

# ASHRAE Indoor Carbon Dioxide Position Document: What's Next?

Andrew Persily

*National Institute of Standards and Technology  
100 Bureau Drive  
Gaithersburg, Maryland USA  
\*andyp@nist.gov*

## SUMMARY

ASHRAE's 2022 publication of a new position document on indoor carbon dioxide (CO<sub>2</sub>) has been a significant contribution to ongoing discussions of how indoor CO<sub>2</sub> can be used to understand ventilation and indoor air quality (IAQ). The position document clarifies what is known about the relationship between CO<sub>2</sub> concentrations and ventilation rates, the effects of CO<sub>2</sub> on building occupants, and how CO<sub>2</sub> concentrations relate to airborne infectious disease transmission. While the position document is a key step to addressing ongoing debate and occasional misunderstanding about indoor CO<sub>2</sub>, this summary speaks to additional efforts that are needed to further resolve these matters and advance the application of indoor CO<sub>2</sub> measurements and analyses in understanding and characterizing IAQ. This paper proposes a number of follow-up activities and research topics that should be addressed, which can then be considered in the next version of the position document and help to advance the application of indoor CO<sub>2</sub> measurements and analyses.

**KEYWORDS:** carbon dioxide, guidance, indoor air quality, research, ventilation

## 1 BACKGROUND

Indoor CO<sub>2</sub> has been considered in the context of building ventilation and IAQ for centuries. While the relationships between indoor CO<sub>2</sub>, ventilation and IAQ have been studied for decades, misinterpretation and misapplication of CO<sub>2</sub> as an indicator of IAQ and ventilation is still too common. Moreover, a variety of organizations and government bodies have issued standards and regulations for indoor CO<sub>2</sub> concentrations in workplaces, and CO<sub>2</sub> sensors have become less expensive and more widely deployed. Indoor CO<sub>2</sub> monitoring has also been promoted as a ventilation indicator to help manage the risks of airborne disease transmission. Finally, many recent research activities have been directed towards examining the impacts of CO<sub>2</sub> on human cognitive performance at commonly observed indoor concentrations that were previously thought not to be of concern.

These factors motivated the development of the ASHRAE Position Document on Indoor Carbon Dioxide, which was approved in early 2022 and is available for free [download](#). The document discusses the following topics: i. the history of indoor CO<sub>2</sub> concentrations in the context of ventilation and IAQ, ii. health and cognitive impacts of exposure to CO<sub>2</sub>, iii. existing standards and regulations for indoor CO<sub>2</sub> concentrations, iv. CO<sub>2</sub> as an indicator of IAQ and ventilation, v. use of CO<sub>2</sub> as a tracer gas for estimating ventilation rates, vi. increases in outdoor CO<sub>2</sub> concentrations, vii. air cleaning directed at CO<sub>2</sub> removal alone, and viii. CO<sub>2</sub> as an indicator of the risk of airborne disease transmission.

The Position Document states the following positions, paraphrased for this summary:

- Indoor CO<sub>2</sub> concentrations, although useful, do not provide an overall indication of IAQ.
- Existing evidence for impacts of CO<sub>2</sub> on health, comfort, and performance is inconsistent and does not justify changes to ventilation and IAQ standards.
- Using indoor CO<sub>2</sub> to assess airborne disease transmission must account for the definition of acceptable risk, space type, and differences between CO<sub>2</sub> and infectious aerosols.
- Differences between indoor and outdoor CO<sub>2</sub> concentrations can be used to evaluate ventilation rates and air distribution using established tracer gas measurement methods.
- Sensor accuracy, location, and calibration are critical for interpreting CO<sub>2</sub> concentrations.
- Air cleaning that removes only CO<sub>2</sub> will not necessarily improve overall IAQ.

The Position Document also recommends research in several areas and the development of guidance on indoor CO<sub>2</sub> measurement and application.

## **2 AREAS MERITING FOLLOW-ON EFFORTS**

This section summarizes some key activities to pursue based on the Position Document:

- Detailed and practical guidance is needed on how to measure and interpret indoor CO<sub>2</sub> concentrations. This guidance needs to cover sensor performance and location in a range of building spaces, reflecting differences in how they are ventilated and their occupancy schedules. This guidance also needs to address sensor calibration, data interpretation and the information that needs to be reported in conjunction with measured concentration data, e.g., ventilation system design information, occupant characteristics and schedule, sensor type and accuracy, and measured outdoor concentrations.
- Given the inconsistent results to date and the controversy regarding how CO<sub>2</sub> exposure at typical indoor levels affects humans, research is needed on CO<sub>2</sub> impacts on the health, comfort, work, learning, and sleep quality of building occupants. This research needs to include investigations of physiological mechanisms for any observed effects.
- Many applications of indoor CO<sub>2</sub> require values for the CO<sub>2</sub> generation rates from building occupants. While methods to estimate these generation rates have improved, the uncertainty of these estimations are not known. Also, they require values for the level of physical activity (met), and improved guidance on the selection of met rates for different spaces and activities is needed, which may require additional research and analysis.
- There has been a longstanding desire for reliable and comprehensive IAQ metrics. While there has been progress in the development of such metrics, additional research is needed on metrics that capture the wide range of indoor air pollutants of interest, including CO<sub>2</sub>.
- The prominence of indoor CO<sub>2</sub> measurement and analysis in light of the COVID-19 pandemic highlights the need for additional research and guidance on the relationship between indoor CO<sub>2</sub> concentrations and infection risk. These efforts need to distinguish between using CO<sub>2</sub> to judge ventilation adequacy and to quantify infection risk.

## **3 CONCLUSIONS**

The ASHRAE Indoor CO<sub>2</sub> Position Document will be considered for re-approval or revision in 2025. Progress on the identified activities and others will improve the next published version of the document.