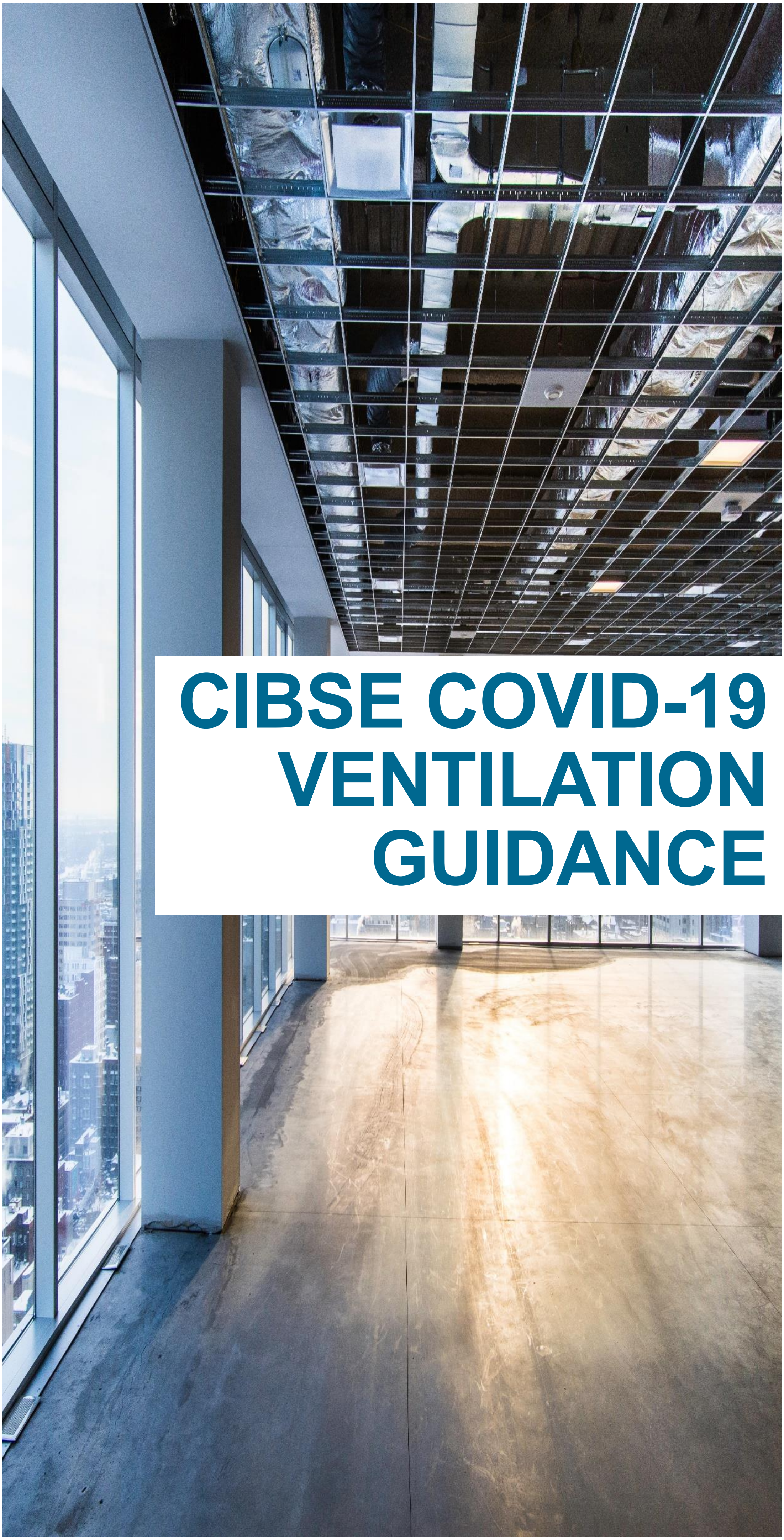

CIBSE COVID-19 VENTILATION GUIDANCE

CIBSE

Version 3

15 July 2020

Introduction

CIBSE published COVID-19 Ventilation guidance on 9th May (and Version 2 on 12th May) in response to the CIBSE position, taken in April, that there was the potential for airborne aerosol transmission of SARS-CoV-2. Taking the precautionary approach and with the spring/summer weather approaching the main principle of the ventilation advice is to ventilate spaces as much as reasonably possible with outdoor air.

Evidence continues to suggest that in poorly ventilated indoor spaces airborne aerosols are a possible transmission route and the precautionary advice remains valid. The WHO has updated its guidance to acknowledge the possibility of airborne transmission on 9th July.

As businesses consider bringing staff back into work premises, a number of issues need to be considered for the safety of everyone entering buildings. Government guidelines should be followed (see government websites for the most up to date information).

