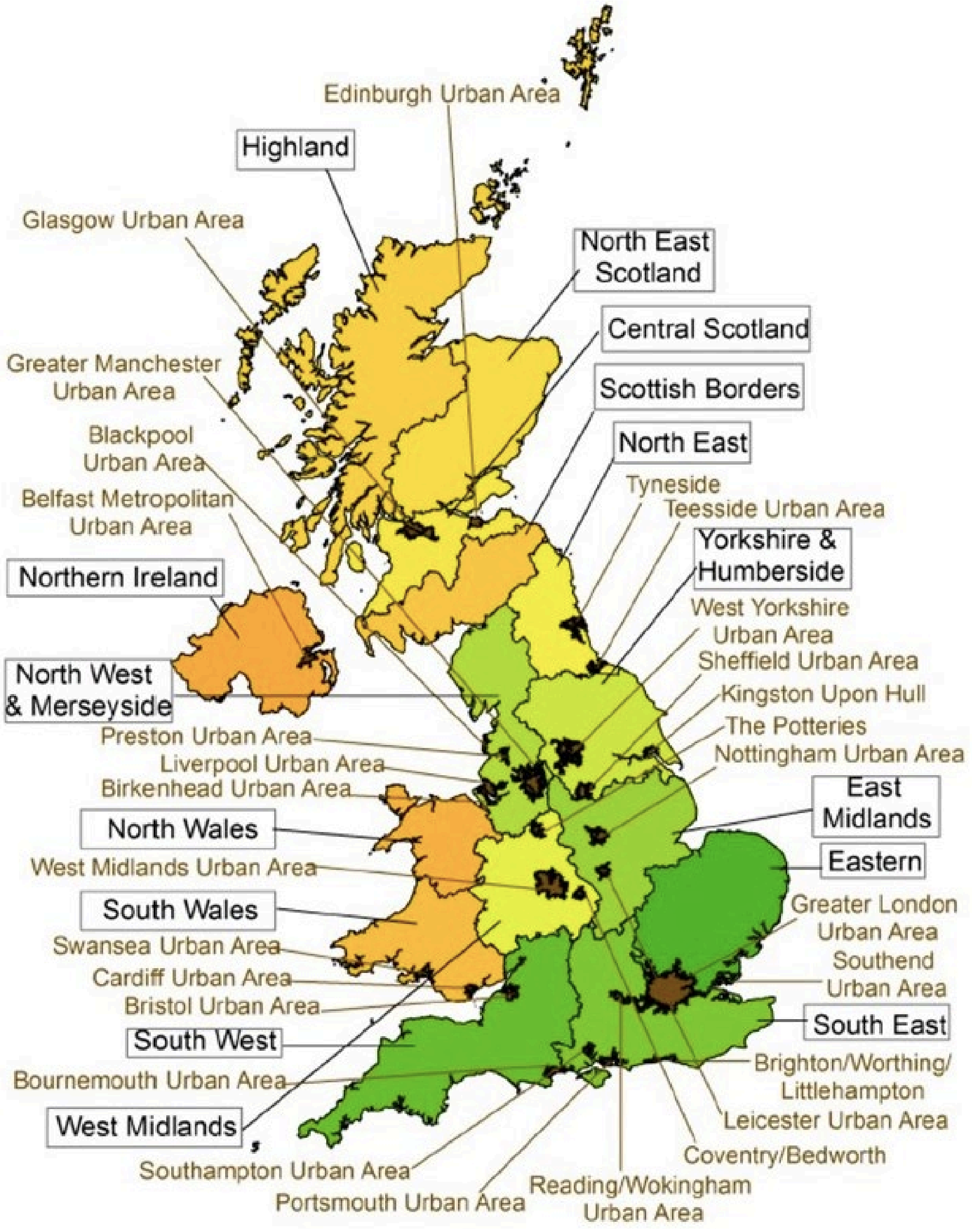

Air Quality Zones

The quality of the air in a building depends on the surrounding environment.

