



Shaping Tomorrow's  
Built Environment Today

## INDOOR CARBON DIOXIDE, VENTILATION AND INDOOR AIR QUALITY

### THE ISSUE

Indoor CO<sub>2</sub> has been considered in the context of building ventilation and indoor air quality (IAQ) for centuries. Most of these discussions have focused on how CO<sub>2</sub> concentrations relate to occupant perceptions of IAQ, and the use of CO<sub>2</sub> to evaluate ventilation rates. While these topics have been studied for decades, misinterpretation of CO<sub>2</sub> concentration as an indicator of IAQ and ventilation is common in the HVAC industry, IAQ research community, and the public.

In addition, recent research has studied the impacts of CO<sub>2</sub> on human performance at commonly observed indoor concentrations. Indoor CO<sub>2</sub> monitoring has also been promoted as a ventilation indicator in the context of managing the risks of airborne disease transmission. Also, concerns have long existed regarding the accuracy of indoor CO<sub>2</sub> concentration measurements, which are now more common due to the availability and more widespread application of less expensive sensors. Given all of these factors, as well as increasing calls to monitor CO<sub>2</sub> in buildings, ASHRAE is working to clarify the use of indoor CO<sub>2</sub> measurements as a tool to help improve IAQ and building ventilation.

### ASHRAE's ROLE

ASHRAE has long been active in providing engineering technology, standards and design guidance to support the goal of providing healthy and comfortable indoor environments in an energy-efficient manner. For decades, these efforts have focused on providing effective ventilation in buildings, designing and operating ventilation systems and managing the wide range of air pollutants within buildings. For example, ANSI/ASHRAE Standards 62.1 and 62.2 are standards that specify minimum ventilation rates and other measures to support the health, comfort and productivity of building occupants; these standards do not include CO<sub>2</sub> limits.

### ASHRAE's VIEW

Monitoring indoor CO<sub>2</sub> can be a useful tool for understanding building ventilation and IAQ, supporting efforts to provide high quality indoor environments and manage the energy needed to do so. Critically, indoor CO<sub>2</sub> measurements should be understood in the context of the built environment, to ensure that they are measured and interpreted in a meaningful way. Claims that ASHRAE Standard 62.1 requires indoor CO<sub>2</sub> concentrations below a certain threshold (typically 1000 ppm) for acceptable indoor air quality are *incorrect*<sup>1</sup>. ASHRAE's IAQ Standards do not use indoor CO<sub>2</sub> values to determine acceptable indoor air quality, as IAQ is impacted by multiple factors (such as temperature, humidity, particulate matter, gas pollutants, etc.).

Because of ASHRAE's mission to act for the benefit of the public, it encourages building designers, lawmakers, policymakers and others to craft informed recommendations for the measurement of indoor CO<sub>2</sub> concentrations. To that end, ASHRAE stresses that:

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<sup>1</sup> Persily, A. 2022. *Development and application of an indoor carbon dioxide metric*. Indoor Air. Volume 32, Issue 7.

- Indoor CO<sub>2</sub> concentrations do not provide an overall indication of IAQ, but they can be a useful tool in IAQ assessments if users understand the limitations in these applications (e.g., number and activity level of occupants compared to the design capacity, length of time a space has been occupied, no combustion or other sources of CO<sub>2</sub> that could impact readings). While CO<sub>2</sub> readings below a threshold value do not assure overall acceptable IAQ, CO<sub>2</sub> readings far above expected ranges<sup>2</sup> may indicate the ventilation system is not functioning properly.
- Existing evidence for the impacts of CO<sub>2</sub> on health, well-being, learning outcomes and work performance is inconsistent and does not currently justify changes to ventilation and IAQ standards, regulations, and guidelines.<sup>3</sup> However, CO<sub>2</sub> can be used to verify if ventilation system performance meets existing IAQ standards, regulations, and guidelines.
- The use of indoor CO<sub>2</sub> measurements to evaluate the risk of airborne disease transmission must account for the type of space and its occupancy and the differences in CO<sub>2</sub> and infectious aerosols. For example, CO<sub>2</sub> concentration is unaffected by filtration and most other air-cleaning methods that reduce infectious aerosol concentration, so it should not be used as a *direct* indicator of infection risk.
- Sensor accuracy, location and calibration are all critical for drawing meaningful inferences from measured indoor CO<sub>2</sub> concentrations.
- Programs or requirements to monitor CO<sub>2</sub> in buildings, when conducted with an understanding of their technical basis, can be helpful, but monitoring CO<sub>2</sub> without such understanding can lead to confusion on the part of building occupants and the public.

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<sup>2</sup> *Ibid.*

<sup>3</sup> In a 2010 study by J.M. Logue, T.E. McKone, M.H. Sherman, and B.C. Singer of the Berkeley National Laboratory titled, Hazard Assessment of Chemical Air Contaminants Measured in Residents, fifteen pollutants were identified as contaminants of concern for chronic health effects in a large fraction of homes. Nine pollutants were identified as priority hazards: acetaldehyde; acrolein; benzene; 1,3-butadiene; 1,4-dichlorobenzene; formaldehyde; naphthalene; nitrogen dioxide; and PM<sub>2.5</sub>. Activity-based emissions are shown to pose potential acute health hazards for PM<sub>2.5</sub>, formaldehyde, CO, chloroform, and NO<sub>2</sub>.