Understanding CO_2 and ASHRAE 62

A Technical Note

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ABSTRACT

Involvement in the indoor air quality assessment of buildings brings with it the responsibility of providing accurate information to the building owner. One of the most misunderstood and misused statements found in reports often refers to ASHRAE Standard 62 and typically states "CO_2 measurements found in this building are in excess of the maximum concentration of 1,000 ppm recommended in ASHRAE Standard 62."

Like many others, I purchased the referenced ASHRAE Standard and was also guilty of listing the 1,000-ppm maximum in my early reports. This was mainly because it was "company policy" and it was one of the measurements we checked during building surveys.

Then something happened. I read the standard. Not just skimming through it or reading so I could attest that I had "read the standard." I mean *reading* to understand its intent. It was during this process that I realized that almost everyone, myself included, was citing the CO_2 portion of the standard incorrectly.

Although ASHRAE Standard 62-1999 is presently available, ANSI/ASHRAE Standard 62-1989 will be used as the source document most everyone references and possesses.

What are some facts about CO_2 and ASHRAE 62?

1. The American National Standards Institute (ANSI) approved ASHRAE Standard 62 on May 16, 1991. ANSI/ASHRAE Addendum 62a-1990 was approved on May 17, 1990, making this an American National Standard titled "Ventilation for Acceptable Indoor Air Quality." By developing into an ANSI Standard, it has become a recognized standard of care.

2. Table 3 "Guidelines for Selected Air Contaminants of Indoor Origin" lists the concentration of CO_2 at 1.8 g/cm^3 (1,000 ppm) and notes **"This level is not considered a health risk but is a surrogate for human comfort (odor). See Section 6.1.3 and Appendix D."**

3. Table C-1 "Standards Applicable in the United States for Common Indoor Air Pollutants," Table C-2 "Guidelines Used in the United States for Common Indoor Air Pollutants," and Table 1 "National Primary Ambient-Air Quality Standards for Outdoor Air" as set by the U.S. Environmental Protection Agency (EPA) do not list CO_2 as a pollutant.

4. Table 3-C "Summary of Canadian Guidelines for Residential Indoor Air Quality" does not list a short-term exposure range for CO_2. The long-term "acceptable" exposure range for CO_2 is < 3,500 ppm.

5. Table 4-C "WHO (World Health Organization) Working Group Consensus of Concern About Indoor Air Pollutants at 1984 Levels of Knowledge" lists CO_2 concentrations of limited or no concern at <1,800 mg/m3 (approximately 1,000 ppm) and concentrations of concern >12,000 mg/m3 (approximately 6,667 ppm).

So what's the problem? ASHRAE states in Table 3, Section 6.1.3 and Appendix D a maximum of 1,000-ppm CO_2, right? I guess the answer is "sort of." The footnote in Table 3 says the 1,000-ppm level is not considered a health risk but a comfort concern (odor) and is further explained in section 6.1.3 that states—"(Appendix D shows the outdoor air needed to control occupant-generated CO_2 under various conditions.)" It later reads—"Comfort (odor) criteria are likely to be satisfied if the ventilation rate is set so that 1,000 ppm CO_2 is not exceeded."

The real explanation and insight of CO_2 and its relationship to the ventilation requirements of the standard are found in Appendix D. It is appropriately titled "Rationale for Minimum Physiological Requirements for Respiration Air Based on CO_2 Concentration." Understanding this appendix will help you comprehend the rationale used to determine the ventilation rates in Table 2. The example given uses a CO_2 generation rate of 0.30 L/min. for a person with an activity level of 1.2-met units. (Note: This activity level would be characteristic of an office, lab, school, or residential environment). In order to find the outdoor flow rate per person we need to

divide the CO_2 generation rate per person, at the appropriate activity level, by the *difference* between the CO_2 concentration in the space and the CO_2 concentration in the outdoor air. Continuing with their example, using the generation rate of 0.30 L/min., an indoor concentration of 1,000 ppm (.001) and an outdoor concentration of 300 ppm (.0003) we conclude the following: $0.30/[.0007 \times 60] = 7.143$ L/s. To convert liters/sec to cubic feet per minute (cfm) we divide 7.143 L/s by 0.4720 to get 15.134 cfm per person. From this we can see that a differential of 700 ppm between the indoor and outdoor concentration of CO_2 is equal to an outdoor ventilation rate of approximately 15-cfm per person.

Now that we understand the method, we can see 1,000 ppm has no real bearing on the ventilation rate, it was just used in the example. We also know the differential between the indoor and outdoor concentrations can be related to the per person outdoor ventilation rate. The following chart summarizes the outcome.

Approximate cfm/person	CO_2 Differential
15	707
20	530
25	424
30	353

If you used or are using the 1,000-ppm as the limit to establish ventilation rates, you are not complying with the standard. In fact, you may be under- or over-ventilating the building. The range of outdoor CO_2 concentration levels typically experienced in the South Florida area is between 350 and 450 ppm. Using an average of 400 ppm, occupied spaces with a 15-cfm/person requirement may be over ventilated by approximately 17 percent, while those with a 20-cfm/person requirement may be under ventilated by approximately 12 percent, when compared to 1,000 ppm level.

SPECIAL NOTE TO READERS

ANSI/ASHRAE Standard 62 is one of five standards under ASHRAE's continuous maintenance. Under continuous maintenance procedures, anyone, including project committee members, may propose

changes at any time. Each change will be considered by the project committee, according to a definite schedule (deadlines are February 20th and September 20th) to be considered at the annual and winter meetings respectively.

It is imperative that one stay abreast of the current standards activity and be ready to adapt to change.

For additional information please see addendum 62f, interpretation IC 62-1989-27 and ASHRAE 62-1999 which, by the way, has changed 6.1.3 to read... "Comfort (odor) criteria with respect to human bioeffluents are likely to be satisfied if the ventilation results in indoor CO_2 less than 700 ppm above the outdoor concentration."

CONCLUSION

Occupied spaces with concentrations >1,000-ppm are not necessarily bad. Conversely, occupied spaces with concentrations <1,000-ppm are not automatically good.

When using CO_2 to determine the ventilation rate, use the differential between indoor and outdoor concentrations. It should also be noted that the inside concentration level used in the differential calculation should be taken at equilibrium.

References

ANSI/ASHRAE 62-1989, "Ventilation for Acceptable Indoor Air Quality" including ANSI/ASHRAE Addendum 62a-1990.

Interpretations for ASHRAE Standard 62-1999 "Ventilation for Acceptable Indoor Air Quality."

ASHRAE 62-1999, "Ventilation for Acceptable Indoor Air Quality" including ASHRAE Addenda Listed in Appendix I.

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