Countryside, city centres, industrial areas, etc. all produce different levels of pollutants.

UK Zones and Agglomerations for Ambient Air Quality Reporting
Agglomeration zones: (brown)
Non-agglomeration zones:
(yellow/green)

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Testing Methods for Dust Contamination

NADCA Test – suitable for square, rectangular dust, but not round.

PVT – not repeatable so not scientific. Now called European Test.

Vacuum Test (VT) – This is the preferred test.

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Vacuum Test

NAADUK recommends pre-weighed filter cartridges, Pre-Barcoded to prevent mistakes, and an independent laboratory to UKAS standards.

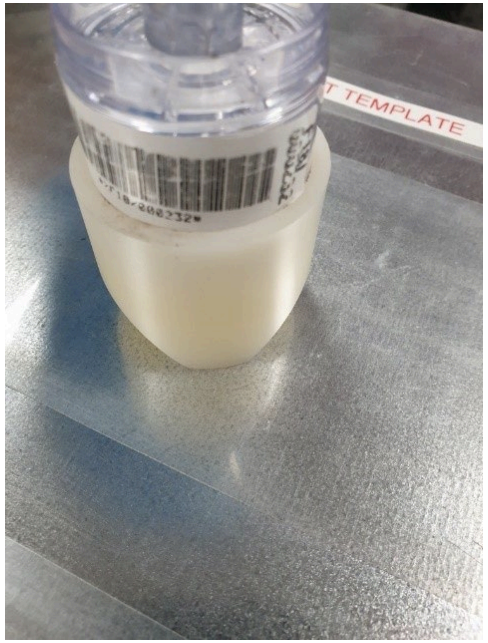
Note: If there is a covering of dust covering the internal duct surfaces, this test is unnecessary as a visual evaluation with / without a reference scale this supply duct would fail anyway.

Adaptor for Circular Duct

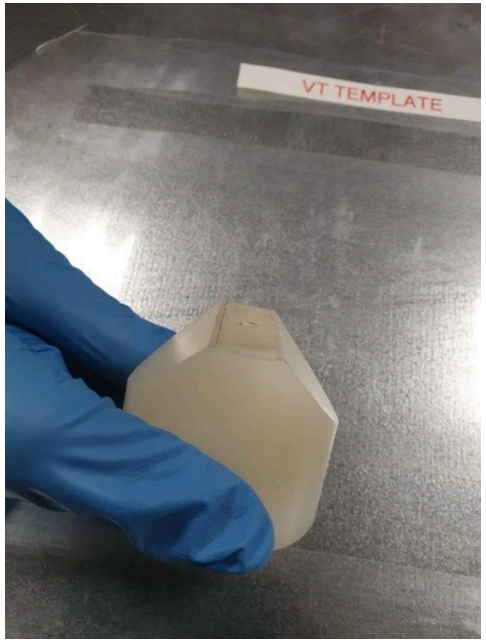
Why should an adaptor be used?

When taking samples on circular ducting it should be used to make sure there is direct contact with the ducting.

These adaptors can be used in circular ducts as well as flat ducts.