On 11 May government produced guidance for employers, employees and the self employed to help them understand how they can work safely during the pandemic. The HSE provides guidance on building safety in general and on air conditioning and ventilation in particular.

The government guidance reminds employers of their legal responsibility for the safety of those entering workplaces:

"To help you decide which actions to take, you need to carry out an appropriate COVID-19 risk assessment, just as you would for other health and safety related hazards. This risk assessment must be done in consultation with unions or workers."

Undertaking that risk assessment may require advice from competent persons, such as professionally registered engineers who are Chartered or Incorporated engineers registered with the Engineering Council.

This CIBSE COVID-19 ventilation guidance is intended to give business owners and managers an outline of ventilation systems commonly encountered in buildings to assist in the preparation to re-open workplaces. This guidance will inform considerations of safe working practices and the provision of ventilation in buildings.

The CIBSE COVID-19 ventilation guidance is under continued review. CIBSE are currently evaluating evidence to provide guidance for the cooler autumn and winter seasons.

During the cooler months heating the volumes of outdoor air needed to supply the high ventilation rates used in summer will be energy intensive. In some systems it may not be possible due to the limitations on the capacity of the heating coils. Therefore, some level of recirculation may need to be considered during the heating season.

The risk of recirculating some air needs to be considered against i) the risk of the reduction in flow of outdoor air that could occur in colder weather to ensure that the air can be supplied to a space at a comfortable temperature and ii) the risk of uncomfortably warm temperatures developing in some spaces.

For naturally ventilated spaces, windows and vents are often the mechanism for providing outdoor air. During the colder months, the natural forces that drive air through these openings (wind and indoor/outdoor temperature difference) are greater and therefore the openings do not to be opened as wide. Opening of just high level vents, rather than low and high level vents, can enable more mixing of the outdoor air with indoor air before reaching the occupied zone – this can help enable more fresh air to be introduced to the space. If natural ventilation openings are the only mechanism for delivering outdoor air into a space it is important not to completely close them when the spaces are occupied as this can result in very low ventilation rates.

Nondispersive infrared (NDIR) CO_2 sensors are useful devices to help assess whether adequate ventilation is being provided to an occupied zone. Indoor ventilation dilutes exhaled CO_2 from sedentary occupants and so the CO_2 concentration in a space is often used to demonstrate ventilation rates, where a CO_2 concentration of 1000ppm (parts per million) is generally indicative of an outdoor air supply of 8-10l/s/person.

eCO_2 sensors should not be used. These devices can only measure volatile organic compounds (VOCs) and make an estimate of CO_2 concentration based on the concentration of VOCs in the air. They do not directly measure the indoor CO_2 concentration.

Germicidal ultraviolet (GUV) devices have been proposed for air cleaning. They use light in the UV-C spectrum and have been shown to inactivate coronaviruses, although there is not yet specific evidence of the efficacy of UV-C irradiation for SARS-CoV-2. There are currently uncertainties about a variety of factors affecting UV performance including dosage, wavelength and exposure time. In addition, consideration will need to address the specific room and system configuration, air flow, distribution and humidity.

CIBSE are also working closely with other institutions to provide cohesive responses and guidance for ventilation of more specialist indoor spaces.

Increased ventilation is one of several recommendations to reduce SARS-CoV-2 transmission risk indoors and therefore should be used in conjunction with other government advice including working from home, social distancing, wearing of face coverings, good hygiene practices, workplace cleaning and test and trace.

Principal changes to version 3

This version of the CIBSE guidance contains a revised introduction which addresses questions about adapting ventilation arrangements during the heating season and includes additional information about thermal wheels (see section 4.2.2.2 on page 11).

Registered charity number 278104

This document is based on the best knowledge available at the time of publication. Due to the rapidly evolving nature of the COVID-19 epidemic this guidance should be read in conjunction with the relevant government guidance, in particular that relating to “Working safely during coronavirus (COVID-19)”

Ventilation

The advice in this document is for building owners/managers and operators when reopening buildings following a period of inactivity and considering the requirements for the ventilation system.

It is to be read in conjunction with any information available on, or linked from [“Working safely during coronavirus (COVID-19)”]

The document is written in the context of a temperate oceanic climate as experienced in the UK and will outline the main actions you should take regarding your ventilation. Section 3 explains different ventilation systems within buildings and their key operating characteristics, Section 4 then explains how you should operate these different types of ventilation to reduce the risk of SARS-CoV2 transmission. This includes preparing the ventilation system for the re-occupation of the building, considerations about operating it during re-occupation.

In some cases the occupancy of a room/zone may be reduced due to social distancing criteria and ordinarily this would result in a reduction of the ventilation airflow required. However, in order to reduce risks associated with viral transmission the number of air changes has to be as high as reasonably possible.

