INDOOR AIR QUALITY ASSESSMENT

Massachusetts Department of Revenue
Child Support Enforcement
703 West Housatonic Street
Pittsfield, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
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Background/Introduction

In response to a request by Jerry Covino, Project Manager, Division of Capital Asset Management and Maintenance (DCAMM), the MDPH Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality (IAQ) at the Massachusetts Department of Revenue, Child Support Enforcement Office (the office) located at 703 West Housatonic Street, Pittsfield, Massachusetts. The request was prompted by general IAQ concerns. In addition, employees reported musty odors in the office during summer months.

On January 16, 2015, the office was visited by Michael Feeney, Director of BEH's IAQ Program to conduct a general IAQ assessment. Mr. Feeney was accompanied by Mr. Covino during this assessment. BEH/IAQ staff offered to re-visit the space to observe conditions during summer months to further investigate reported odors.

The office occupies a single floor of a converted mill building which contains private offices, modular workstations with cloth-covered dividers, reception/waiting area, interview rooms, training/conference rooms and kitchen/lounge areas. Ceilings consist of suspended ceiling tiles. Floors in the majority of areas are carpeted. Windows are not openable in the office space.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 7565. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. BEH/IAQ staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

Approximately 10 employees work in the office. The tests were taken during normal operations and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in all areas tested, indicating a lack of air exchange at the time of the assessment. Without a continuous source of fresh outside air and removal of stale air via the exhaust/return system, indoor environmental pollutants can build up and lead to IAQ/comfort complaints. Fresh air is provided by a rooftop air handling unit (AHU) ducted to ceiling-mounted supply diffusers. Return air is drawn back into ceiling vents and returned to the AHUs. Note that due to low outside temperatures on the day of the assessment, fresh air supply may be automatically or manually restricted by the AHU in order to protect pipes against freezing as well as to maintain comfortable temperatures inside the building.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

Minimum design ventilation rates are mandated by the Massachusetts State Building Code (MSBC). Until 2011, the minimum ventilation rate in Massachusetts was higher for both occupied office spaces and general classrooms, with similar requirements for other occupied spaces (BOCA, 1993). The current version of the MSBC, promulgated in 2011 by the State Board of Building Regulations and Standards (SBBRS), adopted the 2009 International Mechanical Code (IMC) to set minimum ventilation rates. **Please note that the MSBC is a minimum standard that is not health-based**. At lower rates of cubic feet per minute (cfm) per occupant of fresh air, carbon dioxide levels would be expected to rise significantly. A ventilation rate of 20 cfm per occupant of fresh air provides optimal air exchange resulting in carbon dioxide levels at or below 800 ppm in the indoor environment in each area measured. MDPH recommends that carbon dioxide levels be maintained at 800 ppm or below. This is because most environmental and occupational health scientists involved with research on IAQ and health effects have documented significant increases in indoor air quality complaints and/or health effects when carbon dioxide levels rise above the MDPH guidelines of 800 ppm for schools, office buildings and other occupied spaces (Sundell et al., 2011). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is

5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix A.

Temperature readings during the assessment ranged from 71ºF to 73ºF (Table 1), which were within the MDPH recommended comfort guidelines. The MDPH recommends that indoor air temperatures be maintained in a range of 70ºF to 78ºF in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured during the assessment ranged from 22 to 40 percent, with all but one measurement below the MDPH recommended comfort range. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Water coolers were observed in carpeted areas. Spills or leaks from this equipment can moisten carpet and lead to microbial growth and degradation of the carpet. MDPH recommends placing rubber or plastic trays beneath this equipment to protect the carpet from leaks.

A buildup of debris was noted in the refrigerator condensation pan (Picture 1). This debris can readily serve as a mold growth media, be aerosolized by the refrigerator condenser cooling coil fan and a source of musty odor, particularly in humid conditions or moistened by condensation. All refrigerator condensation collection pans should be cleaned regularly.

Other IAQ Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor, and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the indoor environment, BEH/IAQ staff obtained measurements for carbon monoxide and PM2.5.

Carbon Monoxide

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health effects. Several air quality standards have been established to address carbon monoxide

and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 2011). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. During the visit, outdoor carbon monoxide concentrations were non-detect (ND). No measureable levels of carbon monoxide were detected in the building during the assessment (Table 1).

Particulate Matter

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter includes airborne solids that can be irritating to the eyes, nose and throat. The

NAAQS originally established exposure limits to PM with a diameter of 10 μm or less (PM10). In 1997, US EPA established a more protective standard for fine airborne particulate matter with a diameter of 2.5 μm or less (PM2.5). This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 35 $\mu g/m^3$ over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne PM concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 1 $\mu g/m^3$ (Table 1). PM2.5 levels indoors ranged from 7 to 9 $\mu g/m^3$, which were below the NAAQS PM2.5 level of 35 $\mu g/m^3$. Frequently, indoor air levels of particulate matter (including PM2.5) can be at higher levels than those measured outdoors. A number of activities that occur indoors and/or mechanical devices can generate particulate matter during normal operations. Sources of indoor airborne particulate matter may include but are not limited to particles generated during the operation of fan belts in the HVAC system, use of stoves and/or microwave ovens in kitchen areas; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Volatile Organic Compounds

Indoor air concentrations can be greatly impacted by the use of products containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Total volatile organic compounds (TVOCs) can result in eye and respiratory irritation if exposure occurs. For example chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs.

