INDOOR AIR QUALITY ASSESSMENT

Massachusetts Department of Public Health
Northeast Regional Health Office
Saunders Building
Ground Level
Tewksbury Hospital Campus
Tewksbury, Massachusetts 01876

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 the Executive Office of Health and Human Services, Human Resources Department (HRD), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality concerns at the MDPH Northeast Regional Health Office (NRHO) on the ground level of the Saunders Building on the Tewksbury Hospital campus, Tewksbury, Massachusetts.

On October 23, 2008, a visit to conduct an indoor air quality assessment at the NRHO was made by Michael Feeney, Director of the BEH's Indoor Air Quality (IAQ) Program. Reports of poor indoor air quality in offices along the exterior wall of the building prompted this assessment.

The NRHO is located on the ground level at the rear of the Saunders Building (Picture 1). The NRHO consists of several rooms, which have been sub-divided into private offices. Windows open either to the exterior wall of the building or into a courtyard, where some hospital patients and staff smoke throughout the day.

Methods

Tests for carbon dioxide, carbon monoxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a HNu Photo Ionization Detector (PID). BEH staff performed a visual inspection of building materials for water damage and mold growth.

Results

The NRHO has a staff population of 20. Tests were taken under normal operating conditions 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, which is generally indicative of adequate air exchange. It is important to note that the NRHO does not have an operable mechanical ventilation system; rather, the NRHO uses windows and exterior doors to introduce fresh air. Cooling is provided by window-mounted air-conditioners (WACs).

The Massachusetts Building Code requires that each room in an office 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.

Temperature readings in occupied areas at the time of the assessment were measured in a range of 72° F to 77° F, which were within the MDPH comfort guidelines (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 in the building ranged from 17 to 28 percent, which was below the MDPH recommended comfort range on the day of the assessment (Table 1). The MDPH recommends that indoor relative humidity be maintained in a comfort range of 40 to 60 percent. 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

No water damage or mold growth sources were noted within the NRHO at the time of the assement.

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 and acute health effects upon exposure. To determine whether combustion products were present indoors, 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. An operator of an indoor ice must take actions to reduce carbon monoxide levels, if those levels exceed 30 ppm, 20 minutes after resurfacing within a rink (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 were non-detect (ND) (Table 1). Carbon monoxide levels measured in the building were also ND at the time of the assessment.

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 microgram 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 μg/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 concentrations the day of the assessment were measured at 3 μg/m^3. PM2.5 levels measured in the building ranged from 4 to 6 μg/m^3 (Table 1). Both indoor and outdoor PM2.5 levels were below the NAAQS PM2.5 level of 35 μg/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 in buildings 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, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Volatile Organic Compounds

In order to assess whether respiratory irritants of a chemical nature were present, air sampling for the presence of volatile organic compounds (VOCs) was conducted. VOCs are substances that have the ability to evaporate at room temperature. For example, solvent-based chemicals that rapidly evaporate at room temperature and would likely contain VOCs. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals.

BEH staff conducted TVOC sampling in offices (Table 1). Background (i.e. outdoor) TVOC sampling was conducted for comparison. No measurable levels of TVOCs were detected inside the NRHO or outdoors on the day of assessment.

Other Conditions

As previously mentioned, the ground level NRHO offices have windows that open to the courtyard, which is designated as a smoking area for hospital patients and staff. When these windows are open, outdoor pollutants (i.e. environmental tobacco smoke) can infiltrate the NRHO offices. When window-mounted air-conditioners (WACs) for these offices are activated, smoke can be entrained by the WACs and introduced into the indoor office environment (Picture 2).

