INDOOR AIR QUALITY ASSESSMENT

Massachusetts Registry of Motor Vehicles
4210 Washington Street
Roslindale, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
October 2013

Background/Introduction

In response to a request from Mr. Aric Warren, Deputy Director of General Services, Massachusetts Department of Transportation (MassDOT), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality (IAQ) concerns at the Roslindale Branch of the Massachusetts Registry of Motor Vehicles (RMV). The Roslindale RMV branch is located at 4210 Washington Street, Roslindale, Massachusetts.

On June 25, 2013, a visit to conduct an IAQ assessment was made by Sharon Lee, Environmental Analyst/Inspector within BEH's IAQ Program. Ms. Lee was accompanied by Robert Northrup, Program Coordinator, MassDOT. The assessment was prompted by reports of exacerbation of asthma and allergies believed to be associated with building conditions.

The RMV is located on the first floor of the historical Roslindale Community Center (RCC). The RCC is a three- story brick building with a flat rubber membrane roof that was constructed circa 1920. The RMV has occupied the space since 2006. The RMV space consists of a large open service area/waiting room, an office, and a bathroom. The space has a dropped-tile ceiling system and floor tiles. Openable windows were observed.

Methods

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

Results

The RMV has an employee population of approximately 20 and can be visited by up to 500-600 members of the public on a daily basis. The tests were taken during normal operations. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in all areas surveyed, indicating a lack of air exchange at the time of assessment. The RMV lacks mechanical ventilation, and relies on openable windows for fresh air. Radiant heat from ceiling-mounted diffusers warms the building during the heating season (Picture 1), while window-mounted air-conditioners provide chilled air during the warmer months (Picture 2). Both air-conditioning units were operating at the time of assessment. Window air-conditioning units also provide some fresh air from outside when operated in a non-recirculating mode and most have a fan-only mode which can provide fresh air without cooling.

An exhaust vent is located in the bathroom. The exhaust fan is activated by a switch connected to an occupancy sensor which also activates the light. When the light is deactivated, the bathroom exhaust fan also turns off and ceases to remove odors and moisture that typically accumulate in a restroom.

Minimum design ventilation rates are mandated by the Massachusetts State Building Code (MSBC). Until 2011, the minimum ventilation rate in Massachusetts was higher for both occupied office spaces and general classrooms, with similar requirements for other occupied spaces (BOCA, 1993). The current version of the MSBC, promulgated in 2011 by the State

Board of Building Regulations and Standards (SBBRS), adopted the 2009 International Mechanical Code (IMC) to set minimum ventilation rates. **<u>Please note that the MSBC is a minimum standard that is not health-based.</u>** At lower rates of cubic feet per minute (cfm) per occupant of fresh air, carbon dioxide levels would be expected to rise significantly. A ventilation rate of 20 cfm per occupant of fresh air provides optimal air exchange resulting in carbon dioxide levels at or below 800 ppm in the indoor environment in each area measured. MDPH recommends that carbon dioxide levels be maintained at 800 ppm or below. This is because most environmental and occupational health scientists involved with research on IAQ and health effects have documented significant increases in indoor air quality complaints and/or health effects when carbon dioxide levels rise above the MDPH guidelines of 800 ppm for schools, office buildings and other occupied spaces (Sundell et al., 2011). 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.

Temperature readings ranged from 76º F to 81º F during the assessment, which were above the MDPH recommended comfort guidelines in several areas. The MDPH recommends that indoor air temperatures be maintained in a range of 70º F to 78º 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 during the assessment ranged from 56 to 62 percent, which was within or slightly above 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.

Microbial/Moisture Concerns

A few areas had water-damaged ceiling tiles (Table 1). Water-damaged ceiling tiles indicate leaks from plumbing and/or the building envelope system (e.g., roof). Ceiling tiles moistened repeatedly over time can provide a source for mold growth. Water-damaged ceiling tiles should be replaced after a water leak is discovered and repaired.

Carpeting and walk-off mats are located in the entryway and waiting area of the RMV. The carpet and mats appeared water-damaged and soiled (Picture 3). Walk-off mats are designed to reduce the amount of dust, dirt, and moisture entering the building. Deposited materials can become aerosolized due to repeated abrasion as well as be a source of odors when the mat is moistened. These carpet/mats should be vacuumed using a high efficiency particulate arrestance (HEPA) filter vacuum to prevent accumulation of dusts. Consideration should also be given to replacing these mats periodically. Placing scraper mats in the entryway could serve to collect moisture and larger particles, as well as extend the life of carpet/walk-off mats.

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.

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 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/IAQ 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 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, 2011). 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 ranged from non-detect (ND) to 1 ppm (Table 1). These levels of outdoor carbon monoxide can be attributed to heavy vehicle traffic. No measurable levels of carbon monoxide were detected inside the building (Table 1).

