

|  |
| --- |
| Ventilation principles and strategies to reduce transmission of COVID-19 in community and workplace settings v3 |
| June 2023 |
|  |

#### Revision history

| Version | Date | Changes |
| --- | --- | --- |
| 3 | June 2023 | Revision and merger of Purpose, who should read, and rationale sections.Revision and merger of COVID-19 transmission and aerosol transmission sections into one.Updated hierarchy of controls graphic.Revision of all other sections in line with current evidence base, most notably; CO2 monitors, mitigation strategies, air changes per hour and GUV sections.Added section on air moving activities and devices |
| 2 | June 2022 | New Victorian Government ventilation resources incorporated.Four good ventilation principles incorporated.UV device (upper-room GUV, in-room devices) content removed.Air ioniser content removed.Air purifier recommendations updated.Victorian Government ventilation graphics incorporated.CO2 monitor recommendations updated.New term definitions incorporated.Other IPC (Infection Prevention and Control) strategies and recommendations updated. |
| 1.1 | February 2022 | Temperature range recommendations removed. |
| 1 | October 2021 | The guidance has been developed to provide guidance on ventilation strategies to reduce the risk of aerosol transmission in community and workplace settings. |

### Contents

[1. Purpose 2](#_Toc137803168)

[2. COVID-19 transmission 3](#_Toc137803169)

[3. The Hierarchy of Controls 3](#_Toc137803170)

[4. Ventilation of indoor spaces 4](#_Toc137803171)

[4.1 Air changes per hour (ACH) 4](#_Toc137803172)

[4.2 Natural ventilation 5](#_Toc137803173)

[4.3 Mechanical ventilation 5](#_Toc137803174)

[4.4 Augmented ventilation 5](#_Toc137803175)

[5. Ventilation mitigation strategies 6](#_Toc137803176)

[5.1 Natural ventilation strategies 6](#_Toc137803177)

[5.2 Mechanical ventilation strategies 7](#_Toc137803178)

[5.3 Augmented ventilation 8](#_Toc137803179)

[6. Air treatment with Germicidal Ultraviolet (GUV) 10](#_Toc137803180)

[7. Ventilation indicator devices (CO2 monitors) 11](#_Toc137803181)

[8. Community activities and devices that move air 11](#_Toc137803182)

[Definitions 13](#_Toc137803183)

[Further information 13](#_Toc137803184)

[Appendix: Air change per hour (ACH) rates 15](#_Toc137803185)

# 1. Purpose

This resource provides recommendations and guidance on how to optimise ventilation systems and strategies in community and workplace settings to reduce the risk of COVID-19 transmission.

Community and workplace settings include but are not limited to:

* community centres
* hospitality businesses
* retail businesses
* office spaces in multi dwelling buildings
* sites for religious gatherings
* correctional detention centres and facilities
* social services
* education settings

For outpatient and residential care settings, see [Ventilation | health.vic.gov.au](https://www.health.vic.gov.au/covid-19-infection-prevention-control-guidelines/ventilation) <https://www.health.vic.gov.au/covid-19-infection-prevention-control-guidelines/ventilation>.

This guidance should be read in conjunction with resources at Victorian Government [Ventilation Guidance for Businesses](https://www.coronavirus.vic.gov.au/ventilation#types-of-ventilation-and-how-they-can-be-improved) <https://www.coronavirus.vic.gov.au/ventilation#types-of-ventilation-and-how-they-can-be-improved>.

Guidance and recommendations provided in this document are **not** intended for the following settings:

* healthcare or acute care (hospitals, day procedure units and acute care facilities).
* residential aged care or special care facilities.

For ventilation information in these settings, see [Ventilation | health.vic.gov.au](https://www.health.vic.gov.au/covid-19-infection-prevention-control-guidelines/ventilation) <https://www.health.vic.gov.au/covid-19-infection-prevention-control-guidelines/ventilation>.

# 2. COVID-19 transmission

The COVID-19 pandemic has brought about significant changes in understanding the importance of indoor air quality.

The virus (SARS-CoV-2) is primarily spread by inhalation of air carrying very small respiratory particles that contain infectious virus.

The risk of respiratory particle transmission is highest in

* crowded places
* close-contact settings
* confined and enclosed spaces with poor ventilation.