It is primarily intended for application in non-domestic buildings excluding health care and hospital buildings where NHS and PHE guidance should be sought.

If a confirmed case or case(s) of Covid-19 has been identified from a building user then please consult current Government advice.

The advice contained in this document specifically concerns the ventilation provision in indoor spaces and presents advice as to what can be done to reduce the risk of viral infection transmission indoors, as such it should be read in conjunction with advice on social distancing, cleaning and other building management advice.

The key actions are:

- Understand your ventilation system
- Run your ventilation at higher volume flow rate; this may require changes to CO_2 set points (for both mechanical ventilation and automated windows)
- Avoid recirculation/transfer of air from one room to another unless this is the only way of providing adequately high ventilation to all occupied rooms
- Recirculation of air within a single room where this is complemented by an outdoor air supply is acceptable[1]
- If applicable enthalpy (thermal) wheels should be switched off, but the pressure difference will need to be maintained between supply and extract to minimise any leakage flow from the extract to supply side

This CIBSE COVID-19 ventilation guidance is under continued review and CIBSE are currently evaluating evidence to provide further guidance during the cooler autumn and winter seasons.

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[1] this helps enable more fresh air to be provided, get more fresh air to all occupants, and it can make an environment more comfortable

Contents

1 Why indoor ventilation is important to reduce Covid-19 cases

Building ventilation is always an important part of a healthy building environment as it ensures that a steady stream of outside air is brought into the building whilst stale air is exhausted. Stale air includes bioeffluents (body odours and exhaled breath), airborne pollutants (such as smells from cleaning products and furniture), amongst others. Ventilation is also a very important way of diluting any airborne pathogens and there is good evidence that demonstrates room occupants are more at risk of catching an illness in a poorly ventilated room than in a well-ventilated room. This is because in a poorly ventilated room occupants are exposed to a higher concentration of airborne pathogens, and the risk will increase with a greater amount of time spent in such an environment.

Risk = exposure x time

The risk of airborne infection to the individual can therefore be reduced by:

- Reducing time spent in the location
- Reducing airborne exposure concentration of infectious material
- Reducing risk of contact spread through regular handwashing, surface cleaning and reducing deposition of infectious particles.

Ventilation rate and effectiveness play a role in both airborne exposure and deposition rates.

The risk for SARS-CoV2 transmission will be from asymptomatic or pre-symptomatic individuals who occupy a building without knowledge that they are shedding viral particles. Current government advice should be consulted with regards to reducing risks posed by symptomatic individuals.

1.1 Covid risks

Evidence is beginning to emerge that SARS-CoV2, the virus which causes Covid-19, can spread by very small particles – called aerosols – which are released by an infected person when they cough, sneeze, talk and breathe, as well as the larger droplets that are released. Larger droplets will fall by gravity and influences the 2m social distancing measures to reduce spread. However, these fine aerosols can remain airborne for several hours. Although it can be difficult to definitively prove airborne transmission, our knowledge of other similar viruses and the emerging evidence showing high rates of infection in poorly ventilated rooms suggests that we should consider this as a potential transmission route and undertake measures to reduce that risk.

These small droplets may be breathed in and cause infection.

As our understanding of the significance of the various transmission routes of SARS-CoV2 develops, we recommend increasing the rate of supply of outside air to occupants wherever it is practical as a pre-cautionary measure. This is particularly important in poorly ventilated areas. Increasing the ventilation rate helps dilute any airborne contamination and reduces the risk of exposure for building users.

This guidance is subject to change as SARS-CoV2 transmission routes become more clearly defined. Until then this takes a risk averse approach to reduce indoor pollution without significant capital expenditure.

2 Minimise risks

To minimise the risks of airborne transmission of SARS-CoV2 the general advice is to increase the air supply and exhaust ventilation, supplying as much outside air as is reasonably possible. The underlying principle is to dilute and remove airborne pathogens as much as possible, exhausting them to the outside air and reducing the chance that they can become deposited on surfaces or inhaled by room users. Recirculation/transfer of air from one room to another should be avoided unless this is the only way of providing adequately high ventilation to all occupied rooms.

In rooms and zones where there is no direct supply of outside air then consideration should be given to prohibiting access to these spaces by building users, especially where it is likely that they would be occupying such a space for considerable lengths of time (longer than 30 minutes). This may include basement rooms or storage areas which rely on infiltration of air from other spaces.