Environmental Tobacco Smoke (ETS) is a mixture of gases and fine particles emitted by the burning of tobacco products and smoke exhaled by the smoker (USDHHS, 2006). ETS is a pollutant which can have a marked effect on indoor air quality and cause adverse health effects. ETS can exacerbate the frequency and severity of symptoms in those with respiratory conditions (i.e. asthma), as well as those with existing or known heart conditions. The most effective method of preventing exposure to environmental tobacco smoke is to have smoke free buildings. M.G.L. Chapter 270, Section 22 prohibits smoking in public buildings (M.G.L., 2004). Smoking is allowed in an outdoor space (i.e. outdoor patio or deck) if the outdoor space is:

1. Physically separated from the enclosed workspace;
2. Open to the air at all times; and
3. Smoke does not migrate back into the workspace (e.g. through a door or window) (M.G.L, 2004).

While smokers do not have to stand a specific distance from outside of a workplace building, smoke *cannot* migrate back into any enclosed workplace. Any smoke that migrates back into the workspace is considered a violation of the law (M.G.L., 2004).

Conclusions/Recommendations

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

1. Identify an alternative smoking area for patients and staff.
2. Discourage cigarette smoking in the courtyard by removing the benches near the NRHO windows and posting the courtyard with no smoking signs prohibiting smoking.

References

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Picture 1

Section of the Saunders Building That Contains the NRHO

Picture 2

Picture of Bench and Individual in Close Proximity to NRHO Office Window and Window-Mounted Air Conditioner

Location: DPH Northeast Regional Health Office **Indoor Air Results**

Address: Tewksbury Hospital, Tewksbury, MA

Table 1

Date: October 23, 2008

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	TVOCs (*ppm)	Carbon Monoxide (*ppm)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
Background	385	50	35	ND	ND	3					
EB15	447	73	28	ND	ND	4	0	Y	N	N	WAC w/o filter
EB16	578	75	25	ND	ND	4	2	Y	N	N	WAC Door open
EB16A North	535	76	22	ND	ND	5	1	Y	N	N	WAC Door open Cigarette smoke from courtyard
EB16A South	528	78	20	ND	ND	5	1	Y	N	N	WAC Door open
EB17	496	76	20	ND	ND	5	1	Y	N	N	WAC Door open
EB21	538	75	23	ND	ND	6	1	Y	N	N	WAC Door open Cigarette smoke from courtyard
EB25	605	74	24	ND	ND	6	1	Y	N	N	WAC Door open Cigarette smoke from courtyard
EB28	445	74	18	ND	ND	6	0	Y	N	N	WAC Door open

ppm = parts per million WAC = window air-conditioner

µg/m^3 = micrograms per cubic meter ND = non detect

Comfort Guidelines

Carbon Dioxide:	< 600 ppm = preferred	Temperature:	70 - 78 °F
	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
	> 800 ppm = indicative of ventilation problems	Particle matter 2.5	< 35 ug/m^3

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Date: October 23, 2008

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	TVOCs (*ppm)	Carbon Monoxide (*ppm)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
EB32	478	74	20	ND	ND	5	0	Y	N	N	WAC Door open
EB14	458	75	20	ND	ND	5	1	Y	N	N	WAC Door open
EB14 Refrigerator Room	446	75	20	ND	ND	5	1	Y	N	N	WAC Door open
EB13	506	74	19	ND	ND	5	1	N	N	N	
EB13B	448	72	19	ND	ND	5	1	Y	N	N	WAC Door open Window open
EB13A	478	73	18	ND	ND	5	1	Y	N	N	WAC Door open
EB12 South	585	74	28	ND	ND	5	2	N	N	N	
EB 12 Central	572	75	27	ND	ND	5	0	Y	N	N	WAC Door open
EB12 North	576	75	26	ND	ND	5	0	Y	N	N	
EB12B	587	75	26	ND	ND	5	0	N	N	N	
EB12A	568	75	27	ND	ND	5	0	N	N	N	

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									Intake	Exhaust	
EB11	577	75	23	ND	ND	5	1	N	N	N	WAC Door open
EB2	488	77	18	ND	ND	5	1	Y	N	N	WAC Door open
EB4	509	76	17	ND	ND	5	0	N	N	N	
EB3	436	77	15	ND	ND	5	0	Y	N	N	WAC Door open Window open
EB1	462	76	18	ND	ND	5	1	N	N	N	Fan on Door open

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