

COVID Response

November 2021

Guidance on use of Carbon Dioxide CO₂ monitors for assessing ventilation

Occupational Health and Safety Service
HSD215M (rev 1)



UNIVERSITY OF
CAMBRIDGE

Contents

1. Introduction
2. Identification of poorly ventilated spaces
3. Assessment of space to ensure that it is suitable for Carbon Dioxide (CO₂) monitoring
 - 3.1 Ensure the space is suitable for monitoring
 - 3.2 Where CO₂ monitors will be less effective
 - 3.3 Hazardous levels of CO₂
4. Using CO₂ monitors
 - 4.1 How monitors work
 - 4.2 Suitable monitors
 - 4.3 Positioning of monitors
 - 4.4 Number of monitors
 - 4.5 Number of readings required
 - 4.6 Log readings
 - 4.7 Interpretation of readings
5. Next steps
6. Suppliers

References

Appendices

1. Monitor log
2. Action log

Document control

Version	Date	Changes made
HSD215Mrev1	26/11/21	Section 6 changes made to flame fast monitor ordering information

1. Introduction

Good ventilation within buildings is essential in minimising the spread of airborne infectious disease. The Health and Safety Executive (HSE) issued guidance [1] on the 31 July 2021 which explains how CO₂ monitors can be used to check areas identified as poorly ventilated, to give a measured assessment of the reality of the risk of disease transmission from exhaled aerosol.

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 and other airborne respiratory diseases, checking levels of CO₂ will indicate areas where exhaled air has accumulated, which, if an infected individual has been present will contain aerosol. Inhalation of this aerosol increases risk of disease transmission.

This guidance explains how to use CO₂ monitors to confirm if a space is poorly ventilated, how monitors can be used to dynamically monitor ventilation rates in such spaces, and how to consider if permanent installation is necessary. **Monitors are not needed in all indoor spaces, only those who have been identified as poorly ventilated and are therefore higher risk.**

1. Identify poorly ventilated spaces

2.1 [HSD211M Ventilation risk assessment tool](#)

Throughout the COVID Pandemic, University Departments were advised to complete an assessment on ventilation within their internal spaces using this guidance document. Any assessment using this tool which has a Red rag rating (all versions) indicates that rooms/spaces may be poorly ventilated. It is also recommend, that any amber rated spaces/rooms with high occupancy density, be monitored.

2.2 Characteristics of poorly ventilated spaces. - There are some simple ways to identify poorly ventilated areas without using the tool:

- 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.

If you have identified poorly ventilated spaces then move on to part 3 of this guidance

2. Assessment the space to ensure that it is suitable for CO₂ monitoring

3.1 Ensure the space is suitable for monitoring.

Once a poorly ventilated space is identified, the space should be assessed, to see if it is suitable for monitoring. CO₂ monitors are a useful monitoring tool but only when located in suitable spaces. Check table 1 to see if the space would be suitable for monitoring before deciding to use this method. The table gives examples, but every space is different, and you need to consider whether a CO₂ monitor will be appropriate for your space.

Table 1 HSE description of suitable locations for CO₂ monitors (examples adapted to suit the University setting)

Characteristics of space	Examples	Suitability of CO ₂ monitor
Well suited		
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.
Mid-sized spaces of 50-320 square metres. Occupied by a consistent number of people for more than an hour	Larger office and meeting rooms, teaching spaces, restaurants/bars, and some indoor sports (low aerobic activity)	Often well suited to monitoring as the higher number of occupants provides more reliable values
Mid-sized spaces of 50-320 square metres. Occupancy varies over short periods	Larger office and meeting rooms, teaching spaces, restaurants/bars, and some indoor sports (low aerobic activity)	Often well suited to monitoring as the higher numbers of occupants provides more reliable values
Can be used with careful consideration		
Mid-sized spaces of 50-320 square metres. Occupancy varies over short periods	Break out areas/staff rooms	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	Lecture theatres, large seminar rooms	Can be appropriate for monitoring in occupied areas, but might require multiple sensors to provide meaningful measurements
Unlikely to give reliable results		
Small spaces up to 50 square metres. Occupancy varies over short periods	Changing rooms, toilet facilities, small retail e.g. museum shop	Unlikely to give reliable measurements
Large spaces over 320 square metres. Occupancy varies over short periods	Large foyers or atriums, sports halls	Unlikely to give reliable measurements

3.2 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, where you cannot 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 changing rooms/toilets or large offices with one or two occupants.