The key actions are:

- Understand your ventilation system
- Run your ventilation at higher volume flow rate; this may require changes to CO_2 set points (for both mechanical ventilation and automated windows)
- Avoid recirculation/transfer of air from one room to another unless this is the only way of providing adequately high ventilation to all occupied rooms
- Recirculation of air within a single room where this is complemented by an outdoor air supply is acceptable[2]
- If applicable enthalpy (thermal) wheels should be switched off, but the pressure difference will need to be maintained between supply and extract to minimise any leakage flow from the extract to supply side

[2] this helps enable more fresh air to be provided, get more fresh air to all occupants, and it can make an environment more comfortable

3 What ventilation provision is available

Prior to reopening buildings for use it is important to establish what kind of ventilation provision exists in the building and how the ventilation rates can be increased. Section 3 is designed to help the reader identify the ventilation system or systems present, noting that there may be different regimes in different rooms of the building. Some rooms may have more than one type of ventilation provision, so first familiarise yourself with the ventilation types below and then establish the ventilation provision in your building on a room by room (zone by zone) basis. In order to minimise risks of airborne transmission follow the advice in Section 4 for the ventilation type identified in each room/zone to maximise the delivery of outside air into those rooms and reduce the risks of airborne transmission, helping to protect building users

3.1 Natural ventilation

The term natural ventilation is used to describe ways that outside air can enter the building without using fans or other mechanical means. For example, airflow through openings in the building envelope such as windows, doors, wind catchers and other vents.



3.1.1 Mixing boxes

A relatively new technology, these systems use a fan to mix outside air entering a room with some of the air already in the room. This is a useful energy saving system in the heating season as it warms the cooler outside air before it enters the room, reducing the heating in the room and reducing cold draughts.

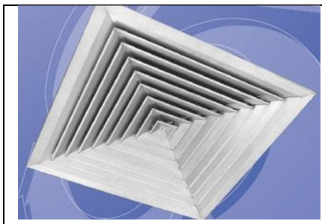
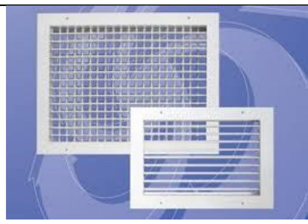
3.2 Mechanical ventilation

Mechanical ventilation is used to describe the means of transporting air into a building by mechanical means, for example fans. Often air is moved through ductwork to deliver outside air into a building and there are several ways in which this can be achieved.

Some ventilation strategies use both natural and mechanical ventilation within the same space; this is often termed mixed-mode ventilation. Typically mechanical ventilation may be the primary means of delivering outside air into the room year round, with the additional benefit of openable windows to provide more outside air to help cooling during the summer or to purge the room, for example from a smell caused by a spillage.

3.2.1 Supply/Extract

The main principle in this type of mechanical ventilation is a series of ducts and inlet grilles which deliver outside air into a space, with another set of ducts which extract stale air out of the room and exhaust it to the outside. There are a number of different systems which use this method and the grilles which deliver the incoming air can be located in the ceiling, on the wall or in diffusers on the floor. For the system to provide adequate outdoor air it is essential to keep these grilles free from blockages.

 Ceiling diffuser	 Floor diffuser	 Wall diffuser

Typical examples of air supply inlets Images courtesy of Gilberts (Blackpool) Ltd

3.2.2 Heat recovery

Some mechanical ventilation systems use heat recovery to extract heat from the warmer stale exhaust air and use that heat to warm the incoming outside air. This has energy saving benefits in the heating season as it helps to reduce the heating needed to warm the room. Some heat recovery systems work on a room/zone by room/zone basis and mix some of the exhaust air with the incoming outside air and therefore recirculate a portion of the air back into the room.

There are some exceptions where air is recirculated within a space, so if you have this type of system please read the recirculation actions carefully in section 4.2.2

3.2.3 Extract only

In this system a fan is used to extract air from the room direct to the outside and air enters the room to replace the extracted air through infiltration – for example via gaps under the door. These systems are typically employed in toilet blocks and wet room facilities.

3.2.4 Air Conditioning

Some air conditioning systems form part of the mechanical ventilation system whereby the outside air is first ‘conditioned’ before being moved along ductwork to the room. This conditioning can include warming of the air in winter or cooling of the air in summer as well as adjusting the humidity of the air.

Some systems that are commonly known as “air conditioning”, only condition the air in a room – i.e. warm the air or cool the air, but are not part of the ventilation system. They are more correctly referred to as “comfort cooling” or “comfort heating”. These systems take air already in a room and warm or cool it before releasing it back (recirculate it) into the room. It is important to understand that these systems are not delivering outside air and are therefore not diluting any airborne pathogens.

