INDOOR AIR QUALITY ASSESSMENT

Division of Insurance
1000 Washington Street, 9th Floor
Boston, MA

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 from Gilles Quintal, Project Manager, Division of Capital Assets Management (DCAM), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted an indoor air quality (IAQ) assessment at the Division of Insurance (DOI) Offices on the 9th Floor of 1000 Washington Street, Boston, Massachusetts. The request was prompted by concerns related to eye and respiratory irritation and headaches experienced by staff in this office in late March and early April. On April 19, 2012, a visit to conduct an assessment was made by Sharon Lee, an Environmental Analyst within BEH's IAQ Program.

The BEH's IAQ Program previously assessed this office with the DCAM as part of a leasing initiative. General recommendations for improving air quality are discussed in that report (MDPH, 2010). This report focuses on conditions that can contribute to respiratory irritation experienced by DOI staff.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor 7525. 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 staff also performed visual inspection of building materials for water damage and/or microbial growth.

Results

The DOI has a population of approximately 50. Tests were taken during normal operations. Test results appear in Table 1 and are numbered to correspond with locations listed on Figure 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in 1 of 36 areas surveyed, indicating optimal air exchange in almost all areas at the time of assessment. Fresh air is drawn into an air-handling unit (AHU) through a vent located on the south exterior wall of the building, then heated or cooled and delivered to occupied areas via ductwork. Air is provided into the office space by ceiling-mounted supply diffusers. Return air is drawn into ducts that are connected to the AHUs, where it is exhausted through a vent on the south exterior wall.

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, please see Appendix A.

Temperature readings ranged from 71ºF to 75ºF during the assessment, 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. Building occupants expressed concerns regarding uneven temperatures and control over thermostats. Consideration should be given to working with building management to achieving temperatures that better meet the needs of the majority of the staff, modifying the thermostat settings to account for longer days of operation, and/or replacing existing 4-way air diffusers with 2 or 3-way diffusers. 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 31 to 35 percent, which was below the MDPH recommended comfort range in all areas surveyed. 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. Relative humidity levels in the building would be expected to drop during the heating season. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

No water damage and/or microbial growth was noted during this assessment; however, a water dispenser was observed in a carpeted area. Spills/leaks from such appliances can be a source of moisture in carpeting that can lead to water damage and mold growth. When possible, these units should be located in tiled areas or placed on a waterproof mat.

Other Indoor Air 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 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 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. Outdoor carbon monoxide concentrations ranged from non-detect (ND) to 4 ppm (Table 1). No measureable levels of carbon monoxide were detected in the building (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.

Outdoor PM2.5 concentration was measured at 19 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from 3 to 11 $\mu g/m^3$ in all occupant areas (Table 1), 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 other mechanical devices and/or activities that occur indoors 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.

As mentioned, the purpose of this assessment was to examine conditions that may have contributed to symptoms reported by DOI staff. The area of concern is outlined in yellow in Figure 1. Staff indicated that most of the symptoms subsided when the AHU filters were changed.

Please note, this area is adjacent to the freight elevator; a fire door separates these spaces. Staff in this area reported experiencing respiratory symptoms when renovation work was also being conducted elsewhere in the building. The freight elevator was likely used to move furnishing for the renovations. Renovation-related work likely contributed to irritant symptoms experienced by staff. Since the area of concern is adjacent to the service elevator and staff often move through the elevator hallway to DOI office areas, it is likely that pollutants related to renovation work were being drawn from the renovation site to the elevator hallway and migrating into occupant space when the door was opened. At the time of assessment, PM2.5 levels for the freight elevator hallway were greater than those measured in the DOI space, which suggests that particulate levels may be higher in this area. Consideration should be given to ensuring appropriate sweeps are placed on the door and access through this door is limited during periods when renovation activities are under way.

Furthermore, respiratory irritation also appeared to coincide with elevated pollen levels forecasted during warmer than average temperatures experienced in March and April (HealthDay, 2012). Pollen is a respiratory irritant that can result in symptoms for affected people.

Finally, dry erase materials, hand sanitizers and some cleaning products were observed in the DOI space. These materials contain volatile organic compounds (VOCs). Frequently, exposure to low levels of total volatile organic compounds (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals.

