INDOOR AIR QUALITY ASSESSMENT
POST-OCCUPANCY ASSESSMENT

Massachusetts Department of Public Health
Western Regional Health Office
23 Service Center Road
Northampton, Massachusetts

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

On October 14, 2011, the Massachusetts Department of Public Health (MDPH) Bureau of Environmental Health's (BEH) Indoor Air Quality Program (IAQ) conducted an IAQ assessment of the MDPH Western Regional Office (WRHO) and Committee for Public Health Counsel Services Office at 23 Service Center Road, Northampton, Massachusetts. The visit was conducted by Michael Feeney, Director of BEH's Indoor Air Quality (IAQ) Program and Kathleen Gilmore, BEH Environmental Analyst/Regional Inspector.

The WRHO is leased office space located in a one-story brick building constructed in 1964. Windows are openable in all areas except the south side of the building.

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. Screening for volatile organic compounds was conducted using a MiniRAE 2000™, Photo Ionization Detector.

Results

The WRHO has an employee population of approximately 60 with an estimated 5 visitors daily. Approximately 25 to 30 additional individuals may enter the building on days when the conference room is in use. The tests were taken under normal operating conditions and results appear in Table 1.

Discussion

Ventilation

Table 1 shows that carbon dioxide levels were below 800 parts per million (ppm) of air in all areas surveyed with the exception of the conference room, indicating adequate air exchange in most areas of the building. Carbon dioxide levels in the conference room may indicate that the air-handling unit (AHU) needs to be adjusted to provide adequate fresh air during occupancy.

Ventilation is provided by a heating, ventilation and air conditioning (HVAC) system consisting of two AHUs. The AHU that services the shared common spaces, private offices and open work areas (i.e. cubicles) is ducted to fresh air diffusers located throughout these areas. Air is returned to the AHU via a ceiling plenum exhaust system with exhaust vents located in the common and cubicle areas. This AHU was upgraded as part of the lease renewal and was operating at the time of this assessment.

The second AHU that services the conference room consists of ducted supply and exhaust ventilation and was operating at the time of this assessment. Fresh air intake and exhaust vents are located on the exterior wall.

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).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). 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, consult Appendix A.

Temperature measurements in the building ranged from 73o F to 76o F, which were within the MDPH recommended range (Table1). The MDPH recommends that indoor air temperatures be maintained in a range of 70o F to 78o F 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 in the building ranged from 60 to 65 percent, which was above the MDPH recommended comfort range the day of the assessment (Table 1). 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.

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 can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the building environment, BEH staff obtained measurements for carbon monoxide.

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 affects. 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, 1997). 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. On the day of assessment, outdoor carbon monoxide concentrations were measured at 1 ppm (Table 1). No measureable levels of carbon monoxide were detected during the assessment (Table 1).

Particulate Matter

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or

less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA established a more protective standard for fine airborne particles. 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 particulate matter concentrations in the indoor environment.

On the day of assessment, outdoor PM2.5 was measured at 1 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from ND to 1 $\mu g/m^3$ (Table 1), which were below the NAAQS PM2.5 level of 35 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in buildings can generate particulate during normal operations. Sources of indoor airborne particulates 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 quality can also be impacted by the presence of materials containing volatile organic compounds (VOCs). VOCs are substances that have the ability to evaporate at room temperature. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. Frequently, exposure to low levels of total VOCs (TVOCs)

may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Outdoor air samples were taken for comparison. Outdoor TVOC concentrations were ND. No measureable levels of TVOCs were detected during the assessment (Table 1).

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Adjust the conference room AHU to provide adequate ventilation when occupied.
2. Consider adopting a balancing schedule of every 5 years for the mechanical ventilation system, as recommended by ventilation industrial standards (SMANCA, 1994).
3. Avoid opening windows during hot humid weather to avoid condensation problems. Care should also be taken to ensure windows are properly closed at night and weekends during winter months to avoid the freezing of pipes and potential flooding.
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. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
5. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website: http://mass.gov/dph/iaq.

References

ASHRAE. 1989. ASHRAE Standard: Ventilation for Acceptable Indoor Air Quality. Sections 5.11, 5.12. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Atlanta, GA.