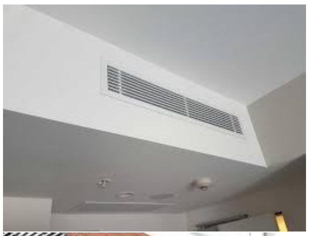
3.2.4.1 Split air systems
A split air system has two main parts: an outdoor compressor and condenser and an indoor air-handling unit (hence the term split – it is in two units. A conduit carries the power cable, refrigerant tubing, suction tubing, and a condensate drain between the outdoor and indoor units. They are typically wall or ceiling mounted, and are quite common, but do not supply any outside air into a room.

3.2.4.2 Fan coil units
These units are usually ceiling mounted or installed in raised floors. A fan passes air over either a heating or cooling coil and into the room. Fan coil units generally have a chilled water coil for cooling and either a hot water coil for heating or an electric heating element. They may be connected to ventilation ducts from the air handling unit to provide outdoor air or they recirculate room air.

3.2.4.3 Chilled beams
These are installed near to the ceiling to provide cooling and come in two forms.

Active Chilled Beams – these form part of the ventilation system and are used to chill incoming outside air as it passes into a room.

Passive Chilled Beams – these cool air already in a room by absorbing the heat and are not responsible for bringing outside air into the room. They will create air mixing due to convection currents caused by the beam cooling air at high level, which then falls to the floor, creating airflow.

System	Image	Outdoor air or recirculated?
Split air systems	 	Only recirculates room air
Fan Coil Units	  	Can be connected to ventilation ducting from the air handling unit to provide outdoor air or recirculates room air with a fan.
Chilled beams -Passive Chilled beams		Recirculates room air via convection
-Active Chilled Beams		Connected to ducting to condition incoming outdoor air

3.3 Specialist localised exhaust ventilation

In some settings specialised extract ventilation is used to remove lots of air from a specific location, for example; cooker hoods in kitchens, local exhaust on CNC machinery, fume hoods. Although these systems generally remove large volumes of air, it is important to ascertain where the replacement air is coming from which replaces that exhausted from the room. It may come directly from outside through windows/doors, or air may enter from other rooms/zones e.g. adjacent corridors or adjoining rooms. In the case of large factory floors replacement air is likely to be from the outside. Specialised local exhaust ventilation is the subject of specific workplace regulations and the Institute of Local Exhaust Ventilation Engineers provide more specialist advice and practitioners who have particular expertise in these systems.

3.4 No obvious ventilation strategy

Some spaces may not have an identifiable ventilation system. For example, it is common for there to be no ventilation in corridors or staircases as these are deemed to be transient spaces and they rely on air infiltration from neighbouring spaces. However, rooms/zones that are occupied routinely without any obvious ventilation strategy are going to be a significant risk and the ventilation provision should be addressed.

4 Recommended actions to improve ventilation

4.1 Natural ventilation

4.1.1 Open external doors to boost ventilation

For small buildings with limited ventilation openings such as small shops or offices within a secure compound, external doors may be used to increase ventilation as long as care is taken over security. Propping open internal doors may be appropriate where it delivers a significant increase in air movement and ventilation rate. It is important to note that fire doors should not be propped open unless fitted with approved automatic closers so that they function as fire doors in the event of an alarm or fire.

4.1.2 Opening windows

It is recommended to actively use openable windows and vents much more than normal as long as security is considered and the open windows do not cause a hazard to anyone moving outside. If possible windows should be open at least 15 minutes prior to room occupation. As the weather is beginning to warm opening windows is a typical behavioural response, however it is important to ensure that windows are open even if it is cooler outside.

If it is windy, cold or raining then it may not be practical to fully open the windows/vents, however they should be open as far as reasonably possible without causing discomfort.

During cooler weather, it may be necessary to have the room heating on more than normal. This will incur energy penalties; however, these are deemed acceptable as the increased ventilation will help remove any airborne virus particles from the building.

During warmer weather and on bright sunny days it may not be appropriate to have the heating on during the cooler mornings as this may exacerbate overheating in the afternoon.

Opening windows can result in draughts that can cause occupant discomfort. Where possible discomfort should be mitigated by ensuring building users are not located directly in a draught for long periods, for example moving desks/room furniture. Relaxing dress codes so that warmer fleeces can be worn is advisable. If there are both high level and low level openable windows in a room then it is recommended to open the high level windows during cooler weather in the first instance, as incoming air will be warmed as it flows down into the room thereby reducing cold draughts. To maximise airflow, both high and low windows should be opened. This does not just increase opening area but creates a more efficient flow, thereby increasing the dilution of pollutants.

4.1.2.1 Single sided ventilation

Where a room only has one side that has openable windows/vents then consideration should be given to areas within the room where air may become stagnant. It is generally considered that rooms can be well ventilated by single sided ventilation if the depth of the room is less than twice the height, or in the case of a single side ventilation with both high and low level windows if the depth of the room is less than 2.5 times the height. In deeper plan rooms it is advisable to use a local recirculation unit or fan at the back of the room to enhance air disturbance and hence reduce the risk of stagnant air. This is particularly important where a small room has multiple or transient occupancy, and when assessing the future occupancy of a space then the ventilation mechanism should be considered as well as achieving the simple 2m separation that is required.