Conclusions/Recommendations

Based on conditions described by DOI staff and observations made by BEH/IAQ staff, it is likely that DOI staff were impacted by both particulates generated by renovations being conducted elsewhere in the building and elevated pollen levels resulting from warm weather. In view of the findings at the time of the visit, the following recommendations are made:

1. Work with building management concerning the renovation schedule in the building. During periods when work is being conducted:
    a. Ensure appropriate door sweeps are installed to the access doors to the freight elevator hallway.
    b. Limit access to office spaces through the service elevator hallway doors.
    c. Consider changing AHU filters more often during renovation projects.
    d. Implement dust control methods, including use of high efficiency particle arrestance (HEPA) filtered vacuums and wet-wiping flat surfaces.
2. 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 particle 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).

3. Place water dispensers on tiled floor areas or on a waterproof mat.
4. 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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Figure 1: Floor plan for DOI space

Location: Division of Insurance **Indoor Air Results**

Address: 1000 Washington St, Boston, MA **Table 1** **Date: 4-19-2012**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 ($\mu g/m^3$)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Background	429	ND-4	64	56	19					
1	630	ND	73	33	3	1	N	Y	Y	
2	589	ND	74	31	3	2	N	Y	Y	
3	718	ND	72	31	3	1	N	Y	Y	
4	571	ND	73	31	3	2	N	Y	Y	
5	600	ND	71	32	4	0	N	Y	Y	
6	576	ND	71	32	3	3	N	Y	Y	
7	594	ND	71	33	4	3	N	Y	Y	
8	682	ND	71	32	4	4	N	Y	Y	
9	578	ND	71	32	4	1	N	Y	Y	
10	572	ND	71	33	4	2	N	Y	Y	
11 (conference room)	608	ND	71	33	4	0	N	Y	Y	

ppm = parts per million $\mu g/m^3$ = micrograms per cubic meter ND = non detect DEM = dry erase materials

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: Division of Insurance

Address: 1000 Washington St, Boston, MA

Table 1 (continued)

Indoor Air Results

Date: 4-19-2012

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 ($\mu g/m^3$)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
12	635	ND	72	33	4	2	N	Y	Y	
13	948	ND	73	34	4	2	N	Y	Y	
14	780	ND	73	33	4	1	N	Y	Y	
15	655	ND	73	35	5	0	N	Y	Y	
17	556	ND	72	31	3	0	N	Y	Y	
18	591	ND	74	31	5	1	N	Y	Y	
19	563	ND	74	31	4	0	N	Y	Y	DEM
20	557	ND	72	32	4	0	N	Y	Y	DEM
21	596	ND	72	32	4	0	N	Y	Y	
22	648	ND	73	32	4	1	N	Y	Y	
23	601	ND	73	31	4	0	N	Y	Y	
24	567	ND	74	31	4	0	N	Y	Y	

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Location: Division of Insurance | **Indoor Air Results**

Address: 1000 Washington St, Boston, MA | **Table 1 (continued)** | **Date: 4-19-2012**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m³)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
25	507	ND	74	31	4	0	N	Y	Y	
26	449	ND	73	31	5	0	N	Y	Y	
27	546	ND	73	31	7	4	N	Y	Y	
28	544	ND	73	32	4	1	N	Y	Y	
29	541	ND	74	31	5	3	N	Y	Y	
30	607	ND	74	31	4	0	N	Y	Y	
31	506	ND	71	34	4	0	N	Y	Y	
32	540	ND	72	33	3	1	N	Y	Y	
33	603	ND	72	33	4	1	N	Y	Y	
35	571	ND	72	31	4	0	N	Y	Y	
36	583	ND	73	31	4	0	N	Y	Y	
37	586	ND	73	32	3	0	N	Y	Y	

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Location: Division of Insurance | **Indoor Air Results**

Address: 1000 Washington St, Boston, MA | **Table 1 (continued)** | **Date: 4-19-2012**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 ($\mu g/m^3$)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
38	552	ND	75	31	11	0	N	Y	Y	

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