Factors that can increase the risk of COVID-19 transmission include

* the presence of one or more infectious person/s shedding virus in the room.
* The risk of transmission increases with the number of infectious persons in the room
* The risk of transmission increases with the activity level of the infectious persons in the room
* the amount of infectious virus in the air
* the rate at which occupants in the space inhale virus particles
* how long a person has been exposed in the room
* movement of air (and viral particles) within a room.

# 3. The Hierarchy of Controls

The Hierarchy of Controls model is a system for managing identified risks in the workplace. The focus should be on applying the most effective and achievable strategies, starting with elimination. Effective ventilation is an engineering control and should be considered as a higher order control measure within the hierarchy of risk controls to reduce COVID-19 transmission.

Figure 1. Hierarchy of Controls



*Image: Safe Work Australia,* [*How*](https://www.safeworkaustralia.gov.au/system/files/documents/1901/code_of_practice_-_how_to_manage_work_health_and_safety_risks_1.pdf) *to manage work health and safety risks Code of Practice May 2018 <https://www.safeworkaustralia.gov.au/system/files/documents/1901/code\_of\_practice\_-\_how\_to\_manage\_work\_health\_and\_safety\_risks\_1.pdf>, p19, Hierarchy of Control Measures.*

For further information, see the department’s [COVID-19 Infection prevention and control guidelines](https://www.health.vic.gov.au/covid-19-infection-control-guidelines) <https://www.health.vic.gov.au/covid-19-infection-control-guidelines>.

# 4. Ventilation of indoor spaces

Ventilation of indoor spaces provides air that will assist in the dilution and dispersion of small particles in the air (for example, dust, pollen and microorganisms).

Ventilation of a space can be provided either mechanically (that is, via a centralised heating, ventilation and air conditioning (HVAC) system or an individual local air conditioning unit) or naturally with passive airflow.

Ventilation for infection control can also be augmented by filtration.

Ventilation should be considered as part of a group of IPC strategies to reduce the risk of COVID-19 transmission in the community and workplaces. For more information, visit the department’s [Preventing Infection in the Workplace](https://www.coronavirus.vic.gov.au/preventing-infection-workplace) <https://www.coronavirus.vic.gov.au/preventing-infection-workplace>.

## 4.1 Air changes per hour (ACH)

Air change per hour refers to the rate at which clean air is moved through a space within an hour. Evidence suggests that air change rates of 4-5 are good, 6 are better and >6 are best.

Aim for 5 or more air changes per hour (ACH) of clean air to help reduce the number of viral particles in the air. This can be achieved through any combination of mechanical ventilation, natural ventilation, or devices that augment existing ventilation systems.

The 5 ACH target provides a guide to air change levels likely to be helpful in reducing infectious particles. The optimum number of ACH remains uncertain.

For guidance on calculating ACH, refer to Centres for Disease Control and Prevention (CDC) May 2023 [Ventilation in Buildings | CDC](https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html) <<https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html>>.

Large volume spaces with very few occupants (e.g., a warehouse) may not require 5 ACH and spaces with high occupancy or higher-risk occupants may need higher than 5 ACH.

While ACH levels higher than 5 (e.g., those used in negative pressure isolation rooms in hospitals) may reduce infectious aerosols further, the potential benefits of increased ventilation should be balanced with the additional upfront costs, periodic maintenance, comfort level, and energy costs that will be incurred.

## 4.2 Natural ventilation

Natural ventilation uses natural wind and thermal air differences to bring fresh air (outdoor air) into a space. Natural ventilation can be passive air flow via openings such as windows, doors and air vents.

The ventilation rate in naturally ventilated spaces can vary significantly throughout the year due to changing weather patterns and unfavourable conditions (for example, temperature, wind and rain).

## 4.3 Mechanical ventilation

Mechanical ventilation replaces or dilutes indoor air with outside air using mechanical equipment (that is, HVAC systems). Conventional HVAC ventilation systems dilute indoor, potentially contaminated air through the introduction of fresh air from the outside while maintaining indoor air quality (IAQ) and thermal comfort.

Ventilation systems are not designed to prevent COVID infection transmission but to meet requirements to control the accumulation of harmful contamination and provide occupant comfort. A well-maintained and appropriately designed HVAC system will, however, contribute to the diffusion and dilution of infectious aerosols, reducing the risk of infection transmission.

## 4.4 Augmented ventilation

Augmented ventilation uses appropriate supplementary devices to improve existing natural or mechanical ventilation. These can assist in:

* reducing the concentration of aerosolised viral particles; **and**
* improving air circulation and distribution in a space to reduce dead spots.