4.1.2.2 Cross ventilation

Greater air flow can be achieved when windows/vents can be opened on different facades to allow air flow through a room. This can also include layouts where cross ventilation occurs by air entering through the external façade, traveling across the floor plate to a central atrium where it is exhausted up and out through vents at roof level.

It is generally recommended that cross ventilation flows should not exceed 15m or 5x floor to ceiling height (whichever is the smallest) as it is known that air pollutants become more concentrated at the leeward side of the room, where the air exhausts, compared to the windward side where outside air enters the room. However, in the case of reducing the risk of Covid-19 transmission this consideration can be relaxed as cross ventilation will increase the outdoor airflow and consequently increase the removal of any airborne pathogens.

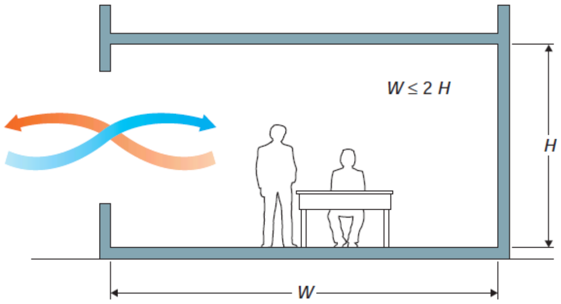


Figure 2.18 Single sided ventilation, single opening

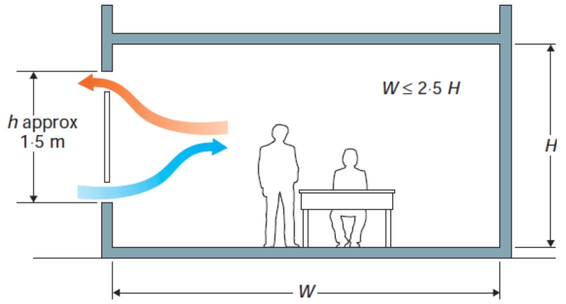


Figure 2.19 Single sided ventilation, double opening

Cross ventilation pathways where air travels from one occupied room/zone into another should be avoided if possible by keeping internal partition doors closed, unless opening such partitions significantly increases the total volume flow rate of outdoor air. Fire doors should not be propped open unless fitted with approved automatic closers so that they function as fire doors in the event of an alarm or fire.

4.1.2.3 Wind catchers

The advice is to use manual override to fully open the wind catchers and then turn off the power to the unit to ensure that the vent remains open.

See manufacturers literature to maximise airflow through these systems.

During cooler days it may be necessary to have the room heating on more than normal which will incur limited energy penalties; however, these are deemed acceptable as the increased ventilation will help remove virus particles out of the building.

During warmer weather and on bright sunny days it may not be appropriate to have the heating on during the cooler mornings as this may exacerbate overheating in the afternoon.

4.1.2.4 Automated windows/vents

Some windows and vents are controlled automatically and open in response to indoor air quality and temperature. To promote more active window opening either use manual override or, if that is not possible, adjust the CO_2 setpoint to 400ppm.

4.1.2.5 Windows in toilet blocks

If windows are the only means of ventilating the toilet block then they should be left open as long as reasonably possible, and windows in adjoining rooms should also be open.

In internal toilets blocks with passive stack or mechanical exhaust systems, the principle of this ventilation system is that air will flow into the toilet block as the door to the block is opened, thus ensuring that contaminants and odours are kept within the toilet block and do not enter adjacent rooms. Opening windows in toilet blocks with mechanical extract ventilation may reverse the air flow when doors open allowing contaminated air to flow from the toilet block into the adjacent room – which is to be avoided. Therefore, in toilet blocks with mechanical extract ventilation the extract ventilation should remain constantly on and windows in the toilet block remain closed. A notice may be required on the toilet doors/walls to explain this and discourage opening.

For external toilet blocks with no adjoining rooms, open windows can supplement the ventilation and can be left open.

It is important to keep toilet doors closed to ensure the ventilation dilutes and removes any pollutants rather than recirculating them to the rest of the building.

4.1.2.6 Window Restrictors
Restrictors will reduce the opening area of your window, and therefore the potential for ventilation. They may be essential for safety and security of occupants. Removal of restrictors to boost air flow should only be done after a risk assessment considering the risk of clashes with people outside walking past open windows (on the ground floor) and the risk of falls from upper floors.