Particulate Matter

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter includes airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to PM with a diameter of 10 μm or less (PM10). In 1997, US EPA established a more protective standard for fine airborne particulate matter with a diameter of 2.5 μm or less (PM2.5). 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 PM concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 40 $\mu g/m^3$ (Table 1), which were above the NAAQS PM2.5 level of 35 $\mu g/m^3$ the day of assessment. PM2.5 levels measured indoors were between 13 and 16 $\mu g/m^3$ (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.

Other Conditions

Other conditions that can affect indoor air quality were observed during the assessment. A personal fan was observed to have accumulated dust. The exhaust vent in the restroom was also occluded with dust, which inhibits its ability to function and may also lead to damage of the fan motor. Activating an exhaust vent or personal fan can result in the aerosolization of accumulated dusts. In addition, if exhaust vents are not functioning, backdrafting can occur, which can also aerosolize accumulated dust particles. Window air conditioners are equipped with filters which need to be cleaned periodically for the units to function properly.

Staff indicated periodic pests concerns. Under current Massachusetts law (effective November 1, 2001) the principles of integrated pest management (IPM) must be used to remove pests in state buildings (Mass Act, 2000). Pesticide use indoors can introduce chemicals into the indoor environment that can be sources of eye, nose and throat irritation. The reduction/ elimination of pathways/food sources that are attracting these insects should be the first step taken to prevent or eliminate infestation.

Lack of storage appears to be a concern at the RMV. Materials were stored on floors and along walls throughout the location (Picture 4), which can make cleaning difficult. Items should be reduced, relocated and/or be cleaned periodically to avoid excessive dust build up. In addition, dust and debris can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation. Accumulated items can also serve as rodent harborage.

Conclusions/Recommendations

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

1. Consider installing wall-mounted/revolving fans to facilitate air circulation.
2. When window air conditioners are in use, operate in a mode that introduces fresh air into the building; the fan-only mode may be used during temperate weather to provide fresh air without cooling.
3. Clean fans and vents periodically to prevent aerosolization of accumulated dust. Also clean filters in the air conditioners periodically.
4. Increase cleaning of walk off mats and carpeting to reduce accumulated dust/debris. Replace mats periodically.
5. Consider installing a scraper mat in the first entryway to facilitate removal of moisture and large particles from shoes.
6. Consider installing a separate switch for the restroom exhaust vent, which is currently activated by a motion sensor light.
7. Continue with current IPM plan, report pest sightings/issues to building management.
8. Improve storage practices to prevent dust accumulation and pest harborage.
9. 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 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).

10. Ensure leaks are repaired and replace water-damaged ceiling tiles. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
11. Relocate or consider reducing the amount of materials stored in offices and common areas to allow for more thorough cleaning.
12. 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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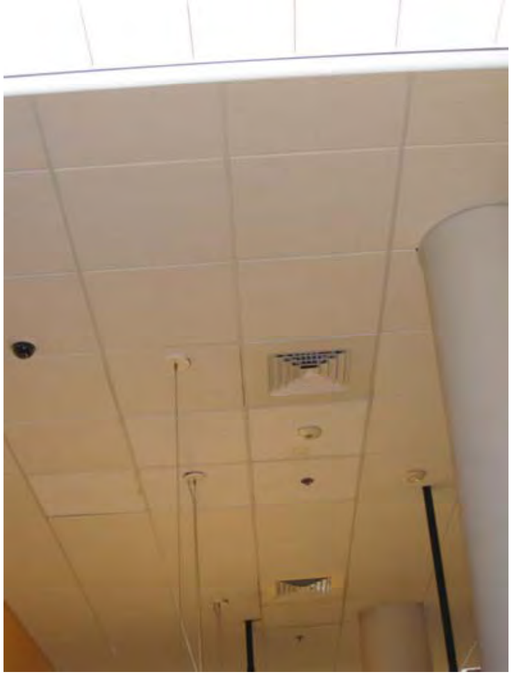
Picture 1



Diffusers for heated air

Picture 2

Window-mounted air conditioning unit

Picture 3

Water-damaged, soiled carpeting in entryway

Picture 4

Lack of storage contributing to cleaning concerns

Location: Registry of Motor Vehicles **Indoor Air Results**

Address: 4210 Washington St., Roslindale, MA **Date: 6/25/2013**

Table 1

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
Outside (Background)	384	ND-1	84	58	40					High traffic area
Staff Restroom	981	ND	76	62	14	0	Y	Y	Y	AT, CPs
Public Restroom	1000	ND	78	62	15	0	N	Y	Y	No soap
Waiting Area	1112	ND	77	56	13	35	N	Y	Y	4 WD CTs
Office	1198	ND	81	56	13	2	Y	Y	Y	Refrigerator
Stations	980	ND	79	59	16	8	N	Y	Y	PF, PC, cooler

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
ND = non detect
AT = ajar tile
CP = cleaning products
CT = ceiling tile
PC = photocopier
PF = personal fan
WD = water-damaged

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%