Adaptor fitted to filter capsule



Side View

Top View

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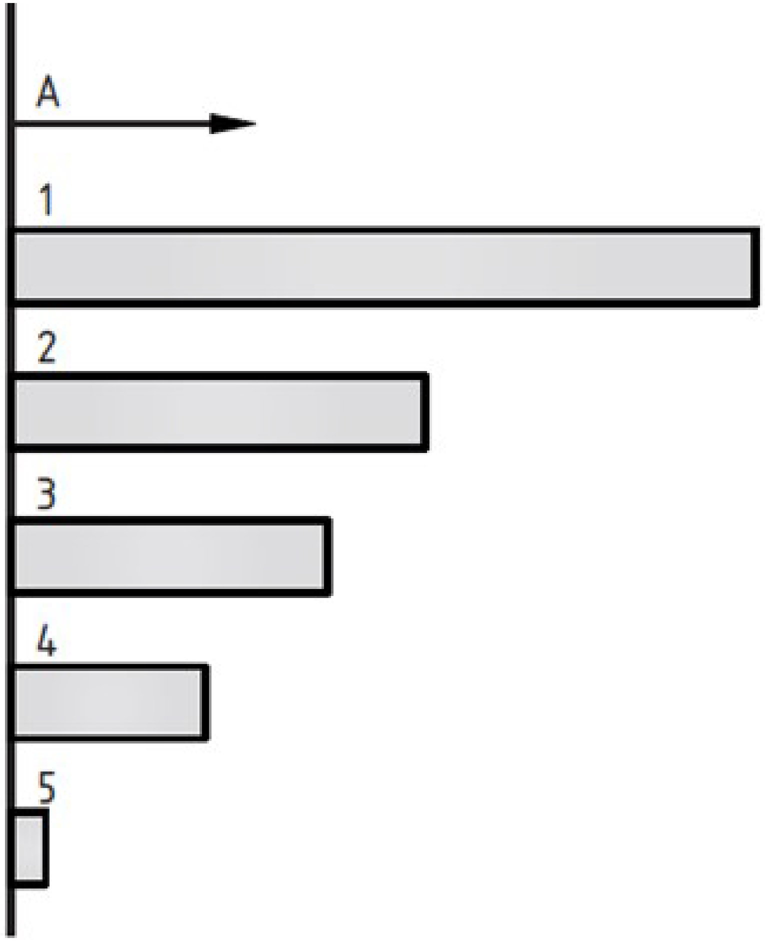
Deposit Thickness Test (DTT)

This is used to assess the level of deposit build up within ventilation ductwork.

NAADUK can’t recommend this test as it is typically not sensitive enough to be used for post clean verification.

A competent company should be able to carry out any required sampling and should use a nominated UKAS laboratory.

Different Evaluation Methods & Their Reliability



Key:

A Reliability

1 Vacuum sampling on filter, or wiping the dust with a cloth

2 Gravimetric tape method

3 Evaluation with optical gel tape

4 Visual evaluation with reference scale

5 Visual survey without reference scale

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Testing For Microbiological Contamination Only

DIFCO Contact Slide

Agar Plate

What could lead to potentially harmful organisms in the air?

- Poor hygiene standards
- Poor maintenance
- Non-maintenance

In some cases pathogenies grow, as shown in these figures.

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Assessment of Surface Sampling Results

- Surface arrangement of microbes is **not usually consistent**, so a single high count is **not enough** to recommend cleaning of the ducts.
- If the microbial counts from a particular area (such as in the AHU) show localised microbiological contamination, i.e. **more than 50% of samples are in the 'high' category**, cleaning of that area should be recommended.
- Cleaning of the entire system is recommended where on average **more than 25% of the sample is in the 'high' category.**

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Classification of Microbiological Limits

The individual fungal and bacterial counts for each place should be converted to counts per 10cm (**cfu per 10cm^2**) At any point in the system, six counts (3 fungal and 3 bacterial) should be available.

Category	Colony forming units (cfu per 10cm^2)
Low	<10
Medium	>10 but <20
High	>20

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Actions to Take After Analysis Results

Air sample microbial levels	Surface microbial levels	Comments	Actions
Unacceptable	Unacceptable	Microbial contamination is demonstrated in both ductwork and supply airstream	It is recommended that the system is cleaned as a priority: that is within 3 months
Acceptable	Unacceptable	There is an increased probability that the supply airstream will become contaminated by microbes from within the ductwork	It is suggested that monitoring of the air supplied by this system should be conducted on a more regular basis or that cleaning the ductwork should be programmed into the maintenance programme

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Actions to Take cont.