Augmented ventilation does not provide outdoor air to a space and is not considered an appropriate substitute for natural or mechanical ventilation strategies.

### 4.4.1 Filtration

Filters are designed to remove particles from airstreams as they pass through. The Minimum Efficiency Reporting Value (MERV) is a scale for the measurement of an air filter’s ability to capture particles between 0.3 to 10 microns (µm) as air passes through. MERV filters range from 1 to 16, the higher the rating, the smaller the particles they capture (i.e., more efficient). The **minimum recommended filter is MERV ≥ 13**; these filters are cost efficient compared to higher MERV rated filters, are efficient at capturing airborne viruses.

Upgrading filters to those with ratings of MERV 13 or higher will reduce the transport of airborne particles while systems are operating, which may help reduce airborne infectious disease transmission within rooms and between rooms.

H13 grade high-efficiency particulate air (HEPA) filters are efficient at filtering larger than 0.3 µm diameter particles in standard tests. Particles larger than 0.3 microns include pollen, pet dander, dust, mould spores, smoke and bacteria as well as aerosols and will be captured by the HEPA filter.

### 4.4.2 Air disinfection

Ultraviolet (UV) light can be used as a supplemental treatment to inactivate airborne viruses such as SARS-CoV-2 in some indoor environments. UV aerosol disinfection has been used in some high-risk healthcare settings to prevent and control respiratory disease transmission. It supplements other ventilation strategies as it can reduce airborne virus concentrations in indoor spaces. However, it does not increase air exchange rates or remove particles from the air. See [Section 6](#_6._Air_treatment).

# 5. Ventilation mitigation strategies

When indoors, ventilation mitigation strategies can help reduce viral particle concentration. The lower the concentration, the less likely viral particles can be inhaled into the lungs (potentially lowering the inhaled dose); contact eyes, nose, and mouth; or fall out of the air to accumulate on surfaces. Not all interventions will work in all scenarios and their selection must be carefully evaluated prior to adoption.

In addition to buildings, vehicles – including public transportation such as buses, subways, trains, school buses, carpools, and rideshares – are also areas where ventilation improvements can be applied to reduce the spread of airborne viruses and lower the risk of exposure.

When considering mitigation strategies, building owners and operators should seek expert consultation if they lack knowledge and experience in implementing those strategies. Indoor Environment Quality (IEQ) rating systems such as the National Australian Built Environment Rating System (NABERS) IEQ can provide guidance for designing, measuring and improving indoor environments. Remote sensing to monitor actual indoor air quality can provide important information for occupants and operators.

While mitigation strategies can be applied across many indoor environments, applying them to different building types, occupancies, environmental and seasonal changes can be challenging. The building owner or operator should identify which strategies are appropriate.

## 5.1 Natural ventilation strategies

The use of natural ventilation strategies will depend on outdoor weather conditions and may be constrained by building design. During extremely hot or cold weather or adverse events, such as bushfires and severe thunderstorms, some natural ventilation strategies may not be practical or feasible. This will reduce the natural ventilation rate as occupants are likely to close windows and doors; however, thermal and occupant comfort should be prioritised in these situations.

* If mechanical ventilation is not available, there should be at least one functional natural ventilation opening such as a door or window (two or more openings is ideal). Cross ventilation in a space (that is, two openings opposite to each other) is effective in displacing aerosol contaminants and creating movement of airflow in larger spaces. However, this will depend on the configuration or placement of openings and will require assessment by a ventilation professional or occupational hygienist.
* Open windows and doors to the outside (outdoors) as much as practicable to increase outdoor airflow into the space if it is safe to do so. Keeping windows and doors open may also create issues relating to outside noise levels. In these circumstances, a temporary compromise, such as temporarily closing a door until noise has subsided, should be considered.
* In scenarios where optimising natural ventilation may be limited (for example, in cold weather), consider opening windows and doors intermittently for short durations (for example, 10 minutes every hour).
* A break time between the use of a space or room between two groups of people (for example, meeting rooms) should be established based on the air exchange rate (see [Appendix](#_Appendix:_Air_change)). During this time, windows and doors should be opened to maximise the air exchange and fans may be used to promote air movement.
* A box fan or exhaust fan may be retrospectively installed in a window to facilitate air movement in or out of a space, dilute aerosol particles in the space, and improve air movement.
* In hallways and corridors, windows and doors should always remain open to promote outdoor air ventilation where practical or feasible.
* Whirlybirds or extractor fans may be installed to enhance the effects of other ventilation strategies.