4.1.2.7 Security considerations for open windows
There are security issues to consider with respect to leaving windows open, especially when the building is not occupied. A walk-round may be required to ensure that all windows that pose a security issue are closed before the building is vacated, and windows reopened as early as possible before reoccupation by the majority of the building users. Where leaving windows open does not cause a security issue it is recommend to do this overnight on warm/hot days to maximise purge of the room air. On cold days and nights this may cause over cooling and significant discomfort so should be avoided.

4.1.3 Mixing boxes
As these devices are designed to supply air to a single room/zone then the mixing mode can continue to be used if this enables more outdoor air to be supplied to the room in a reasonable manner (by reducing draughts when outside air temperature is low). However, to maximise outdoor air provision the device should be used in full outdoor air mode if possible.

4.2 Mechanical ventilation

4.2.1 Supply/Extract

In buildings with mechanical ventilation systems extended operation times are recommended. Change the clock times of system timers to start ventilation at nominal speed at least 2 hours before the building usage time and switch to lower speed 2 hours after the building usage time. In demand-controlled ventilation systems change CO_2 setpoint to lower, 400 ppm value, in order to maintain the operation at nominal speed. Keep the ventilation on 24/7 with lower ventilation rates when people are absent. Refer to manufacturer's guidance for help. Relative humidity should be kept above 40% wherever possible.

4.2.2 Heat recovery

There are several methods by which heat recovery can be achieved; the manufacturer's literature for the system installed should provide information on what method is employed.

4.2.2.1 Twin coil unit or plate heat exchange

This system keeps the supply air and the extract air streams physically separate; just the heat energy is transferred and the air streams never mix. On this basis the heat recovery device can remain online, but the unit should be inspected to ensure there are no leaks (which might lead to transfer of air from outflow to inflow duct).

4.2.2.2 Regenerative rotary air to air heat exchangers (enthalpy wheels / thermal wheels)

These heat recovery devices have a risk of air leakage and moisture transfer between the supply and exhaust air streams at the rotary heat exchanger. The magnitude of this leakage will vary depending on the installed configuration of the fans, and the relative pressures in the supply and extract ducts. Where properly configured direct air leakage passes from the supply to the extract duct and is therefore not a concern. Actual configuration and pressure balances should be checked by an engineer, and poorly configured or balanced systems must be bypassed or remedied. There is also a risk, as yet unquantified, of viral particles in the exhaust air stream being carried over to the supply air stream on the surface of the adsorbent material used in the wheel. On this basis, if provision is available, the rotary heat exchanger (thermal wheel) should be bypassed. In systems where this is not possible the rotor should be turned off and ventilation rates increased as much as reasonably possible.

However, the heat recovery function is integral to the system design in terms of air flow and meeting heating demand. In order to ensure the maximum reasonable outdoor air flows to dilute any indoor viral contaminant in the heating season it is advisable to turn the rotor **on.** Not doing so may result in lower air flow rates and less outdoor air entering the building. The expected reduction in dilution of any potential indoor viral source with lower flow rates is considered to be a greater risk for viral transmission than the potential for viral transfer across the thermal wheel. Turning the rotor on has the added benefits of maintaining the energy efficiency of the system and assisting (in the case of enthalpy wheels) with maintaining higher humidity levels in the building. Outside of the heating season the wheel should be switched **off**. In summary the benefits of maintaining high outdoor air rates to dilute internal viral contaminants outweigh the risks of viral particles being transferred via the thermal wheel. Systems should be checked for configuration and correct operation by a competent engineer. Personnel should adopt the usual safety procedures for dusty work and should wear appropriate personal and respiratory protective equipment.

4.2.2.3 Recirculation sectors in centralised air handling units

It is recommended to avoid central recirculation during SARS-CoV-2 episodes to prevent the risk of airborne transmission and recirculation of airborne viral particles in the building. The advice is to close recirculation dampers via the Building Management System or manually.

Bypassing the recirculation sector may impact the building cooling or heating capacity; this has to be accepted because it is more important to seek to reduce contamination and protect public health than to guarantee thermal comfort. This may require education for building occupants and a relaxing of dress codes.

Some air handling units and recirculation sections may be equipped with return air filters. This should not be a reason to keep recirculation dampers open as these filters do not normally filter out particles with viruses effectively since they have standard efficiencies (G4/M5 or ISO coarse/ePM10 filter class) rather than HEPA efficiencies. Note, HEPA filters should only be used in air filters that have been designed for HEPA use otherwise there is a high possibility of air leaking around the HEPA filter rendering the air filtration inefficient, or reducing the rate of supply of fresh air through increased resistance. Please consult manufacturer guidance.

4.2.3 Duct cleaning has no practical effect

Duct cleaning is not effective against room-to-room infection because the ventilation system is not a contamination source if the guidance above about heat recovery and recirculation is followed. Viruses attached to small particles will not deposit easily in ventilation ducts, will normally be carried out by the air flow, and any that do settle will become unviable over time. Therefore, no changes are needed to normal duct cleaning and maintenance procedures.

