INDOOR AIR QUALITY ASSESSMENT

January 16, 2009

Massachusetts Department of Revenue
Shetland Park Office Complex
35 Congress Street
Salem, Massachusetts 01970

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
March 2009

Background/Introduction

The Massachusetts Department of Public Health (MDPH) has been working with collective bargaining unit representatives; the Massachusetts Human Resources Division; and management and staff of the Massachusetts Department of Revenue (MDOR) offices to address a series of indoor environmental concerns. In an effort to further investigate indoor air quality issues, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted an indoor air quality assessment at the Massachusetts Department of Revenue (DOR) offices located on the third floor of the Shetland Park Office Complex, 35 Congress Street, Salem, Massachusetts. On January 16, 2009, Michael Feeney, Director of BEH's Indoor Air Quality (IAQ) Program, visited DOR to conduct an indoor air quality assessment. The primary purpose of this visit was to conduct carbon dioxide air sampling to assess whether balancing of the heating, ventilating and air-conditioning (HVAC) system by RDK Associates have improved air exchange in the DOR Salem office.

Methods

Tests for carbon dioxide, carbon monoxide, temperature and relative humidity were conducted with a TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The DOR offices have a combined employee population of approximately 135. Real-time tests were taken during normal operations (i.e., during the work day) and results appear in Table 1. The approximate area of testing is indicated by room/office number, function or occupant's last name (Table 1).

Discussion

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm) in 30 out of 55 areas surveyed (carbon dioxide range: 608 ppm to 963 ppm). It is important to note that the assessment occurred on a day when outdoor temperatures were below freezing (temperature range: 12^{o} F to 17^{o} F). During cold weather temperature extremes, outdoor air intake is typically minimized to maintain thermal comfort as well as to protect heating, ventilating and air-conditioning (HVAC) equipment from freezing and subsequently bursting. The HVAC system in this building has two settings: low and high. The HVAC system was reportedly set on low to prevent heating coils from freezing during this extreme cold weather.

The Massachusetts Building Code requires that each area have a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (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 information concerning carbon dioxide, please see Appendix A.

Temperature readings in the building ranged from 69° F to 75° F, which were within the MDPH recommended comfort guidelines in the majority of areas (Table 1). The MDPH recommends that indoor air temperatures be maintained in a range of 70° F to 78° 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 measured inside the building ranged from 8 to 12 percent, which was below the MDPH recommended comfort range (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. 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.

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 inside the building, BEH staff obtained measurements for 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 non-detect (ND) (Table 1). No detectable levels of carbon monoxide were measured inside the building at the time of the assessment (Table 1).

Conclusions/Recommendations

The air sampling for carbon dioxide conducted in the Salem DOR office in January 2009 (carbon dioxide range: 621 ppm to 963 ppm) demonstrated improvements in comparison to the results from January 2007 (carbon dioxide range: 969 ppm to 1313 ppm; MDPH, 2007). These decreases in the carbon dioxide range would indicate that the repairs and balancing of the HVAC system has improved air exchange.

In addition to the recommendations made in previous DPH IAQ assessments, the following additional recommendations are made to improve indoor air quality:

1. Implement the Required and Recommended actions outlined in the RDK report.

References

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989

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. 2007. Indoor Air Quality Assessment Department of Revenue, Shetland Park, 35 Congress Street, Salem, MA. Massachusetts Department of Public Health, Boston, MA. February 2007. http://www.mass.gov/Eeohhs2/docs/dph/environmental/iaq/salem_dor_2007.pdf

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.

