INDOOR AIR QUALITY ASSESSMENT

Massachusetts Department of Public Health
Southeast Regional Health Office
1750 Purchase Street
New Bedford, Massachusetts

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

At the request of Ron O'Connor, Director, Massachusetts Department of Public Health (MDPH), Southeast Regional Office (SERO), the MDPH, Bureau of Environmental Health (BEH) conducted an indoor air quality (IAQ) assessment at the SERO located at 1750 Purchase Street, New Bedford, Massachusetts. On March 9, 2012, a building evaluation and IAQ testing was conducted by Cory Holmes, Environmental Analyst/Regional Inspector in BEH's IAQ Program. The assessment was prompted due to mold concerns from suspected roof leaks and exacerbation of allergies among SERO staff.

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. BEH staff also performed visual inspection of building materials for water damage and/or microbial growth.

Results

The SERO has an employee population of 22, with approximately 10-12 staff in the office daily due to off site field work, meetings, etc. The SERO typically has 2-3 visitors a day, however up to 35 visitors may be in the office during meetings or trainings. The tests were taken during normal operations and results appear in Table 1.

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 optimal air exchange at the time of the assessment (Table 1). Mechanical ventilation is provided by a heating, ventilation and air conditioning (HVAC) system controlled by digital thermostats. Three air handling units (AHUs) located on the rooftop (Picture 1) draw in fresh air, filter and heat/cool it. Fresh air is distributed to occupied areas via ducted diffusers. By design, diffusers are equipped with fixed louvers that direct air along the ceiling to flow down the walls and create airflow. Air returns to the AHUs through ceiling-mounted return vents.

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 HVAC system was reportedly balanced prior to occupancy in 2008.

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, consult Appendix A.

Indoor temperatures ranged from 70 ºF to 75 ºF in occupied areas, which were within the MDPH recommended comfort range (Table 1). 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 in the building ranged from 19 to 23 percent, which was below the MDPH recommended comfort range in all areas surveyed during the assessment. 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.

Microbial/Moisture Concerns

As mentioned previously, the assessment was prompted by the presence of water-damaged ceiling tiles that occupants believe to be associated with roof leaks. Mr. O'Connor reported that building maintenance personnel have been on-site several times over the past year to repair roof leaks, however, new damage continues to occur, usually after heavy wind-driven rain conditions. Three primary areas of leaks were listed as conference room 132, work area 117 and room 134 (the vaccine storage room). Of the three, only the vaccine storage room had current water damage in the form of a stained ceiling tile (Picture 2). BEH staff also observed a stained ceiling tile in the file room (Picture 3). Ceiling tiles were removed in each of these areas to examine conditions above the ceiling tile system for water-damaged building materials that could provide a source for mold growth. No mold-colonized materials were observed in any of the areas at the time of the assessment. The ceiling plenum mainly contains metal and concrete block materials, which are not conducive to mold growth. In addition, the ceiling plenum is an area that has a large volume of moving air, which aids in the drying of any moistened materials.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed and discarded.

Several areas had plants (Table 1); in one case a plant was observed on paper towels (Picture 4), which is a porous material conducive to mold growth. Plants can be a source of pollen and mold, which can serve as respiratory irritants for some sensitive individuals. Plants should be properly maintained and equipped with drip pans to prevent water damage to porous building materials. Plants should also be located away from ventilation sources (e.g., air diffusers, portable fans) to prevent the aerosolization of dirt, pollen or mold.

A mop bucket with dirty water was also observed in the custodial closet, which can provide a source of unpleasant odors and bacterial growth (Picture 5). After each use, buckets should be emptied/rinsed and mops set to dry.

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 building 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. Outdoor carbon monoxide concentrations were non-detect (ND) the day of the assessment (Table 1). No measureable levels of carbon monoxide were detected in 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.

The outdoor PM2.5 concentration was measured at 8 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from 4 to 7 $\mu g/m^3$ (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 activities that occur indoors and/or mechanical devices 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.

Conclusions/Recommendations

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

1. Remove/replace water-damaged ceiling tiles.

2. Continue to work with building management to address roof leaks. Consider contacting a roofing contractor to conduct high-pressure water testing and/or infra-red analysis to determine source of roof leaks.
3. Replace missing insulation on bottom of ductwork in 134 vaccine room (Picture 2), to prevent condensation on metal surfaces and further water damage to ceiling tiles.
4. Ensure all plants are equipped with non-porous drip pans. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.
5. Empty and rinse mop buckets after each use. Mops should be cleaned, disinfected and set up to dry between uses.
6. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
7. 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).
8. Clean accumulated dust and debris periodically from supply diffusers, return/exhaust vents and personal fans.

References

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Picture 1

Rooftop Air Handling Units, 1750 Purchase Street

Picture 2

Water-Damaged Ceiling Tile in Vaccine Storage Room 134,
also Note Insulation Removed from Base of Metal Ductwork

Picture 3

Water-Damaged Ceiling Tile in File Room

Picture 4

Plant on Paper Towels

Picture 5

Dirty Mop/Water in Bucket in Custodial Closet

Location: MDPH Southeast Regional Office **Indoor Air Results**

Address: 1750 Purchase Street, New Bedford, MA **Table 1** **Date: 3/9/2012**

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Carbon Monoxide (*ppm)	PM2.5 ($\mu g/m^3$)	Occupants in Room	Windows Openable	Ventilation		
Background	329	51	22	ND	8					Overcast, cool, westerly winds 17-31 mph, gusts up to 50 mph
New Bedford Meeting Room	424	72	21	ND	5	3	N	Y	Y	DO
Brockton Meeting Room	386	72	19	ND	5	0	N	Y	N	DO
Break Room	422	73	20	ND	7	0	N	Y	Y	DO
102 Reception	420	70	22	ND	5	1	N	Y	Y	
103/106	468	71	22	ND	5	1	N	Y	Y	
104/105	495	70	22	ND	5	0	N	Y	Y	Plant on paper towel
107/108	524	71	22	ND	5	1	N	Y	Y	Plants
109/113	460	71	22	ND	5	2	N	Y	N	
114/115	476	72	22	ND	5	1	N	Y	Y	Plants
116/118	489	73	21	ND	5	1	N	Y	Y	

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter

ND = non detect
WD = water damaged

DO = door open
CT = ceiling tile

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: MDPH Southeast Regional Office **Indoor Air Results**

Address: 1750 Purchase Street, New Bedford, MA **Table 1 (continued)** **Date: 3/9/2012**

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Carbon Monoxide (*ppm)	PM2.5 (μg/m³)	Occupants in Room	Windows Openable	Ventilation		
119/122	460	73	21	ND	7	1	N	Y	Y	
125/126	401	72	20	ND	5	1	N	Y	Y	
128 Interview Room	395	72	19	ND	5	0	N	Y	N	
129 Office	477	71	23	ND	5	1	N	Y	Y	DO
130 Office	442	71	23	ND	5	0	N	Y	N	DO
131 File Room	512	75	22	ND	6	0	N	Y	N	Light dust/debris accumulation on supply louver vents, 1 WD CT
132	551	74	23	ND	6	3	N	Y	N	Area of reported roof leaks, no current WD, no visible mold growth above CTs
134 Vaccine Storage Room	395	68	19	ND	4	0	N	Y	Y	1 WD CT-suspected roof leaks during certain wind/weather conditions, missing fiberglass insulation on bottom of metal ductwork above CTs-possible condensation issue, no visible mold growth

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Comfort Guidelines

Carbon Dioxide:	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems	Temperature: Relative Humidity:	70 - 78 °F 40 - 60%