Natural ventilation strategies usually require human intervention and a communications strategy to ensure occupants are aware of their roles (e.g., keeping windows open or leaving doors ajar) should be developed.

## 5.2 Mechanical ventilation strategies

### 5.2.1 HVAC systems

For centralised HVAC systems and individual air conditioning units with outside air connections (excluding split systems), the following strategies may be adopted to reduce the risk of aerosol transmission. All components of an HVAC system (including filters and amenity exhaust ducts) should be inspected, cleaned, maintained and serviced as part of regular maintenance schedules and as per the manufacturer’s instructions.

* HVAC or air conditioning units should utilise as much outdoor air as reasonably possible within the site or facility. Increased outdoor air ventilation, or appropriately filtered air can dilute or displace airborne particles including those carrying viruses, resulting in lower inhaled viral doses for susceptible individuals in an indoor space.
* Run pre- and post-occupancy purge cycles to flush a space with clean air after occupancy (for example, before and after business or operating hours where staff will be on-site, or between meetings). Ideally, HVAC systems should operate for the time taken to complete a total change of air in a space (see [Appendix](#_Appendix:_Air_change)).
* Where possible, recirculation of air (recycled air) between rooms or spaces should be turned off.
* If compatible, filters may be upgraded to provide a higher level of filtration and remove more particulates in the air within the system. A higher-grade filter should not be installed if the ventilation rate is compromised or reduced. Consult a ventilation professional or manufacturer before upgrading filters.
* If an HVAC system does not currently have a filter installed, these may be retrospectively installed in the HVAC system if compatible or feasible.
* Temperature and humidity set points should be maintained as per standard settings and be considered as a minimally effective IPC measure. Staff and occupant thermal comfort and safety should be prioritised.
* Disable or turn off demand-controlled ventilation controls that reduce air supply based on environmental factors (for example, occupancy, carbon dioxide levels or temperature) to ensure that the air supply may remain in operation throughout use of a space.
* Ventilation in bathrooms and kitchens at a workplace site or facility (provided by exhaust fans or windows) should operate during occupancy, such as business operating times and two hours before and after occupancy as a purging cycle.

### 5.2.2 Evaporative cooling

When in use, evaporative cooling systems bring in large quantities of air from outside. Some windows or doors need to be left open for these systems to circulate fresh air effectively.

When their cooling function is not required, continue to run evaporative coolers or ducted systems once or twice a day in ‘fan-only’ mode to flush rooms with fresh outside air.

It is important to note that evaporative cooling systems will only be useful during the warmer periods of the year, and are unlikely to be used during the cooler months.

Evaporative cooling systems need to be serviced regularly to make sure they are running effectively, and the filter changed regularly according to the manufacturer’s instructions.

## 5.3 Augmented ventilation

Augmented ventilation is the use of supplementary devices in addition to mechanical and/or natural ventilation to achieve an increase in clean air rates in a space and promote uniform air mixing and movement. Air recirculation and filtration devices may be used to supplement or enhance ventilation; however, they should not be used in place of other mechanical and natural ventilation strategies.

Augmented ventilation should aim to contribute to 5 or moreACH of clean air in the space to help reduce the number of viral particles in the air.

### 5.3.1 Air cleaning devices (air purifiers, air scrubbers and air filters)

An air cleaning device is a portable air circulator which draws air through a series of filters to remove particles before releasing cleaned air. Air cleaning devices can recirculate air back into a room or can be ducted to exhaust air to the outside. They can be used to increase the air exchange in a space and improve indoor air quality when used appropriately.

The use of air cleaning devices can be considered in:

* community settings and workplaces where there are low ventilation rates despite implementation of natural and mechanical ventilation; **or**
* settings with elevated risk of COVID-19 infection transmission (see section [2 COVID-19 transmission](#_1.2_Aerosol_transmission)).

Position portable air cleaning devices so that air intakes are clear of obstructions. Most air cleaning devices draw air in from the front so that you can position them near a wall or in a corner, to promote good air movement. Portable air cleaning devices should be positioned with a small amount of space around the sides and the back.