3.3 Hazardous levels of CO₂

CO₂ is a hazardous substance and in very high levels can be harmful to health. HSE guidance EH40* sets levels of such substances and gives workplace exposure limits (WELS). WELS are set as either exposure over 8hrs or 15 minutes as a time weighted average (TWA). These are set out in table 2

Table 2 - CO₂ WELS

	8hr WEL (PPM)	15 minute WEL (PPM)
CO ₂	5000	15000

The levels of CO₂ being measured by ventilation monitors are significantly below from these exposure limits. Levels of CO₂ detected (Maximum 2000 PPM) will not cause harm or have detrimental health effects to occupants they **only indicate poor ventilation**. Ensure that if you use them that the distinction is made in all communication as we would not want them to cause undue alarm or panic. Even when a monitor displays a high level of CO₂ there is no need to evacuate a space, but ventilation should be immediately increased. In spaces where this is not possible, finish the work being carried out and then minimise room use until the monitor returns to green.

4. Using CO₂ monitors

4.1 How monitors work

The amount of CO₂ in the air is measured in parts per million (ppm). Monitors take these measurements over time using the PPM levels. Table 3 illustrates levels of where action will be necessary.

Table 3 - Monitoring levels of CO₂ for ventilations – Action levels

	Green (Acceptable -no additional measures needed-) CO ₂ PPM	Amber (additional control measures will be needed) CO ₂ PPM	Red (restricted measures will be needed) CO ₂ PPM
High occupancy and normal usage e.g. non aerobic/sitting/talking	<800	801-1500	1501-2000

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.

4.2 Suitable monitors

There are many different CO₂ monitors on the market and it is important that you carefully choose a monitor that is suitable for the space. Ensure that any monitor you choose is a non-dispersive infrared (NDIR) CO₂ monitor. It is useful for the monitor to have a logging function so that results can be compared to space usage. We would also recommend models with a colour coded display function, which changes as levels of CO₂ change and actions need to be taken to improve ventilation.

The University Safety Office have tested a number of models and for the majority of spaces, have concluded that the Flamefast V2 model will be suitable (see suppliers below, page 8).

4.3 Positioning of monitors

Monitors should be placed in a suitable location for monitoring to be effective. Monitors should always be used in accordance with manufacturer's instructions and usually placed -

- 1.5m from the floor so that they are closer to head height
- 1m away from doors and windows to prevent draughts affecting readings
- 1m away from occupants or CO₂ will be captured directly from their exhaled breath
- Away from direct sunlight as heat may have impact on the effectiveness

4.4 Number of monitors

In larger spaces, it may be necessary to have multiple units to ensure that any fluctuations of levels can be detected across the space. It may be useful to identify areas where air may linger such as alcoves or confined areas and place a monitor in these. Ensure you follow manufacturer's advice for maximum detection areas and use enough units to cover the space.

4.5 Number of readings required

Best results will be achieved monitoring over one to two days, and will ensure you identify how varying factors affect readings. Any decisions should be based on a breadth of readings from the varying scenarios in the space – ensure you take readings considering the following;

- Number of occupants in the space
- Natural ventilation -windows – how many are open? The location of the windows, amount opened and combinations of those opened.
- Mechanical ventilation – assess different settings and levels of fresh/recycled air feed if possible.
- Time of year – outdoor/indoor temperature differences will change ventilation rates.
- Monitor location – ensure that all monitors are installed to manufacturer's instructions, trial different positions to see how this affects readings.
- Where spaces have multiple uses/activities, ensure that you test the space for each activity. For example where some involves aerobic activity e.g. gym, aerosol generation will increase.