Air sample microbial levels	Surface microbial levels	Comments	Actions
Unacceptable	Acceptable	The ductwork system is unlikely to be the source of microbial contamination in the occupied space	Seek to identify other sources of microbes such as damp patches in basements and heavily soiled carpets. Conduct suitable cleaning, removal or repair
Acceptable	Acceptable	Microbiologically clean system	No specific microbial action is needed

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Methods Used in Cleaning Ventilation Systems

Before starting any work it is the contractor's responsibility to check the asbestos register.

- All cleaning in ductwork should be done in the direction of airflow, contractors should isolate zones where possible by using the open/shut operation of VCD **Mechanically mark position to enable correct rest**.
- Make sure the type and placement of the access panel are correct.
- Check if the ducting is fire rated before fitting panels
- On all dry-cleaning methods, make sure a suitable (negative air) air mover machine is in place with appropriate filtration
- Wet cleaning methods should be avoided if possible because it could lead to an increase of microorganisms. If it is needed, the system must be completely dried before commissioning.

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Different Cleaning Methods for Contractors

1. Hand Vacuuming
2. Rotary Brushing
3. Air Lance
4. Air Whip / Skipper Balls
5. Hand Wiping
6. Hand Brushing / Sweeping

In all cases a negative air machine (air mover) should be used to prevent dust debris getting into the surrounding environment.

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Hand Vacuuming **

This is the most common method, using a high efficiency filtered vacuum unit with appropriate attachments.

Rotary Brushing

Pneumatic

Rotary brushing is one of the most common methods.

Rotary brush systems feature vacuum units and rotary brushes, used to dislodge dust and other particles from the air duct. They use reversing directional brush machines, either pneumatic or electrical powered. In all cases a negative air machine (air mover) should be used with appropriate filtration.

In most cases, the brush is linked to the vacuum unit with a flexible pipe, meaning it can move through twists and turns inside the vents, as the motor spins the brush like a drill.

Electric

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Air Lance

This is a flexible airline with attached gun and regulator.

It lowers or increases the pressure to clean off delicate areas, i.e. linings, or to dislodge the build-up of dust in difficult areas.

It should be used with a negative air machine.

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Air Whip / Skipper Balls

This can be several multi tubes of a nozzle or a faced nozzle with predrilled holes angled to drive the air whip and lead down the duct, dislodging the dust.

A compressor forces air out of the small holes along the nozzle, which creates enough air pressure to get rid of any dust from the internal surfaces of the ductwork.

Must be used with a negative air machine.

Skipper Balls

Air Whip

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Hand Wiping

This can be done in the dry from using **lint-free** or a form of **antistatic dust cloths**.

Some cleaning agents can be sprayed onto the duct to help clean particularly stubborn areas as long as all COSHH standards are applied.

Hand Brushing / Sweeping

This is used mainly on very large ducts and then the debris is bagged for collection and disposal.

Lint-Free Cloth

Antistatic Dust Cloth

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Filters

Why do filters need to be inspected thoroughly?

Badly fitted or incorrect filters and not changing filters regularly are the biggest contributors to duct contamination.

What kind of filters are designed to remove small particles from the air?

- HEPA filters
- Panel Filters
- Electrostatic Filters

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Filters cont.

There may be changes to much higher and more combination filter systems. This might involve electrically charged, charcoal and filter combination, including UV light systems.

All new designs will now be under review because of the COVID-19 virus and potential future pandemics.

The Importance of Air Filtration

- Air filters ensure healthy indoor air by removing harmful fine dust (e.g. pollen, bacteria, yeasts and moulds)
- They keep air handling equipment clean, keeping it hygienic and efficient

Why are air purity requirements constantly improving?

- Industrial processes are increasingly sensitive and sophisticated
- Stricter environmental legislation
- More people with health-conscious attitudes

Benefits From Using Air Filters

Air filters must be used to clean the air to protect people's health.

- Urban air quality is polluted by small PM1 particles and gases coming from combustion and diesel engines. Ultrafine particles like PM1 are the most damaging form of fine particles because the particles go directly into the bloodstream.
- Bacterial and fungal spores must be removed from the air stream.