Position air cleaning devices:

* away from open doors and windows
* in areas of low movement (‘dead spots’); often in corners or the points furthest away from any door and window openings
* near HVAC supply grilles, where possible, to aid circulation of the filtered air
* to ensure that they do not create trip hazards, such as from loose cables
* to ensure that they do not obstruct entry and exit paths, such as fire exits.

Portable air cleaning devices should not be positioned near open windows or underneath extract grilles. Do not place objects on top of air cleaning devices. See below for factors to consider when purchasing and deploying portable air cleaning devices.

Table 1. Air cleaning device purchasing factors

| Factor  | Considerations and recommendations |
| --- | --- |
| Filter requirement | Air cleaners equipped with a H13 HEPA filter are recommended. Air cleaning devices with a lower grade filter may not be as efficient in removing airborne viral particles. |
| Filter maintenance | All parts of the air cleaning device will require maintenance and replacement as per the manufacturer’s instructions. Emphasis should be placed on the cleaning and maintenance of the pre-filter and HEPA filter. A HEPA-filtered vacuum cleaner should be used if the pre-filter requires manual cleaning. The effectiveness of the air purifier could be reduced if the filter is replaced with a lower quality filter.Filter changes should be undertaken outdoors where possible. Where required, appropriate Personal Protective Equipment (PPE) should be worn as per the manufacturer’s instructions. |
| Surface cleaning and disinfection | The surface of air cleaning devices should be treated as a frequently touched surface and cleaned to prevent it from becoming a source of infection. Follow the manufacturer’s instructions on how to appropriately clean device surfaces. |
| Noise levels (dB) and fan speed | Noise levels generated will depend on the fan speed and distance from the device. Each air purifier operates at a different noise level depending on the fan level.Maximum recommended air purifier noise level (dB) for different environments:

|  |  |
| --- | --- |
| Quiet for sleeping at night | 35-40 |
| Quiet areas e.g., quiet restaurants, classrooms or office | 40-45 |
| Loud office and childcare | 40-50 |
| Noisy environment e.g., café or gym | >50 |
| Loud environments | >60 |

For reference, a whisper is about 30 decibels (dB), normal conversation is about 60 dB, and a motorcycle engine running is about 95 dB.Two quieter air purifiers instead of one larger unit is an option. |
| Costs | Costs relate to outright purchase or rental, filter replacement, energy and regular maintenance. Portable air cleaners are cost-effective, flexible solutions to reduce the risk of airborne infectious disease transmission in spaces where other ventilation and filtration modifications are impossible, or where building occupants seek additional reassurance about air quality. |
| Size  | Size of the air cleaning device should be appropriate to the space it will be used in. Properly sized portable air cleaners with HEPA filters can reduce in-room concentrations of airborne particles, including those carrying viral material.It may be appropriate to use more than one air purifier in a room. |
| Electrical | Measured in Watts and Amps.Overseas models need to be checked for compatibility with the Australian standard voltage and frequency. |
| Add-ons | Additional disinfection features such as UV, air ionisations, or ozone are not required for infection prevention and control purposes.Air purifiers that use ionisers, plasma/ozone/photocatalytic oxidation/precipitators and UV technology: these are currently unproven technologies, and in some cases dangerous technologies. These technologies can significantly degrade air quality by producing ions, ozone and oxidation. This can cause irritation, trigger asthma and/or degrade materials. |

For more information on air cleaners, see the University of Melbourne [Guide to Air Cleaner Purchasing](https://sgeas.unimelb.edu.au/engage/guide-to-air-cleaner-purchasing) <https://sgeas.unimelb.edu.au/engage/guide-to-air-cleaner-purchasing>.

### 5.3.2 Split system air conditioners

Split system air conditioners (split systems) usually consist of two mechanical units: an indoor unit that provides conditioned air into a space (containing heat exchange coils, filters, fan) and an outdoor unit that transfers refrigerant to and from the indoor unit (contains the compressor, propeller fan, circuit board and heat exchange coils).

Multi-split systems have more than one indoor unit connected to a single outdoor unit. They are used to heat or cool different spaces or rooms.

Ducted split systems have a single outdoor unit connected to a concealed indoor unit, which is then ducted to a single or multiple rooms.

Split systems recirculate air and promote air movement, but usually do not bring fresh air into a space unless specified (that is, unless they are designed to include outdoor air provision). Split systems should be used in conjunction with mechanical or natural ventilation to promote air movement and to minimise pockets of stagnant air and are not a replacement for natural or mechanical ventilation.