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

MDPH. 1997. Requirements to Maintain Air Quality in Indoor Skating Rinks (State Sanitary Code, Chapter XI). 105 CMR 675.000. Massachusetts Department of Public Health, Boston, MA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

US EPA. 2006. National Ambient Air Quality Standards (NAAQS). US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC. http://www.epa.gov/air/criteria.html.

Location: Western Regional Health Office **Indoor Air Results**

Address: 23 Service Center Road **Table 1** **Date: 2/18/2011**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m^3)	TVOCs (ppm)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Background:	-	55	37	322	0-.7	63	ND	-	-	-	Clear, wind 9.2mph (SSW), dewpoint 33˚F, visibility 10 miles (weather underground)
Committee for Public Counsel Services											
Lobby	0	72	29	894	ND	10	ND	N	Y	N	
Front Desk	1	72	30	990	ND	10	ND	Y	Y	N	
Room 2	0	72	29	958	ND	10	ND	Y	Y	N	DO, paper accumulation
Room 3	1	72	30	1015	ND	12	ND	Y	Y	N	DO
Room 4	0	72	29	934	ND	12	ND	Y	Y	N	DO, floor slopes toward exterior wall.
Room 5	0	72	30	1065	ND	11	ND	N	Y	N	DO
Room 6	0	71	29	885	ND	10	ND	N	Y	N	
Library	0	71	29	998	ND	11	ND	N	Y	Y	

ppm = parts per million
µg/m3 = micrograms per cubic meter
ND = non detect
AD = air deodorizer
AT = ajar ceiling tile
CT = ceiling tile
DEM = dry erase materials
DO = door open
FC = food container
MT = missing ceiling tile
PC = photocopier
WD = water-damaged

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%
Particle matter 2.5 < 35 ug/m^3

Location: Western Regional Health Office **Indoor Air Results**

Address: 23 Service Center Road **Table 1 (continued)** **Date: 2/18/11**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m^3)	TVOCs (ppm)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Room 10	0	71	30	908	ND	11	ND	N	Y	N	
Storage Room	0	72	29	1035	ND	12	ND	N	Y	Y	DO
Western Regional Health Office											
Radon	1	72	29	1017	ND	10	ND	Y	Y	Y	
Charlie Kaniecki	0	72	28	920	ND	10	ND	N	Y	N	
Boiler Room	0	72	29	948	ND	15	ND	N	N	N	WDCTs, MTs, AT
Library	0	71	29	860	ND	21	ND	Y	Y	N	
Kitchen	1	72	33	1063	ND	11	ND	Y	Y	N	DO
Chris Fairbanks (cubicle)	0	72	31	1078	ND	9	ND	N	Y	Y	

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									Supply	Exhaust	
Front Lobby0	0	73	33	1085	ND	10	ND	N	Y	Y	
106	1	73	31	1069	ND	11	ND	N	Y	Y	
105	0	73	32	1049	ND	9	ND	Y	Y	N	DO
103	0	73	32	1053	ND	9	ND	N	Y	N	
127	0	73	33	1143	ND	11	ND	N	Y	N	DO
125	1	74	31	1157	ND	10	ND	N	Y	N	
123	0	74	31	1086	ND	10	ND	Y	Y	N	DO
120	1	73	31	1070	ND	10	ND	N	Y	Y	
143	3	73	32	1109	ND	9	ND	N	Y	Y	
141	2	73	32	1135	ND	10	ND	N	Y	Y	

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									Supply	Exhaust	
115	1	73	32	1191	ND	10	ND	Y	Y	N	DO
114	2	73	31	1120	ND	10	ND	N	Y	Y	FC
134	0	74	31	1106	ND	11	ND	N	Y	Y	
Copy Room	1	76	31	1211	ND	9	ND	N	Y	Y	DO, laminator, PC
Storage Room	0	74	31	1150	ND	10	ND	N	Y	N	DO
129	0	74	30	1117	ND	9	ND	N	Y	Y	
153 (conference room)	11	72	34	976	ND	21	ND	Y	Y	Y	DO, DEM (Note WD CT in hallway)
Accessible Restroom								N	N	Y	AD, exhaust tied to light fixture – ie goes off when light is turned off
Women's restroom								Y	N	Y	Exhaust is on a timer

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