4.2.4 Outdoor door air filters

Outdoor air is not seen as a high risk source of SARS-CoV2 viral particles. Therefore, it is not necessary to change existing outdoor air filters and replace them with other filter types. They should be changed in line with the standard maintenance regime requirement.

4.2.5 Changing filters

From the filter replacement perspective, normal maintenance procedures can be used. Clogged filters are not a contamination source in this context, but they reduce supply airflow which has a negative effect on the ability to remove and dilute concentrations of contaminant. Thus, filters must be replaced according to normal procedure when pressure or time limits are exceeded, or according to scheduled maintenance

HVAC maintenance personnel may be at risk when filters (especially extract air filters) are not changed in line with standard safety procedures. Filters may have active microbiological material on them, including viable viruses, particularly in any building where there has recently been an infection. Filters should be changed with the system turned off and technicians must use appropriate PPE including gloves and eye protection, overalls and personal respiratory protection. Used filters must be disposed of in a sealed bag in the appropriate waste stream.

4.2.6 Extract only

If the ventilation provision is extract only and the make-up air (the air that enters the room to replace that exhausted) is outside air from infiltration through the building fabric (i.e. gaps) then this is unlikely to present an increased risk of viral transmission. However, if the main make-up airflow pathway is from another room or zone then it will increase the risk of spreading any airborne viral particles between zones.

For extract ventilation in toilet blocks please see section 4.1.2.5 Windows in toilet blocks.

4.2.7 Split air systems

Within a room/zone these systems are good at providing thermal comfort by warming or cooling the indoor air and the air movement they provide can help prevent stagnant areas of air within a room. However, it is important to understand that they do not provide any outside air into the room/zone and without a dedicated source of outside air supply into a room they could be responsible for recirculating and spreading airborne viral particles into the path of socially distanced building users. Ensure that there is a source of outside air provision (either natural or mechanical ventilation) when these units are in operation.

4.2.8 Fan coil units

If a room/zone has no or very little outside air ventilation provision then the action of a fan coil unit could create air movement that is likely to spread any airborne viral particles throughout the room and the advice is to turn off the fan coil unit fan.

However, if there is a good outdoor air ventilation supply (either mechanical or natural) to the room/zone then the action of the fan coil unit fan will help de-stratify the air and reduce the chance of pockets of stagnant air, helping to dilute any airborne pathogens.

4.2.9 Chilled beams

Active Chilled Beams – these form part of the ventilation system and are used to chill incoming outside air as it passes into a room. These can operate as normal.

Passive Chilled Beams – these cool air already in a room by absorbing the heat and are not responsible for bringing outside air into the room. They will create air mixing due to convection currents, but as with fan coil units, if there is a good supply of outdoor air these can still be operated and do provide comfort.

4.2.10 Room air cleaners

Room air cleaners effectively remove particles from air, providing a similar effect compared to ventilation. To be effective, air cleaners need to have at least HEPA filter efficiency and to have a substantial part of room air pass through them. Unfortunately, most attractively priced room air cleaners are not effective enough. Devices that use electrostatic filtration principles (not the same as room ionizers) often work quite well too. Because the airflow through air cleaners is limited, the floor area they can effectively serve is normally quite small, typically less than 10 m^2, and the appropriate location of these is essential. The cleaner must not be located in a stagnant zone; a cleaner located in the centre of the room will clean more of the room air in most cases due to the air circulation passing it. Locating the cleaner close to the breathing zone is an alternative, however this requires a cleaner per person.

Special UV cleaning equipment for room air treatment is also effective at killing bacteria and inactivating viruses but this is normally only a suitable solution for health care facilities.

4.3 Specialist localised exhaust ventilation

Specialist localised exhaust ventilation is provided for specific safety reasons and should continue to be operated as normal.

It is worth considering where make-up air into the room with specialised ventilation is travelling from; ideally the make-up air should come from outdoor air rather than from adjacent rooms.

4.4 No obvious ventilation strategy

If there is no obvious ventilation strategy in a room/zone then building users should be discouraged from using these spaces. If they are used only transiently e.g. stairwells, corridors, then more robust cleaning regimes for these locations should be implemented.

Contributors to this guidance: The primary authors were Dr Chris Iddon, Dr Abigail Hathway, and Dr Shaun Fitzgerald, with contributions from Frank Mills, David Stevens, George Adams, and Prof. Tony Day. Dr Hywel Davies co-ordinated the group. Further information on preparing and using buildings during the Covid-19 pandemic can also be obtained from other professional bodies and https://www.gov.uk/coronavirus