4.6 Log readings

Some monitors will log PPM readings over time and create a log. In addition to this information, you will also need to log how the room is used at these times to see what human activity or ventilation used has caused PPM levels to rise and fall. Use log sheets in Appendix 1.

4.7 Interpretation of readings

Table 3 illustrates where readings may need further action.

If you have an amber or red alert (where possible) change ventilation factors in the space until you reach a good level of ventilation (>800PPM). In addition to these action levels always follow manufacturer's guidance. Log the readings and actions you have taken and the length of time it takes to resolve on the log sheet Appendix 2. Try a number of actions to see what is the most effective.

Examples of actions (not all will be possible in each space)

- Open windows/doors – vary numbers and distance opened
- Open windows on either side of a space to increase cross ventilation
- Open windows at varying heights, having a high and low opening will enhance ventilation.
- Increase the amount of fresh air intake in mechanical ventilation systems
- Increase the number of air changes per hour in mechanical systems
- Decrease number of room occupants
- Decrease duration of use of the space

5 Next steps

- **Communicate room ventilation needs to occupants**

Instruct room occupants of the amount and type of ventilation needed for each space. Signage should be placed on the door or instructions given via internal communications. Signs should include which windows need to be opened/settings on ventilations are needed and for what length of time/frequency, and should include the maximum occupancy levels for the ventilation to remain effective.

- **Restrict usage**

In rooms where no additional ventilation can be implemented, you can continue to use as a single occupancy space.

- **Get additional support with mechanical ventilation or window maintenance**

For any high risk spaces where you think mechanical ventilation/windows may need maintenance or where you would like more information on the system and how it works, a request can be put into the Estates Facilities helpdesk 01223 (3)37784 efhelpdesk@admin.cam.ac.uk

- **Permanent installation of monitors – long term reactive monitoring**

In spaces where amber/red alerts are frequent and the space has a good flexible ventilation method e.g. an openable window, you should consider installing a monitor permanently.

It is recommended, that in these cases a monitor be used with an easy to read colour display. Instruct space users to increase ventilation each time an amber light is displayed. Ventilation can then be reduced once the display returns to green.

Permanent installation will also be of benefit during colder months, as room occupants will be able to only open windows when necessary. This will benefit their own comfort and help increase energy conservation.

6 Suppliers

Flamefast - CO2 monitor vision [Flamefast Gas Safety \(flamefast-gas-safety.co.uk\)](http://flamefast-gas-safety.co.uk)

Contacts john@flamefast.co.uk Selina.foster@flamefast.co.uk

These monitors are recommended for initial assessment and may be useful in the longer term for rooms that have good flexible ventilation methods. They have a coloured alert system and can log readings over time.

- Unit cost £80.00 (excl. VAT) (discounted price agreed for the University by the Safety Office, ensure this is mentioned when ordering)
- The University have a central account with Flamefast you do not need to set up a Departmental account. (account ref is – UNICAM1) requests should be
- All invoices should be sent to-
University of Cambridge Shared Services
Finance Division
Greenwich House
Maddingley Road
Cambridge
CB30TX
sharedservicesfinance@admin.cam.ac.uk

Departments should raise a Purchase Order for each purchase clearly stating their Department.

For more permanent installations the Safety Office does have **alternative suppliers**, [please contact for further details](#) or to discuss any other queries you have regarding monitoring.

References

1. [HSE Publications EH40](#)
2. [HSD211M Ventilation Risk assessment tool](#)

Appendix 1 Monitor log

Department				
Room				
Completed by (insert name				
Time of room use (Insert times across the day at 1-2 hourly intervals when occupied -start to finish)	Occupancy level -	Activity	Ventilation in use e.g. mechanical ventilation, number of windows	PPM level detected

Appendix 2 Action log

Room			
Occupancy level			
PPM Level (when concern arose)	Action taken	Time of action	Time when returned to <800 PPM



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