

June 2022

ADVISORY ON CO₂ MONITORING TO ASSESS VENTILATION ADEQUACY

1. Introduction

- 1.1 This Advisory Note guides premises managers on how carbon dioxide (CO₂) monitoring can be used as a proxy for ventilation adequacy, so that premises managers can take timely mitigating measures when ventilation is poor (when CO₂ levels are above 800ppm). Measures to improve ventilation in indoor spaces can be found in the [Guidance Note on Improving Ventilation and Indoor Air Quality in Buildings amid the COVID-19 Situation](#).

2. Prioritisation of premises for CO₂ monitoring and ventilation improvements

- 2.1 As Singapore transitions to COVID-19 endemicity, premises managers should take active steps to ensure good ventilation, especially in enclosed, air-conditioned indoor environments. Good ventilation reduces the amount of virus aerosols and other indoor air pollutants that could be present. This will help mitigate the risk of aerosol-based transmission to protect the health of occupants, workers and general public in these premises. Measures to improve ventilation will also enhance our resilience against new COVID-19 variants of concern and future airborne infectious disease threats.
- 2.2 Ensuring good ventilation is critical in premises with higher risk of aerosol transmission, due to risk factors such as mask-off or bioaerosol-generating activities, prolonged time duration spent by occupants within the space, and/or the presence of vulnerable populations. A list of such higher risk premises is shown below. Managers of such premises should proactively ensure that these premises are always well-ventilated.

List of premises with higher risk of aerosol transmission and/or presence of vulnerable group

- Hospitals and clinics
- Eldercare facilities, including nursing homes and day activity centres
- Establishments with food and drinks served on-site*
- Gyms and fitness studios

*Include food establishments, event venues, function rooms, nightlife establishments, karaoke establishments etc.

- 2.3 CO₂ monitoring can be used as a quick, easy-to-implement proxy for ventilation adequacy, and to identify pockets of under-ventilated spaces or overcrowding within the premises. High CO₂ levels imply that there is insufficient outdoor air intake and/or overcrowding, and measures should be taken to improve

ventilation or reduce occupancy. Managers of higher risk premises should carry out CO₂ monitoring regularly and take prompt action to improve ventilation, where necessary.

- 2.4 For more information, please refer to appended Guide to Premises Managers on CO₂ Monitoring.

GUIDE TO PREMISES MANAGERS ON CO₂ MONITORING

What to Use?

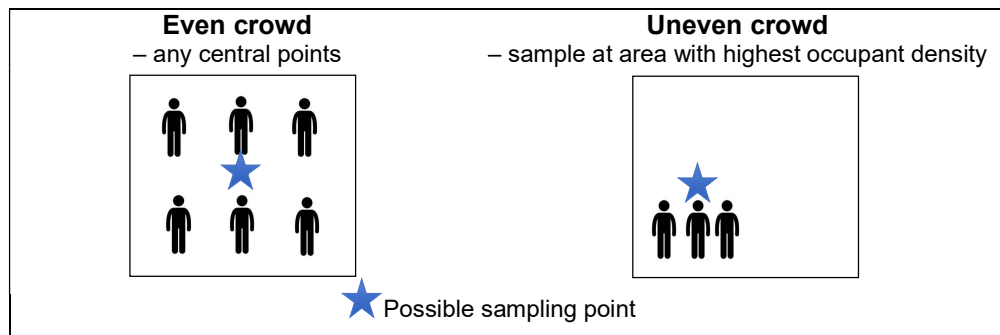
- Use a non-dispersive infrared (NDIR) portable CO₂ meter or install CO₂ monitors (NDIR) with real-time display, depending on your operational needs.



[Note: Refer to Annex for recommended specifications of CO₂ meters]

Where to Measure?

- Measure at spaces with highest occupant density.
- Place CO₂ meters between 75cm and 120cm from the floor and as close as possible to the occupants' breathing zone level, away from windows, doors or supply air vent where practicable.
- Position CO₂ meters at least 0.5m away from any human occupant where practicable, as exhaled breath contains CO₂, which may influence the readings and give rise to misleading measurement.
- To better identify locations with poorer air flow, take measurement from multiple locations within the space.



How to Measure?

- Measure CO₂ levels over a period of 5 min per sampling location.
- The average CO₂ level over the measurement period serves as a quick assessment of ventilation adequacy.
- Take measurements during peak occupancy, or at timings that are deemed to be representative of the premises' activity. Instantaneous or 'snapshot' readings can be misleading, so several measurements should be taken throughout the day. The frequency of measurements should be sufficient to ensure that changes in the use of the space throughout the day are represented in the readings.

Note: Some CO₂ meters can auto-calculate and display the average CO₂ reading over measurement period

What do the Numbers Mean?



It is recommended to keep the CO₂ levels below 800 ppm over the measurement period in enclosed air-conditioned spaces. If the CO₂ levels are above 800ppm¹, premises managers should assess the situation and take the necessary measures to improve ventilation.

Note: While high CO₂ levels indicate poor ventilation and/or overcrowding, CO₂ levels are not directly correlated to risk of exposure to virus. Good ventilation and existing measures (masks, cleaning) are still needed, even if CO₂ levels are within the recommended limits.

Next Steps

- Taking CO₂ measurements can help to identify poorly ventilated spaces in the indoor environment.
- You may refer to the latest [Guidance Note](#), published by BCA, NEA and MOH, for recommended measures to improve ventilation in your premises. Common ways include opening operable windows and doors, operating exhaust fans (e.g. in toilets, kitchens) at full capacity, or adding dedicated outdoor air supply/exhaust.
- If you are unable to improve ventilation due to site constraints and the CO₂ readings are consistently above 800ppm, consider installing portable air cleaners with high-efficiency air filters such as HEPA filters, which can help to remove virus aerosols. You may refer to [Technical Advisory on Use of Air-Cleaning Technologies to Mitigate COVID-19 Aerosol Transmission Risk](#) and [List of Portable Air Cleaners Against COVID-19 Virus Aerosols](#) for more information.

Note: Localised air cleaning will not improve ventilation in indoor space but can help to reduce spread of diseases by removing virus aerosols.

¹ The indoor CO₂ levels should ideally not exceed 800 ppm in the context of COVID-19, and under no circumstance should they exceed the SS554:2016 (Singapore Standard SS554: 2016 Code of Practice for Indoor Air Quality for Air-Conditioned Buildings) recommended limit of not more than 700 ppm in excess of outdoor levels, which is approximately 1,100 ppm.

ANNEX

(1) Recommended Specifications for CO₂ Meters

- ✓ Non-dispersive infrared (NDIR)
- ✓ Able to measure between 300 to 3,000ppm or more
- ✓ Logging frequency of at least once every minute
- ✓ Accuracy of not more than ± 50 ppm or $\pm 5\%$ (measured within the specified measurement range)
- ✓ Resolution of 10ppm or less
- ✓ Can be calibrated
- ✓ [Good to have] Provide average readings based on selected measurement duration

(2) References

(A) Guidance Note on Improving Ventilation and Indoor Air Quality in Buildings amid the COVID-19 Situation	
https://go.gov.sg/bca-nea-moh-guidance-improve-ventilation	
(B) Technical Advisory on Use of Air-Cleaning Technologies to Mitigate COVID-19 Aerosol Transmission Risk	
https://go.gov.sg/aircleaning-advisory	
(C) List of Portable Air Cleaners Against COVID-19 Virus Aerosols	
https://go.gov.sg/list-of-portable-air-cleaners-covid-19	