### 5.3.3 Fans

Like split systems, electrical fans (including portable pedestal, box and fixed ceiling fan types) can circulate air in a room and promote air movement in a space, but do not provide fresh air. Air currents and movement provided by fans can encourage dilution and even distribution of particles (including viral particles) if there is a source of fresh air.

If there are existing mechanical and natural ventilation strategies in place, fans may be used to encourage even air distribution. Pedestal or portable fans should ideally be placed in dead spots or areas with poor airflow, avoiding a potential build-up of viral particles in this area. Windows and doors should remain open where possible. A fan can be placed in front of an open window (facing to the outside) to increase air flow by pushing indoor air outside.

Fans should not be used if someone in the space has respiratory symptoms that are consistent with COVID-19 or is suspected or confirmed to have COVID-19. Once the person has left the space, fans may resume operation. Fans should not be directed to blow air from one person directly onto another person.

* Avoid the use of the high-speed settings
* Use ceiling fans at low velocity
* Direct the fan discharge towards an unoccupied corner and wall spaces or up above the occupied zone
* Position portable or pedestal fans:
	+ in areas of low movement (‘dead spots’), often in corners or the points furthest away from any door and window openings
	+ in corners or dead spots to aid air circulation
	+ to ensure that they do not create trip hazards, such as from loose cables
	+ to ensure that they do not obstruct entry and exit paths, such as fire exits.

# 6. Air treatment with Germicidal Ultraviolet (GUV)

GUV can be used as a supplemental treatment to inactivate airborne viruses, such as SARS-CoV-2. GUV can be effective in many spaces, but it can be especially useful as an additional layer of protection to reduce infectious particles in indoor spaces that host large gatherings or where the risk of disease transmission is high. Historically, UV aerosol disinfection has been used in high-risk healthcare settings to prevent and control respiratory disease transmission. It may not be appropriate for most settings and should be considered a last resort.

As UV is ionising radiation, installation of UV disinfection devices requires careful consideration and extensive professional consultation for a range of factors, such as occupational health and safety, material durability and design of space.

Upper-room (or upper-air) GUV uses specially designed GUV fixtures mounted on walls or ceilings to create a treatment zone of ultraviolet (UV) energy that is focused up and away from people. These fixtures treat air as it circulates from mechanical ventilation, ceiling fans, or natural air movement. The advantage of upper-room GUV is that it treats the air closer to and above people who are in the room.

In-duct GUV systems are installed within a heating, ventilation, and air conditioning (HVAC) system. These systems are designed to serve one of two purposes:

* Coil treatment GUV keeps HVAC coils, drain pans, and wetted surfaces free of microbial growth. These devices produce low levels of UV energy. This energy is continually delivered 24 hours a day, which is why they are effective.
* Air treatment GUV systems can be effective at applying intense UV energy to inactivate airborne pathogens as they flow within the HVAC duct, however air speed must be slow enough to allow adequate exposure to UV.

HVAC air treatment GUV systems require more powerful UV lamps or a greater number of lamps, or both, to provide the necessary GUV required to inactivate pathogens in a short period of time, because air moves quickly through HVAC ducts.

Air treatment systems are often placed immediately downstream of the HVAC coils. This location keeps the coil, drain pan, and wetted surfaces free of microbial growth and treats the moving air.

# 7. Ventilation indicator devices (CO2 monitors)

Carbon dioxide (CO2) monitoring can provide information on ventilation in a space, which can be used to enhance protection against COVID-19 transmission.

Limited information exists regarding a direct link associating CO2 concentration to a risk of COVID-19 transmission. Changes in CO2 concentrations can indicate a change in room occupancy and be used to adjust the amount of outdoor air delivered. However, CO2 concentrations cannot predict who has COVID-19 infection and might be spreading the virus, the amount of airborne viral particles produced by infected people, or whether the HVAC system is effective at diluting and removing viral concentrations near their point of generation.

Ventilation based on CO2 measurements cannot recognise the increased risk of transmission when multiple room occupants are infected.

A potential target for the baseline concentrations that is used to represent good ventilation is CO2 readings below 900 parts per million (ppm). It is important to note, however, that a single concentration value may not be an appropriate target for all space types and occupancies for the purposes of assessing the ventilation rate and achieving the target does not guarantee a reduction in transmission risk.