RDK. 2008. Final Report of the Ventilation System. RDK Engineers, Andover, MA

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

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: Salem DOR **Indoor Air Results**

Address: 35 Congress Street, Salem, MA **Table 1** **Date: 01 – 16 – 2009**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
background									
Records	0	75	11	797	ND	N	Y	Y	WD CT – 1
W1	3	71	10	822	ND	Y	Y	Y	Carpet cut; Sealed pipes
W2	3	72	11	888	ND	Y	Y	Y	
W06	1	73	10	840	ND	Y	Y	Y	
Front Desk	2	72	9	703	ND	N	Y	N	
W3	1	72	12	886	ND	Y	Y	Y	
W4	1	72	11	854	ND	Y	Y	Y	
W5	2	72	11	853	ND	Y	Y	Y	

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
AC = air conditioner
AD = air deodorizer
AP = air purifier
aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
DO = door open
FC = food container
GW = gypsum wallboard
MT = missing ceiling tile
NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WD = water-damaged
WP = wall plaster

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: Salem DOR **Indoor Air Results**

Address: 35 Congress Street, Salem, MA **Table 1 (continued)** **Date: 01 – 16 – 2009**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
W6	4	72	11	880	ND	Y	Y	Y	
W7	3	72	12	963	ND	Y	Y	Y	
W8	1	73	11	905	ND	Y	Y	Y	
Conference Room West	0	73	10	831	ND	N	Y	N	
W01	0	73	9	813	ND	N	Y	Y	
W03	2	73	10	837	ND	N	Y	Y	
W04	0	73	10	798	ND	N	Y	Y	DO
W05	1	73	10	819	ND	N	Y	Y	DO

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Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
Law Library	1	72	9	637	ND	Y	Y	Y	
1	0	71	11	681	ND	Y	Y	Y	WD CT – 5; DO
2	2	73	10	808	ND	Y	Y	Y	
2	1	71	10	677	ND	Y	Y	Y	DO
3	0	73	9	669	ND	Y	Y	Y	DO
6	1	73	8	621	ND	N	Y	N	DO
7	0	73	9	622	ND	N	Y	N	DO
8	1	73	9	630	ND	N	Y	Y	DO

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Address: 35 Congress Street, Salem, MA **Table 1 (continued)** **Date: 01 – 16 – 2009**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
9	2	74	11	880	ND	Y	Y	Y	
9	0	73	9	651	ND	N	Y	Y	DO
10	1	73	9	662	ND	N	Y	Y	DO
11	1	73	9	653	ND	N	Y	Y	DO
12	1	73	9	683	ND	N	Y	Y	WD CT – 2; DO
13	0	73	8	642	ND	N	Y	Y	DO
14	2	75	11	878	ND	Y	Y	Y	
14	2	73	9	703	ND	N	Y	Y	DO

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Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
15	0	73	9	676	ND	N	Y	Y	DO
16	0	73	9	671	ND	N	Y	Y	DO
17	1	71	9	711	ND	N	Y	Y	DO
18	0	71	9	682	ND	N	Y	Y	DO
18	2	74	11	881	ND	Y	Y	Y	
20 Mail	0	69	12	848	ND	N	N	Y	DO
22 Kitchen	3	69	11	720	ND	N	Y	N	
24	2	74	12	944	ND	Y	Y	Y	

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Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
25	0	69	10	673	ND	N	Y	Y	AT – 1
28	2	74	11	870	ND	Y	Y	Y	
33	3	73	12	942	ND	Y	Y	Y	
36	2	74	12	930	ND	Y	Y	Y	
38	0	73	12	829	ND	N	Y	N	
51	0	71	11	836	ND	Y	Y	Y	
53	1	71	12	878	ND	Y	Y	Y	
65	1	72	10	716	ND	Y	Y	Y	

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							Supply	Exhaust	
68	5	72	9	642	ND	Y	Y	Y	WC carpet
72	2	72	9	651	ND	Y	Y	Y	
82	2	72	9	636	ND	Y	Y	Y	
86	3	72	8	608	ND	Y	Y	Y	WC – carpet; WD fridge
98	3	72	9	672	ND	Y	Y	Y	
102	2	72	8	624	ND	Y	Y	Y	
105	3	72	9	666	ND	Y	Y	Y	

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