Ventilation and air conditioning during the coronavirus (COVID-19) pandemic

1. Overview

The law says employers must make sure there's an adequate supply of fresh air (ventilation) in enclosed areas of the workplace. This has not changed during the pandemic.

You should be maximising the fresh air in a space and this can be done by:

- natural ventilation which relies on passive air flow through windows, doors and air vents that can be fully or partially opened
- mechanical ventilation using fans and ducts to bring in fresh air from outside, or
- a combination of natural and mechanical ventilation, for example where mechanical ventilation relies on natural ventilation to maximise fresh air

You should consider ventilation alongside other control measures needed to reduce risks of transmission as part of making your workplace COVID-secure, such as social distancing, keeping your workplace clean and frequent handwashing.

This guidance will apply in most workplaces – it will help you and your workers:

- assess the risk from aerosol transmission in enclosed areas
- identify poorly ventilated areas
- decide on the steps you can take to improve ventilation

Why ventilation is important

Adequate ventilation reduces how much virus is in the air. It helps reduce the risk from aerosol transmission, when someone breathes in small particles (aerosols) in the air after a person with the virus has been in the same enclosed area.

The risk is greater in areas that are poorly ventilated.

Ventilation reduces the aerosol risk but has minimal impact on:

- droplet transmission (where people are within 2 metres of each other)
- contact transmission (touching surfaces)

Assessing the risk of aerosol transmission

Adequate ventilation can look different in different workplaces or settings.

You can reduce the risk of aerosol transmission by:

- making sure infected workers (or any visitors with coronavirus symptoms) do not come into the workplace
- providing adequate ventilation with fresh air
- limiting the number of people in an area
- thinking about activities that increase deeper breathing (including singing, physical exertion and shouting)
- workers spending less time in occupied areas

Deciding what adequate ventilation looks like in your workplace should be considered as part of a risk assessment.

2. Identifying poorly ventilated areas and using CO2 monitors

The priority for your risk assessment is to identify areas of your workplace that are usually
occupied, and poorly ventilated.

You should prioritise these areas for improvement to reduce the risk of aerosol transmission.

There are some simple ways to identify poorly ventilated areas:

- Look for areas where people work and where there is no mechanical ventilation or natural ventilation such as open windows, doors, or vents
- Check that mechanical systems provide outdoor air, temperature control, or both. If a system only recirculates air and has no outdoor air supply, the area is likely to be poorly ventilated
- Identify areas that feel stuffy or smell bad

Using carbon dioxide (CO2) monitors

People exhale carbon dioxide (CO2) when they breathe out. If there is a build-up of CO2 in an area it can indicate that ventilation needs improving.

Although CO2 levels are not a direct measure of possible exposure to COVID-19, checking levels using a monitor can help you identify poorly ventilated areas.

Types of CO2 monitor to use

There are many different types of CO2 monitors available. The most appropriate portable devices to use in the workplace are non-dispersive infrared (NDIR) CO2 monitors.

How to use a CO2 monitor

CO2 levels vary within an indoor space. It's best to place CO2 monitors at head height and away from windows, doors, or air supply openings.

Monitors should also be positioned at least 50cm away from people as their exhaled breath contains CO2. If your monitors are too close they may give a misleadingly high reading.

Measurements within a space can vary during the day due to changes in numbers of occupants, activities, or ventilation rates. Doors and windows being open or closed can also have an effect.

The amount of CO2 in the air is measured in parts per million (ppm). If your measurements in an occupied space seem very low (far below 400ppm) or very high (over 1500ppm), it's possible your monitor is in the wrong location and you should move it to another location in the space to get a more accurate reading.

Instantaneous or 'snapshot' CO2 readings can be misleading, so you should take several measurements throughout the day frequently enough to represent changes in use of the room or space. Then calculate an average value for the occupied period.

You may need to repeat monitoring at different times of the year as outdoor temperatures change and this will affect worker behaviour relating to opening windows and doors when your space relies on natural ventilation.

Your readings will help you decide if a space is adequately ventilated.

How to get the most accurate readings

- Check your monitor is calibrated before making CO2 measurements. Follow the manufacturer's instructions, including the appropriate warm-up time for the device to stabilise
- Know how to use your portable monitor correctly, including the time needed to provide a reading
- Take multiple measurements in occupied areas to identify a suitable sampling location to give a representative measurement for the space. In larger spaces it is likely that more than one sampling location will be required
- Take measurements at key times throughout the working day and for a minimum of one full working day to ensure your readings represent normal use and occupancy
- Record CO2 readings, number of occupants, the type of ventilation you're using at the time and the date. These numbers will help you use the CO2 records to decide if an area is poorly ventilated

How the measurements can help you take action

CO2 measurements should be used as a broad guide to ventilation within a space rather than treating them as 'safe thresholds.

Outdoor levels are around 400ppm and indoors a consistent CO2 value less than 800ppm is likely to indicate that a space is well ventilated.