Monitoring and remote sensing has been developed beyond CO2. Some sensors can monitor particular pollution, volatile organic compounds (VOCs), carbon monoxide, and other air contaminants. There are also options to allow information to be viewed in real time on a dashboard.

For more information on indoor CO2 recommendations, refer to

* Australian Building Codes Board [Handbook: Indoor Air Quality](https://www.abcb.gov.au/sites/default/files/resources/2021/Handbook-Indoor-Air-Quality.pdf) <https://www.abcb.gov.au/sites/default/files/resources/2021/Handbook-Indoor-Air-Quality.pdf>.
* Australian Standards [AS 1668.2](https://infostore.saiglobal.com/en-au/standards/as-1668-2-2012-120207_saig_as_as_251941/) <https://infostore.saiglobal.com/en-au/standards/as-1668-2-2012-120207\_saig\_as\_as\_251941/>.

Centres for Disease Control and Prevention (CDC) May 2023 [Ventilation in Buildings | CDC](https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html) <https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html>.

# 8. Community activities and devices that move air

The following devices and activities can create air currents or turbulence which may disperse aerosols.

**Hand and hair dryers**

These are safe to use and unlikely to contribute to the spread of COVID-19.

**Vehicle air conditioning**

When in a shared vehicle, the heating and air conditioning system should be turned to fresh air mode (not recirculated air) to bring fresh outdoor air into the car. Windows should be kept open when practical.

**Breath-testing devices**

Breathalysers are safe to operate in either active or passive modes. In passive mode, the person speaks closely into the device but does not contact it directly. In active mode, the person blows with one long continuous breath into a disposable mouthpiece attached to the device. Where possible, the active mode test should be conducted outdoors, with maximum distance between the police officer and the person blowing into the device.

The operator conducting breath testing should wear a mask.

The breathalyser mouthpiece can be disposed of into a normal rubbish bin. The police officer should perform hand hygiene after disposal of the mouthpiece. All reusable devices and equipment should be cleaned and disinfected between each use, according to the manufacturer’s instructions.

**Musical instruments**

Some instruments pose a higher risk of aerosol generation than others. Compared to the aerosols produced in normal speaking and breathing, wind instruments can be categorised as low risk (for example, tuba), intermediate risk (bassoon, piccolo, flute, clarinet, bass clarinet, and French horn) and high risk (trumpet, trombone, and oboe).

When higher risk instruments are played, they generate more respiratory particles of a smaller aerosol size compared to lower risk instruments and speaking. It is this generation of greater numbers of respiratory particles (which may contain infectious virus) that increases the risk of airborne disease transmission.

Other high-risk routes of transmission of COVID-19 when playing instruments include:

* breath condensation and saliva collection in some instruments after playing
* sharing and touching reeds.

Condensation and saliva should always be collected and disposed of hygienically. Hand hygiene should be performed before and after playing shared musical instruments, and surfaces should be cleaned between each use.

These additional measures are recommended when playing wind and brass instruments to reduce the risk of infection transmission:

* Reduce the number of people in an indoor space. This might require changed seating arrangements for different musical activities involving the use of wind and brass instruments, including orchestras, bands, or music classes.
* Increase physical distancing between the musicians. Musicians playing high-risk instruments should be two metres apart whenever practicable, and the distance between wind instrument players and other musicians should be maximised.
* Distance the audience as far as practical from brass and wind musicians.
* Maximise ventilation in enclosed spaces.
* Monitor and clean breath condensate (the ‘spit valve’) regularly. Musicians must drain this fluid, dispose of it in a rubbish bin and then perform hand hygiene.
* Do not share wind instruments unless thoroughly cleaned and disinfected between use.
* Use a barrier cap on the bell end of a brass instrument. This can significantly reduce the release of respiratory aerosols. This may be considered a mitigation method for playing in groups, especially in hard-to-ventilate spaces.

**Singing in group settings, such as choirs**

During singing, droplets and aerosols are emitted and can follow ambient airflow patterns in a space. If a person is infectious, they may transmit COVID-19. The longer the singing, the greater the risk.

Measures that may reduce the risk of infection transmission include:

* singing outside or in a well-ventilated room
* physical distancing between singers.

**E-cigarettes and vaping devices**

It is recommended that people maintain a two-metre distance from a person who is vaping or smoking. The frequent hand-to-mouth action and sharing devices with others may increase the risk of infection. Hand hygiene should be performed before and after using the device.