The most common air filters in comfort ventilation are ePM1, ePM2,5 and ePM10. ePM1 is recommended in buildings like schools, hospitals, offices and apartments.

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Maintenance of Air Filters

The filter service life is determined by the following factors:

- Hygiene issues (e.g. microorganisms, fungal spores, odours)
- Economic efficiency
- Reaching the final pressure drop specified for the filter system
- Defective filter

When replacing the filter using PPE all filters across the entire duct cross-section should be changed **at the same time** and while the system is **at standstill**.

Maintenance cont.

What should I do with contaminated filters?

- They should be transported carefully and disposed according to local legislation

Before installing new filters, what do I need to do?

- Check, clean and repair if necessary the connections between filter frames and partitions
- Clean the filter frames (or the filter housing) and the sealing faces

Do I need to perform regular maintenance?

- Visually inspect coarse and fine dust filters and particle measurements on particular air filters of classes H and U
- Optical and / or electrical differential pressure gauges and indicators need to be checked
- If testing is impossible, the filter should be replaced after the period specified by the manufacturer

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Transport and Storage

How should filters be transported?

- They should be transported and stored in their original packaging, preferably on pallets

Where should they be stored?

- Indoors, protected against rain / moisture and at temperatures above freezing point

What needs to happen prior to assembly?

- Filters should not be unpacked until right before assembly
- When unpacking, avoid touching the delicate filter medium
- They should be checked for any transport damage – damaged filters should not be used

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Disposal of Filters

Filters should be disposed in an environmentally friendly way. They should be bagged up to prevent contamination, and PPE must be worn when changing filters.

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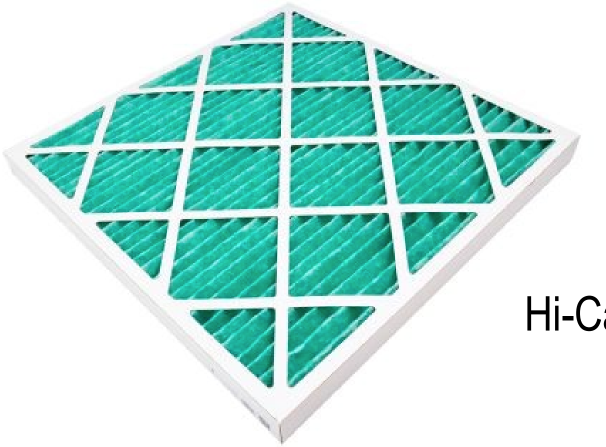
Examples of Commonly Used Filters:

Panel Filters

Energy saver pleated panel filter



Hi-Capacity panel filter

Metal Filter

Fire Rated Metal frame pleated panel filter

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Bag Filters

Jay Flow – Glass bag filters

Clean pack – Synthetic bag filters

Reloadable Filter

Re-loadable galvanised steel frames and a range of cut media pads

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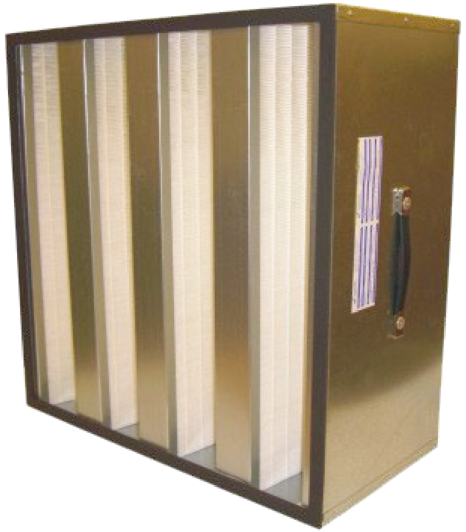
Compact Filters

HEPA Filters

Compact Minipleat Filters with 25mm Header and Microfine Glass Fibre Media

UHV high volume HEPA filter with steel case



Compact Minipleat panel filters with header frames

Laminar flow HEPA panel filter, for use in controlled contamination environments

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Molecular Filter

The Carboflow range of combination filters are essentially two filters in one. Activated carbon media combined with microfine glass fibre.