Of note is the presence of copy machines within office areas directly adjacent to seating with no dedicated exhaust ventilation. Photocopiers can be sources of pollutants such as VOCs, ozone, heat and odors, particularly if the equipment is older and in frequent use. Both VOCs and ozone are respiratory irritants (Schmidt Etkin, 1992). Photocopiers should be kept in well ventilated rooms and should be located near windows or exhaust vents.

Additional sources of TVOCs in the office area include dry erase boards and related materials. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Hand sanitizer was also observed in the space; these products may contain ethyl alcohol and/or isopropyl alcohol, which are highly volatile and may be irritating to the eyes and nose. Sanitizing products may also contain fragrances to which some people may be sensitive.

Cleaning products, air freshening sprays and scented products were also found in the office. Plug-in air fresheners and other air deodorizers contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Many air fresheners contain 1, 4-dichlorobenzene, a VOC which may cause reductions in lung function (NIH, 2006). Furthermore, deodorizing agents do not remove materials causing odors, but rather mask odors that may be present in the area. Many cleaning products contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Cleaning products should be properly labeled and stored in an appropriate area. In addition, a Material Safety Data Sheet (MSDS) should be available at a central location for each product in the event of an emergency.

Conclusions/Recommendations

IAQ staff did not detect any musty odors during the assessment. In order to address these concerns, it is recommended that the office be reassessed during the summer when the HVAC system is in its cooling mode. In view of the findings at the time of the visit, the following recommendations are made:

1. Clean the refrigerator's condensation collection pan or accumulated debris. Inspect the refrigerator's condensation collection pan for debris at least twice a year and clean as needed.
2. Operate all ventilation systems throughout the building continuously during periods of occupancy to maximize air exchange.
3. Consider having the HVAC system balanced every five years.
4. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
5. Place water coolers/dispensers in areas without carpeting or place on a waterproof mat.
6. Consider installing local exhaust vents near photocopiers or relocating them to areas with local exhaust ventilation and away from occupants.
7. Use dry erase markers only in well ventilated areas. Clean dry erase boards and trays to prevent accumulation of materials.

8. Reduce the use of hand sanitizing products especially those containing fragrances.

9. Avoid the use of air freshener sprays, solids and diffuser reeds to avoid exposure to VOCs and fragrance compounds.

10. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. Copies of these materials are located on the MDPH's website: http://mass.gov/dph/iaq.

References

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Picture 1

Refrigerator condensation collection pan

Location: DOR Child Support Enforcement

Address: 703 W. Housatonic St., Pittsfield, MA

Table 1

Indoor Air Results

Date: 1/16/2015

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Background (outdoors)	322	ND	<32	28	1					
Reception	1027	ND	72	40	9	0	N	Y	Y	
Front desk	1271	ND	72	32	9	0	N	Y	Y	
5	1201	ND	72	27	8	0	N	Y	Y	Door open
6	1122	ND	72	25	8	0	N	Y	Y	Refrigerator drip pan
8	1371	ND	73	22	8	0	N	Y	Y	Water cooler
10	1337	ND	72	23	7	2	N	Y	Y	Door open
11	1338	ND	72	22	8	1	N	Y	Y	
12	1362	ND	73	23	8	1	N	Y	Y	
13	1385	ND	73	22	8	0	N	Y	Y	
14	1379	ND	73	22	8	1	N	Y	Y	
16	1332	ND	72	23	8	0	N	Y	Y	Water cooler

ppm = parts per million µg/m^3 = micrograms per cubic meter ND = non detect

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: DOR Child Support Enforcement **Indoor Air Results**

Address: 703 W. Housatonic St., Pittsfield, MA **Table 1 (continued)** **Date: 1/16/2015**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
17	1589	ND	72	23	9	0	N	Y	Y	Door open
18	1382	ND	72	22	8	0	N	Y	Y	
20	1401	ND	72	24	8	0	N	Y	Y	
22	1402	ND	72	23	8	0	N	Y	Y	
23	1282	ND	71	22	8	0	N	Y	Y	Door open
24	1271	ND	72	23	8	0	N	Y	Y	
28	1348	ND	72	22	8	0	N	Y	Y	

ppm = parts per million µg/m^3 = micrograms per cubic meter ND = non detect

Comfort Guidelines

Carbon Dioxide:	< 600 ppm = preferred	Temperature:	70 - 78 °F
	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
	> 800 ppm = indicative of ventilation problems		