

INDOOR AIR QUALITY REASSESSMENT

March 3, 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

In an effort to further address concerns associated with the effectiveness of heating, ventilating and air-conditioning (HVAC) improvements at the Salem Department of Revenue (DOR) offices, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted an IAQ reassessment at the DOR offices located on the third floor of the Shetland Park Office Complex, 35 Congress Street, Salem, Massachusetts. On March 3, 2009, Michael Feeney, Director of BEH's Indoor Air Quality (IAQ) Program, visited DOR to conduct an indoor air quality assessment. Mr. Feeney originally conducted sampling on January 16, 2009. Given that January 16, 2009 was a Friday prior to a long weekend, building occupants felt that reduced occupancy might be an important factor associated with lower levels of carbon dioxide.

Methods

Air 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 27 out of 55 areas surveyed (carbon dioxide range: 574 ppm to 919 ppm). It is important to note that carbon dioxide levels were lower in 75% of areas tested versus the sampling that occurred on January 16, 2009. It is probably also worthwhile to note that the assessment occurred on a day when outdoor temperatures were below freezing (temperature range: 25° F). During cold weather temperature extremes, outdoor air intakes are typically minimized to maintain thermal comfort as well as to protect heating, ventilating and air-conditioning (HVAC) equipment from freezing and subsequently bursting. As mentioned in the previous MDPH report, the HVAC system has two settings: low and high. As was the case at the time of the January 2009 testing, the HVAC system was again 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 70° F to 74° 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 10 to 15 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 March 2009 (carbon dioxide range: 574 ppm to 919 ppm) was ***significantly improved*** compared to results from both the January 2009 (carbon dioxide range: 621 ppm to 963 ppm; MDPH, 2009) and the January 2007 (carbon dioxide range: 969 ppm to 1313 ppm; MDPH, 2007). As stated previously, carbon dioxide levels were ***lower in 75% of areas tested*** on March 3, 2009 as compared to the sampling that occurred on ***January 16, 2009***. These results indicate that the RDK repairs/balancing have improved air exchange in the DOR Salem office and that the HVAC system will restrict fresh air flow in order to prevent frozen heating coils. In addition to the recommendations made previously in DPH IAQ assessments, the following 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.

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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.

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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/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
background		25	41	327					
Records	0	73	15	841	ND	N	Y	Y	
W1	3	71	14	868	ND	Y	Y	Y	
W2	4	72	14	846	ND	Y	Y	Y	
W06	1	74	14	899	ND	Y	Y	Y	
Front Desk	1	72	11	630	ND	N	Y	N	
W3	5	72	13	831	ND	Y	Y	Y	
W4	6	73	14	871	ND	Y	Y	Y	
W5	4	74	13	835	ND	Y	Y	Y	

ppm = parts per million

µg/m³ = 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/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
W6	5	73	13	832	ND	Y	Y	Y	
W7	6	72	13	821	ND	Y	Y	Y	
W8	3	72	13	820	ND	Y	Y	Y	
Conference Room West	0	72	13	823	ND	N	Y	N	
W01	1	72	15	868	ND	N	Y	Y	
W03	0	73	14	827	ND	N	Y	Y	
W04	0	73	14	841	ND	N	Y	Y	DO
W05	1	74	14	899	ND	N	Y	Y	DO

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							Supply	Exhaust	
Law Library	0	72	10	574	ND	Y	Y	Y	
1 office	0	73	11	630	ND	Y	Y	Y	DO
2 office	0	74	13	828	ND	Y	Y	Y	
2	1	73	11	653	ND	Y	Y	Y	DO
3 office	0	73	10	596	ND	Y	Y	Y	DO
6 office	1	73	11	612	ND	N	Y	N	DO
7 office	0	73	11	641	ND	N	Y	N	DO
8	0	72	11	638	ND	N	Y	Y	DO

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							Supply	Exhaust	
9	0	74	12	890	ND	Y	Y	Y	
9 office	0	72	12	636	ND	N	Y	Y	DO
10 office	0	72	12	645	ND	N	Y	Y	DO
11 office	0	71	12	648	ND	N	Y	Y	DO
12 office	1	71	12	648	ND	N	Y	Y	DO
13 office	0	72	12	655	ND	N	Y	Y	DO
14 office	1	74	15	858	ND	Y	Y	Y	
14	1	72	12	676	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 office	0	71	12	648	ND	N	Y	Y	DO
16 office	1	71	12	634	ND	N	Y	Y	DO
17 office	0	70	12	611	ND	N	Y	Y	DO
18 office	1	71	11	630	ND	N	Y	Y	DO
18	2	74	13	807	ND	Y	Y	Y	
20 Mail	1	71	14	807	ND	N	N	Y	DO
22 Kitchen	0	70	14	754	ND	N	Y	N	
24	1	74	13	813	ND	Y	Y	Y	

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							Supply	Exhaust	
25	0	73	13	804	ND	N	Y	Y	
28	1	73	13	842	ND	Y	Y	Y	
33	1	74	13	873	ND	Y	Y	Y	
36	2	73	13	857	ND	Y	Y	Y	
38	2	73	14	862	ND	N	Y	N	
51	1	73	15	919	ND	Y	Y	Y	
53	3	72	15	871	ND	Y	Y	Y	
65	2	71	11	591	ND	Y	Y	Y	

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Location: Salem DOR

Indoor Air Results

Address: 35 Congress Street, Salem, MA

Table 1 (continued)

Date: 03 - 03 - 2009

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
68	2	71	11	582	ND	Y	Y	Y	
72	1	71	11	585	ND	Y	Y	Y	
82	2	72	11	584	ND	Y	Y	Y	
86	1	72	11	586	ND	Y	Y	Y	
98	2	71	11	604	ND	Y	Y	Y	
102	1	71	14	764	ND	Y	Y	Y	
105	1	71	12	607	ND	Y	Y	Y	

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