Sitesafe Filter Unit

For removal of formaldehyde and other low boiling point aldehydes. Used in mortuary, hospitals, undertakers etc.

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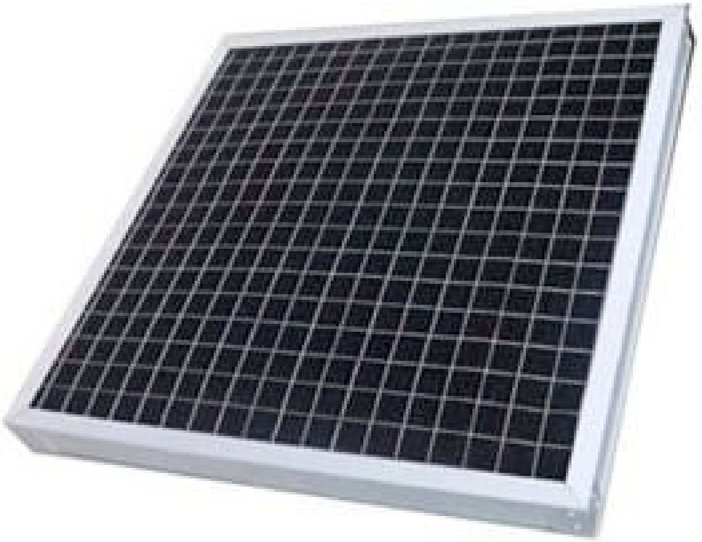
Carbon Filters

Carbon filter odour reduction panel. Typically used for air supply drawn from busy road areas, car parks of from under flight paths



Loose fill panels. Range of carbon activated carbon panels often used for museums, archives, etc.

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Access Panels

Variety of Access Panels

Access panels should be to BSEN12097 specification and not obstructed

They should have quick release panels and not be riveted or screwed on

All access panels should be labelled and accessible

Access panels should be installed every 15m

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Standards for Access Panels – BS EN 12097 Specification

- Requirements for the shape, dimension and location for access panels for cleaning and service in ductwork systems
- Access panels can be closed and opened repeatedly without damage or cutting into the duct
- Access components must match the performance of the ductwork in terms of strength and air tightness
- Easy opening panels
- The access components should allow cleaning
- Ductwork mounted components that prohibit cleaning must have a point of access from both sides
- Sharp pointed screws not to be used within 1m of opening

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Access Panel Location

In-line equipment	Location
Control dampers	Both sides / Up-stream panel
Fire dampers	Both sides / To suit damper maintenance
Heating/cooling/re-claim coils	Both sides / Panel on both sides
Attenuators (rectangular)	Both sides / Up-stream panel
Attenuators (circular)	Both sides / Up-stream panel
Filter sections	Both sides / Up-stream panel
Air turning vanes	Both sides / Up-stream panel
Changes in direction	One side
In-duct fans/devices	Both sides / Up-stream panel
Inlet/exhaust louvre	One side / One panel to suit
Intermediate cleaning panels	As and Where Required

In cases where human access is required because the ductwork is too large to be cleaned mechanically, human access should be allowed subject to a risk assessment.