An average of 1500ppm CO2 concentration over the occupied period in a space is an indicator of poor ventilation. You should take action to improve ventilation where CO2 readings are consistently higher than 1500ppm.

However, where there is continuous talking or singing, or high levels of physical activity (such as dancing, playing sport or exercising), providing ventilation sufficient to keep CO2 levels below 800ppm is recommended.

Where CO2 monitors will be less effective

CO2 monitors are not suitable for use in areas that rely on air cleaning units because these remove contaminants (such as coronavirus) from the air but do not remove CO2.

In large, open spaces and spaces with higher ceilings, such as food production halls or warehouses, you can't be sure the air is fully mixed and CO2 monitors may be less representative.

Monitors are of limited use in less populated areas. These include fitting rooms or large offices with one or two occupants.

The Scientific Advisory Group for Emergencies (SAGE) published a paper on the use of CO2 monitoring. The table below gives examples of spaces where monitors may be useful.

Although this table gives some examples, every space is different, and you need to consider whether a CO2 monitor will be appropriate for you.

Characteristics of space	**Examples**	**Suitability of CO2 monitor**
Small spaces up to 50 square metres floor area. Occupied by a consistent number of people for more than an hour	Small offices and meeting rooms	Can be used, but results should be treated carefully as concentrations can be affected by the differences between individual breathing rates.
Small spaces up to 50 square metres. Occupancy varies over short periods	Changing rooms and small retail premises	Unlikely to give reliable measurements
Mid-sized spaces of 50-320 square metres. Occupied by a consistent number of	Larger office and meeting rooms, classrooms, restaurants/bars, and some indoor sports (low aerobic activity)	Often well suited to monitoring as the higher number of occupants provides more reliable values

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Mid-sized spaces of 50-320 square metres. Occupancy varies over short periods	Larger office and meeting rooms, classrooms, restaurants/bars, and some indoor sports (low aerobic activity)	Often well suited to monitoring as the higher numbers of occupants provides more reliable values
Mid-sized spaces of 50-320 square metres. Occupancy varies over short periods	Some retail spaces	Can be used, but results should be treated carefully as concentrations may be affected by variations in occupancy levels
Large spaces over 320 square metres. Occupied by a consistent number of people for a longer period of time	Indoor concert venues, large places of worship and airport concourses	Can be appropriate for monitoring in occupied areas, but might require multiple sensors to provide meaningful measurements
Large spaces over 320 square metres. Occupancy varies over short periods	Rail concourses and shopping malls	Unlikely to give reliable measurements

Suitability of CO2 monitoring in different types of space

3. Assessment of fresh air (ventilation) in the workplace

There are a number of factors to consider when deciding on the ventilation needed in your work areas.

Consider the following questions to help you build up a picture of the risk and decide if you need to take action to reduce it.

How do you provide fresh air (ventilation) to your workplace?

Adequate ventilation reduces how much virus is in the air and therefore reduces the risk from aerosol transmission for workers in that area.

You should maximise the fresh air in an area and this can be done by:

- natural ventilation which relies on passive air flow through windows, doors and vents that can be fully or partially opened
- mechanical ventilation using fans and ducts to bring in fresh air from outside, or
- a combination of natural and mechanical ventilation, eg where mechanical ventilation relies on natural ventilation to maximise fresh air

Your workplace may have different means of providing ventilation for different areas. It may be helpful when doing your assessment to make a list of areas in your workplace and how they are ventilated. Floor or design plans may help with this.

Alternatively, you could walk around the building and make a note of each area and how it is ventilated.

Remember to include changing rooms and areas used for breaks, such as canteens. If you are not able to easily tell how an area is ventilated, it may be because it is poorly ventilated.

How many people use or occupy the area?

The more people who use or occupy an area the greater the risk that an infected person is there, increasing possible exposure to aerosol transmission. Reducing the number of people who use or occupy an area reduces this risk.

This risk increases if an area is poorly ventilated and occupied by more than one person.

Consider how many people use or occupy an area at any one time. Is there a set number of people each day or do numbers fluctuate?

How much time do people spend in the area?

The longer people use or occupy an area, the greater the risk. Consider how many people use or occupy an area for a sustained period (for example a full shift), and how many come and go throughout the day. Can you reduce this in any way?

How large is the area?

The larger the area, the lower the risk. This is because larger areas:

- have more air to help dilute the virus
- tend to be designed with higher ventilation rates
- mean it takes longer for aerosols to build up

What tasks or activities take place in the area?

Activities that make you breathe deeper, for example physical exertion or shouting, will increase generation of aerosols and increase the risk of transmission.

These activities increase transmission risk even in areas with adequate ventilation. If possible, avoid or redesign these activities to reduce the risk, for example moving activities outside or working alone where possible.

Are there any features in the workplace that affect ventilation?

