INDOOR AIR QUALITY ASSESSMENT

Division of Capital Asset Management
One Ashburton Place
Boston, 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 from Elsie Petit-Frere, Deputy Director of Operations, Bureau of State Office Buildings, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted an indoor air quality (IAQ) assessment at the Division of Capital Asset Management (DCAM) Bidding and Compliance Office (BCO) located on the 16th floor of The McCormack Building, One Ashburton Place, Boston, Massachusetts. The request was prompted by occupant concerns of odors related to recent interior renovations as well as general IAQ complaints.

On January 30, 2012, a visit was made to this location by Michael Feeney, Director of BEH's IAQ Program and Ruth Alfasso, Environmental Engineer/Inspector to conduct an IAQ assessment. DCAM's offices are located on several floors of the McCormack Building, a 22-story high-rise built in the mid-1970s. The BCO is located in the middle of the west side of the 16th floor. The space consists of offices, modular workstations with cloth-covered dividers, open space and a large conference room. Ceilings consist of suspended ceiling tiles. Flooring in the majority of areas, consists of carpet squares. At the time of the visit, a section of carpeting, cloth dividers and modular furniture had recently been replaced. Windows are not openable in the DCAM offices.

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. Air tests for Total Volatile Organic Compounds (TVOCs) were

conducted with a Mini-RAE 2000 photoionization detector. BEH staff also performed visual inspection of building materials for water damage and/or microbial growth.

Results

Approximately 20 people work in the BCO with approximately 20 members of the public visiting daily. Tests were taken during normal operations and results appear in Table 1. Note that the Table lists names on the cubicles at the time of the assessment to mark location.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm) in all areas surveyed, indicating adequate air exchange at the time of the assessment (Table 1). On the DCAM floors, ventilation is provided by heating, ventilation and air-conditioning (HVAC) units. Fresh air is supplied to each floor by a combination of air diffusers located on the light fixtures in the suspended ceiling and induction units located at the base of windows (Picture 1). On the 16th floor, the originally designed HVAC system configuration has been altered. Fresh air is supplied by ceiling mounted diffusers with exhaust ventilation provided by plastic grilles in the suspended ceiling, converting the HVAC system into a ceiling plenum return system.

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 existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing was not available at the time of the assessment.

The Massachusetts Building Code requires that each room 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 more information concerning carbon dioxide, please see Appendix A.

Temperatures in occupied areas ranged from 73 ºF to 75 ºF, which were within the MDPH recommended comfort guidelines. The MDPH recommends that indoor air temperatures be maintained in a range of 70 ºF to 78 ºF 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 ranged from 12 to 21 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. 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

A water cooler and mini refrigerator were found located on carpeting (Picture 2). Carpeting underneath this equipment is vulnerable to water damage, which can lead to mold growth. The carpeting under this equipment should be covered by a rubber/plastic mat to prevent moistening. No signs of current water damage or moistened materials were noted in this area.

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 school 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 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, Refrigerating 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 the assessment, outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). No measureable levels of carbon monoxide were detected inside the building 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.

Outdoor PM2.5 was measured at 6 $\mu g/m^3$ (Table 1). Indoor PM2.5 levels ranged from 1 to 4 $\mu g/m^3$ (Table 1). Both indoor and outdoor PM 2.5 levels 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 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.

Volatile Organic Compounds

Indoor air 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. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs.

The concerns that prompted the assessment at this location specifically concerned odors from materials that had been used during the renovation of the space. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. An outdoor air sample was taken for comparison. Outdoor TVOC concentrations were ND. No measureable levels of TVOCs were detected inside the building during the assessment (Table 1). Please note, that the TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling.

Indoor air concentrations can be greatly impacted by the use TVOC-containing products. While no measureable levels of TVOCs were detected in the building during the assessment, materials containing VOCs were present. BEH staff examined rooms for products containing these respiratory irritants.

There were concerns regarding a "petroleum fume" odor. It was reported that this odor may have originated from a substance used to lubricate drawer slides, particularly the keyboard

drawer on new modular furnishings. No such odors were detected during the visit, however, as with any application of a volatile material, the TVOCs and odors will dissipate over time as the product evaporates and the building's exhaust system removes vapors.

Cubicle 5 had a solid air freshener (Picture 3). Air fresheners 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). In addition, air fresheners do not remove materials causing odors, but rather mask odors which may be present in the area. Hand sanitizer was also found in the office. Hand sanitizer products may contain ethyl alcohol and/or isopropyl alcohol which are highly volatile and may be irritating to the eyes and nose, and may also contain fragrances to which some people may be sensitive (GOJO, 2007).

Other Conditions

Other conditions that can potentially affect indoor air quality were identified during the assessment. Several personal fans were observed to have accumulated dust/debris. Dust particles can become re-aerosolized when fans are activated providing a source of eye/respiratory irritation.

In several areas, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for maintenance staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. Particular attention should be made to the file storage rooms.

Conclusions/Recommendations

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

1. Discontinue the use of strongly-scented air fresheners in the building, particularly around individuals who may be sensitive to them. Since the modular furniture is newly installed, it is suggested that the installation contractor be contacted to repair all sticking drawers.
2. Avoid the use of odorous lubricants on furniture once they have been installed in a workspace.
3. 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).
4. Consider outfitting water dispensers and refrigerators with a rubber/plastic mat to prevent water damage to carpeting.
5. Clean personal fans and supply/return vents periodically of accumulated dust/debris.
6. Relocate or consider reducing the amount of stored materials to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
7. 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

Induction Unit in Office

Picture 2

Refrigerator and Water Dispenser on Carpet

Picture 3

Air Freshener

Location: Division of Capital Asset Management, Human Resources **Indoor Air Results**

Address: One Ashburton Place, 16th floor **Date: 1/30/2012**

Table 1

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp (°F)	Relative Humidity (%)	TVOCs (*ppm)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
Background	360	ND	40	40	ND	6					In front of building (temperature and RH from wunderground.com). Sunny and windy
Adjacent to Toni Raye	524	ND	73	13	ND	2	0	N	Y	Y	Air freshener
Andrea Liang	498	ND	74	13	ND	1	0	N	Y	Y	Solar gain through window
Adjacent to Stacey Jones-Walker	470	ND	74	13	ND	1	0	N	Y	Y	Portable heater under desk
Next to printer	457	ND	74	13	ND	3	0	N	Y	Y	Printer, door to hallway
Douglas Chavez	452	ND	75	12	ND	2	1	N	Y	Y	PF
Adjacent to Guido Federico	404	ND	74	12	ND	1	2	N	Y	Y	
Adjacent to Jim Gaudreau	441	ND	75	12	ND	4	3	N	Y	Y	
Mukia Baker-Gomez	428	ND	74	21	ND	2	0	N	Y	Y	

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

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%