Air Quality Management Services, Inc.

"Discovering Solutions for Healthier Living"

May 17th, 2017

RSU #38
C/o Brigette Williams
2250 Millard Harrison Drive
Readfield, Maine 04355

Re: Limited Indoor Carbon Dioxide (CO_2) Assessment at Manchester Elementary School on 17 School Street in Manchester, Maine.

AQM Project #: 17-242

Air Quality Management Services, Inc. (AQM) conducted a limited Carbon Dioxide (CO_2) assessment at your request on May 9th, 2017 inside McNaughton's Classroom.

I. Background

AQM's services were retained on March 30th, 2017 (AQM Project # 17-164) due to a reported concern for air quality in the McNaughton Classroom (reportedly due to odors detected upon entering the Classroom and reported headaches). AQM was originally asked only to perform mold testing, but given the complaint (headaches), AQM also performed measurement of Carbon Dioxide (CO_2) levels. AQM found CO_2 levels to be below regulatory levels, but exceeding comfort guidelines. The Students and Mrs. McNaughton were reportedly relocated to another Classroom in the Building, due to the recent findings in the previous sampling event (See Above). AQM returned on April 24th, 2017 (AQM Project # 17-200) to perform full facility Carbon Dioxide Screen.

For this most recent testing event, Client mentioned that Students have been returned to McNaughton Classroom and has requested another round of CO_2 testing to determine current levels. Mrs. McNaughton was not present during this sampling event, another Teacher was present. Two (2) conditions were assessed; 1st Condition (1) with windows and door closed and the 2nd Condition (2) with windows and door open. Condition 2 is an attempt to determine whether opening all windows and the door would significantly reduce CO_2 levels (with the assumption that reduced CO_2 levels indicate improved ventilation). This was a simple experiment to check if levels of CO_2 would be reduced by opening windows and door. This was monitored over an 18 minute period; levels will likely fluctuate with more time and wind conditions outdoors (more air flowing in through the windows). Condition 2 is likely not feasible during cooler months.

This round of sampling was performed:

- 10:00 – Outdoor Reading Collected
- 10:32 – Condition-1: 9 Students and 1 Teacher present in the Classroom with Windows & Doors Closed.
- 10:50 – Condition-2: Students and Teacher present in the Classroom with Windows and Door Open.

II. Testing

Carbon dioxide (CO_2) was measured with a TSI IAQ-Calc 7545 meter.

III. Observations

Classroom was occupied at the time of the sampling event.

IV. Results

Table 1. Carbon Dioxide (CO_2) Levels

Sampling Time	Site	CO_2 (ppm)	Comments
10:30	Outdoors	503	
10:32	McNaughton – Condition-1	1672 (max)	All Windows & Door Closed
10:50	McNaughton – Condition-2	1168 – 1202	All Windows & Door Open
Criteria	----	1000 (1) / 5000 (2)	----

Key: ppm = parts per million; CO_2 = Carbon dioxide; N/A = Not Applicable
(1) ASHRAE (Prior) Limit Guideline (Maximum); (2) OSHA PEL (Permissible Exposure Limit)

Carbon dioxide (CO_2) was well below the OSHA regulatory limit; however it was elevated relative to the former ASHRAE Limit (1000 ppm) for both Conditions tested. Note that ASHRAE no longer specifies a specific numerical guideline for CO_2. Past ASHRAE guideline documents specified an upper limit of 1000 ppm for carbon dioxide, but this is not stated in current guidelines. The 1000 ppm limit has never been considered a requirement and is neither a ceiling nor a time weighted average value. Rather, it has been considered a target concentration level based on adequate removal of human bioeffluents / odors. Since comfort (odor) criteria are likely to be satisfied when the CO_2 does not exceed 1000 ppm the converse is also likely to be true, i.e., when the CO_2 level exceeds 1000 ppm, the comfort (odor) criteria may not be satisfied.

In addition to the above odor / comfort based criteria, there is recent evidence that moderate amounts of Carbon Dioxide can lead to measurable cognitive effects among occupants (Satish U, Mendell MJ, Shekhar K, Hotchi T, Sullivan D, Streufert S, Fisk WJ. 2012. Is CO_2 an Indoor Pollutant? Direct Effects of Low-to-Moderate CO_2 Concentrations on Human Decision-Making Performance. Environ Health Perspect 120:1671–1677; http://dx.doi.org/10.1289/ehp.1104789). This study found that moderately high indoor concentrations of carbon dioxide (CO_2) can significantly impair people's decision-making performance. On nine scales of decision-making performance, test subjects showed significant reductions on six of the scales at CO_2 levels of 1,000 parts per million (ppm) and large reductions on seven of the scales at 2,500 ppm. Refer to the above citation for additional details. The lower level (1000 ppm) used in the recent study noted here is not a calculated threshold level, but simply the lowest level in the study that produced a measurable effect in individuals (2500, 1000 and 600 ppm levels were used in the study, with no effects noted at 600 ppm). Therefore it is possible for effects to occur below 1000 ppm (but above 600 ppm), based on this study. For McNaughton Classroom, CO_2 levels were

IV. Results – Continued

elevated beyond the mid-level used in the study (1000 ppm) but below the maximum level (2500 ppm). Based on this study, some effects on decision-making performance are possible. Some effects may also be possible in those areas with CO_2 between 600 and 1000 ppm; however, note that 600 ppm is not a threshold level, but is merely the highest level with no effects in the quoted study. Achieving 600 ppm CO_2 in a building may not be economically feasible nor is it known to be necessary.

To AQM's knowledge, the levels of CO_2 in McNaughton Classroom are below the level where the CO_2 itself would produce any direct health effects (the 5000 ppm level is generally used as this threshold). However, as an indicator of ventilation, with higher CO_2 levels it is likely that ventilation in the area is not optimal. When this is the case, volatile chemicals from common indoor materials and products (e.g. cleaning solutions, markers, perfumes and fragrances, etc.) and even common particulates may accumulate and potentially affect sensitive individuals. Improving ventilation (outdoor air exchange) should alleviate these issues.

V. Discussion and Recommendations

- Based on measurements performed, it appears that opening the windows and door in the McNaughton Classroom can reduce CO_2 levels by 28 to 30%. This is a reasonable improvement and can be beneficial during the warmer months where such practices are feasible. However, the CO_2 level still exceeded 1000 ppm, and therefore additional improvements in ventilation would be beneficial.
- Improve ventilation with the outdoors in the building to reduce CO_2 levels. Ideally, this is best achieved with a building mechanical system or with local unit-ventilators / air-exchangers. Verify ventilation efficacy with additional CO_2 monitoring after upgrades have been implemented.

AQM appreciates this opportunity to have aided in this project. In the event you have questions or require further assistance, please do not hesitate to contact us.

Sincerely,

Randy Geoffroy, CMI
Industrial Hygienist