You may have large machinery, equipment or other features that would prevent air circulating. This could create stagnant parts of the area so consider how to improve the flow of air in that area.

Do you use desk or ceiling fans?

Desk or ceiling fans should not be used in poorly ventilated areas.

Does your workplace use local exhaust ventilation?

Your business may use local exhaust ventilation (LEV) to control risks from other workplace hazards such as dust or welding fumes. If these discharge the air outside, they will increase ventilation in the area.

Is there a complex ventilation system?

Workplaces that may have complex ventilation systems include:

- some old buildings
- buildings with multiple floors and rooms, with different ventilation systems
- systems designed for product manufacturing reasons, which may include additional recirculation

If your workplace has a complex ventilation system, there is guidance from the Chartered Institution of Building Services Engineers (CIBSE), or you may need to get a ventilation engineer to provide expert advice on what system you need to reduce any potential transmission risks.

How will you tell your employees about the outcome of your assessment?

You should tell your workers about the outcome of the risk assessment. This will help them understand how they can play their part to reduce the risk of spreading coronavirus.

4. How to improve natural ventilation

You can improve natural ventilation by fully or partially opening windows, air vents and doors. Don’t prop fire doors open.

Buildings are designed to provide an adequate amount of ventilation and, where this is through windows and air vents, you should be able to open them. If they cannot be opened, the ventilation in that area will be affected.

If you identify an area that requires improvement, you should decide if that area should continue to be used until improvements are made.

It is important not to close windows or doors completely when people are using or occupying a naturally ventilated area. This can result in very low levels of ventilation.

Lower temperatures and windy weather conditions in the winter months will increase natural ventilation through openings. This means you don’t need to open windows and doors as wide. Look to see if trickle vents can be opened. There is more advice on balancing ventilation with keeping warm.

Purging (airing rooms)

Airing rooms as frequently as you can improves ventilation. Open all the doors and windows fully to maximise the ventilation in a room. It may be better to do this when the room is unoccupied.

Talking to your workers about improving ventilation

Making sure an area has enough fresh air through natural ventilation relies on people doing what is expected of them. You should explain the reason for adequate ventilation to workers so they can play their part in reducing the risk.

5. How to improve mechanical ventilation (including air conditioning)

Mechanical ventilation brings fresh air from outside into a building.

You should speak to the people who manage the day-to-day operations of your workplace ventilation systems to:

- understand how they operate
- make sure they're supplying fresh air into an area and how much
- make sure they're maintained in line with manufacturers' instructions

You shouldn't lower mechanical ventilation rates if the number of people reduces in an area temporarily.

You should base ventilation rates on the maximum 'normal' occupancy of an area.

Maximising fresh air

These systems will provide adequate ventilation if they are set to maximise fresh air and minimise recirculation.

If your system draws in fresh air, it can continue to operate. You need to know how much fresh air it draws in and if this provides adequate ventilation. You may need to increase the rate or supplement with natural ventilation (opening doors, windows and air vents) where possible.

You can also consider extending the operating times of mechanical ventilation systems to before and after people use work areas.

Recirculating air

It is preferable not to recirculate air from one space to another.

Recirculation units for heating and cooling that do not draw in a supply of fresh air can remain in operation provided there is a supply of outdoor air, for example windows and doors left open.

Recirculation units (including air conditioning) can mask poor ventilation as they only make an area feel more comfortable.

Find out more

More information about different ventilation systems is provided by the Chartered Institution of Building Services Engineers (CIBSE).

6. Balancing ventilation with keeping warm

Providing adequate ventilation does not mean you have to make your workplace feel cold.

There are simple steps you can take to make sure your workplace is adequately ventilated without being too cold:

- opening windows and doors partially can still provide acceptable ventilation while keeping the workplace comfortable. Opening higher-level windows will probably create fewer draughts.
- if the area is cold you could relax dress codes so people can wear extra layers and warmer clothing
- you can only use fan convector heaters if the area is well ventilated

In this sway natural ventilation can be used alongside heating systems to maintain a reasonable temperature in the workplace.

7. Air cleaning and filtration units

You can use local air cleaning and filtration units to reduce airborne transmission of aerosols where it is not possible to maintain adequate ventilation.

These units are not a substitute for ventilation. You should prioritise any areas identified as poorly ventilated for improvement in other ways before you think about using an air cleaning device.

If you decide to use an air cleaning unit, the most suitable types to use are:

- high-efficiency filters
- ultraviolet-based devices.

Any unit should be appropriate for the size of the area they're used in to ensure they work in the way they are intended to.

Carbon dioxide (CO_2) detectors are not suitable for use in areas that rely on air cleaning units. This is because filtration units remove contaminants (such as coronavirus) from the air but do not remove CO_2.

Air cleaning devices are also used to disinfect workplaces and there is HSE guidance on disinfecting using fog, mist and other systems during the pandemic.