Opening sizes suggested for access to rectangular and flat oval ducts:

Duct size up to longest size major axis	Recommended dimension of opening	
200mm	300mm	150mm
300mm	300mm	200mm
400mm	450mm	300mm
>500mm	450mm	450mm

Opening sizes suggested for access to circular ducts:

Duct size up to	Recommended dimension of opening	
310mm	250mm	150mm
450mm	400mm	300mm
550mm	400mm	300mm
>600mm	500mm	400mm

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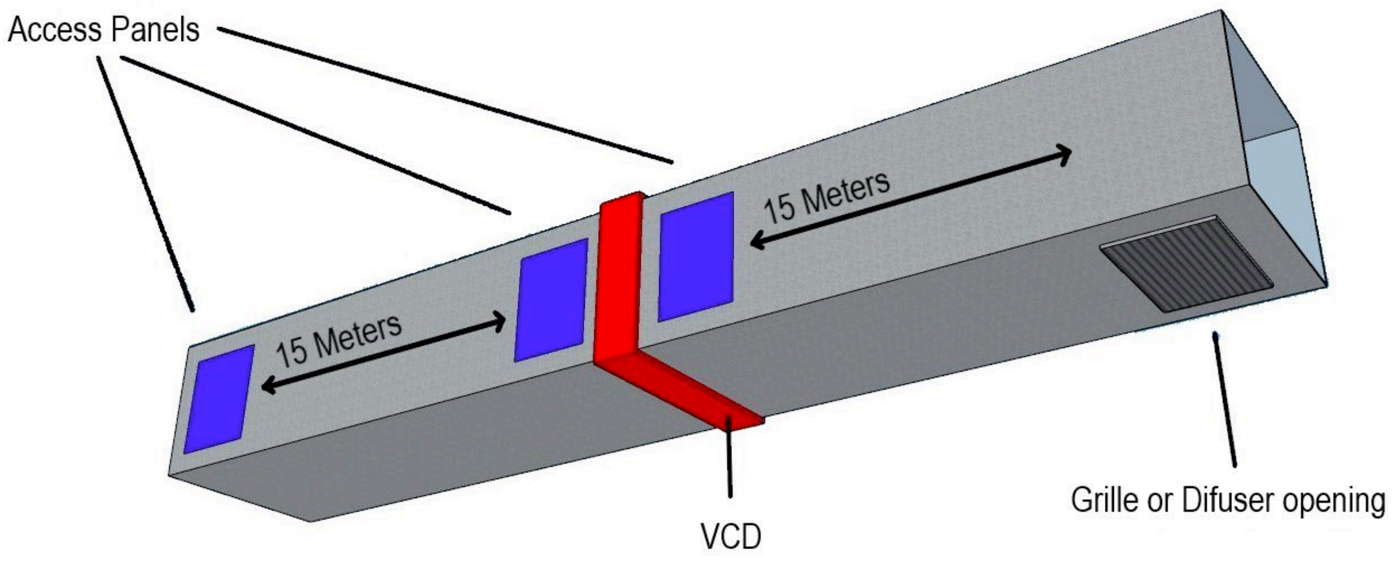
Fitting Access Panels

There must be enough access panels to allow cleaning of all surfaces, using openings already in place e.g. Grille / Diffuser openings.



Some manufacturers may not recommend large access panels are located too close together because it may interfere with structural integrity.

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Access Panels

Hatches fitted into the duct provide access for cleaning and maintenance.

They are either curved for round duct – although saddles can be fitted – and rectangular doors installed OR square for a square duct.

They must be **airtight** and to the **same integrity or fire rating** as existing ductwork.

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Ceiling Tile Access Panel

Ceiling Access Panels can provide easy access for electrical or insulation equipment repairs / replacements.

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Fire Resisting Access Panels

These must **only** be fitted by approved and competent contractors in accordance with the manufacturer's instructions. They provide protection and isolate the compartment to prevent the fire from spreading.

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Access Panel Installation

When installing access panels into a grease extract system, they should be fitted at intervals **not exceeding 3 metres**, unless **suitable load testing** has been carried out on the ducting.

This is according to the recommendations **BS EN 15780**.

This is for both **horizontal** and **riser** ducts.

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Caution:

For Fire Resisting ductwork **do not** attempt to fit standard access doors as these will **fail in the event of a fire** and will also **invalidate the insurance.** Always refer to the manufacturer's instructions for the installation of access doors and fixing, as they may be different from other products.

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