# Definitions

|  |  |
| --- | --- |
| Term | Definition |
| Air cleaners (portable) | An air cleaner is a portable air circulator which draws air through a series of filters to remove particles and gases before releasing purified air. Air cleaners can recirculate air back into a room or be ducted to exhaust air outside a placement area.For this document, air cleaners include air scrubbers, filtration units, air cleaning units and air purifiers. The appliances are most commonly labelled as air purifiers in Australian retail stores. |
| Clean air change rate (ACH) | The rate at which clean air volume is moved into and out of a space within an hour. This is measured in air changes per hour (ACH). |
| COVID-19 | The disease caused by SARS-CoV-2 (virus). |
| Dead spots | Areas within an enclosed space where there is very little or no air movement. This is where virus laden aerosols could remain suspended in the air for long periods of time. |
| HVAC systems | HVAC systems are conventional ventilation systems used to dilute contaminated indoor air through the introduction of fresh air from the outside while maintaining indoor air quality and thermal comfort.There are three basic components of HVAC systems:* outdoor air intake and air exhaust ducts and controls
* air handling units
* air distribution systems.
 |
| Ventilation rate | The amount of outdoor air that is introduced into a space and the quality of the outdoor air (measured in m3/hr, L/s/p or ACH). L/s/p refers to litres per second per person. |
| Whirlybird | A wind-driven turbine located on a roof to improve extraction of air from a building. |

# Further information

Centres for Disease Control and Prevention (CDC) May 2023 [Ventilation in Buildings | CDC](https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html) <<https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html>>.

World Health Organisation (WHO) [Roadmap to improve and ensure good indoor ventilation in the context of COVID-19 (who.int)](https://www.who.int/publications/i/item/9789240021280) <https://www.who.int/publications/i/item/9789240021280>.

Victorian Department of Health [Ventilation | Coronavirus Victoria](https://www.coronavirus.vic.gov.au/ventilation) <https://www.coronavirus.vic.gov.au/ventilation>.

Victorian Department of Health [COVID-19 Infection Prevention and Control Guidelines | health.vic.gov.au](https://www.health.vic.gov.au/covid-19-infection-prevention-control-guidelines) <https://www.health.vic.gov.au/covid-19-infection-control-guidelines>.

The Lancet COVID-19 Commission Task Force on Safe Work, Safe School, and Safe Travel (July 2022) The First Four Healthy Building Strategies Every Building Should Pursue to Reduce Risk from COVID.

# Appendix: Air change per hour (ACH) rates

General guidance on ACH and time required for airborne-contaminant removal is provided below. Depending on design and space configurations, a room may have areas of stagnant air flow (dead spots) where ventilation cannot be improved by increasing the ACH. It is recommended that a qualified ventilation professional is consulted to improve the ACH in these areas.

Table 3. Air changes / hour (ACH) and time required for airborne-contaminant removal by efficiency.

|  |  |  |
| --- | --- | --- |
| ACH  | Time (mins) required for removal: 99% efficiency | Time (mins) required for removal: 99.9% efficiency |
| 2 | 138 | 207 |
| 4 | 69 | 104 |
| 6+ | 46 | 69 |
| 8 | 35 | 52 |
| 10+ | 28 | 41 |
| 12+ | 23 | 35 |

Table 3 should only be used once the viral load (contamination source / infected patient) has been removed from the room.

This guidance has been adopted from the Centers for Disease Control and Prevention, Healthcare Infection Control Practices Advisory Committee (HIPAC) [Guidelines for Environmental Infection Control in Health-Care Facilities](https://www.cdc.gov/infection-control/hcp/environmental-control/recommendations.html) <https://www.cdc.gov/infection-control/hcp/environmental-control/recommendations.html>.

To receive this document in another format phone 1300 651 160 using the National Relay Service 13 36 77 if required, or email <COVID19InfectionControl@health.vic.gov.au>.

Authorised and published by the Victorian Government, 1 Treasury Place, Melbourne.

© State of Victoria, Australia, Department of Health, **June 2023.**

Available at [COVID-19: Ventilation principles and strategies to reduce aerosol transmission in community and workplace settings | health.vic.gov.au](https://www.health.vic.gov.au/covid-19-ventilation-principles-strategies-to-reduce-aerosol-transmission-community-workplace) <https://www.health.vic.gov.au/covid-19-ventilation-principles-strategies-to-reduce-aerosol-transmission-community-workplace>.