INDOOR AIR QUALITY ASSESSMENT

John Adams Courthouse
One Pemberton Square
Boston 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 Mr. Stephen Carroll, Director of the Court Facilities Bureau (CFB), Administrative Office of the Trial Court, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality concerns in Room 2-656 at the John Adams Courthouse (JAC), One Pemberton Square Boston, Massachusetts. On May 11, 2011, a visit to conduct an indoor air quality (IAQ) assessment was made to the JAC by Michael Feeney, Director of BEH's IAQ Program. Concerns about lingering environmental effects from water damage related to a leaking air-handling unit (AHU) located above Room 2-656 prompted the request.

Room 2-656 is located along an interior courtyard of the JAC, which was completely renovated and then reopened in 2004. As mentioned, an AHU is located in the ceiling area above Room 2-656, with the fresh air intake located on the exterior wall. A coil within the unit reportedly froze and broke during the winter of 2004/2005, causing water damage to the walls and ceiling of Room 2-656. A drain pan was installed beneath the AHU as a result of that incident. In February 2011, water from the drain pan moistened the ceiling and walls of Room 2-656 (personal conversation with Stephen Carroll, May 11, 2011).

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. Moisture content of porous building materials (gypsum wallboard and wood) was measured with a Tramex Non-Destructive Moisture Encounter Plus.

Results

The area was occupied by 1 employee at the time of the assessment. Tests were taken during normal operations; results of the air tests appear in Table 1 and results of moisture testing appear in Table 2.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm), indicating adequate air exchange at the time of the assessment (Table 1). Fresh air is drawn into the AHU and supplied to occupied areas via ceiling-mounted fresh air diffusers. A wall-mounted fan coil unit (FCU) installed beneath the room's window, supplements heating and cooling.

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 of the HVAC system occurred when the JAC was reopened in 2004.

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.

The temperature measured in Room 2-656 was 71° F, which was within the MDPH recommended comfort guidelines at the time of the assessment. 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 Room 2-656 was 43 percent, which was also within the MDPH recommended comfort range at the time of the assessment. 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

In order for building materials to support mold growth, a source of water exposure is necessary. As stated previously, the walls and ceiling were reportedly moistened by water originating from the AHU above Room 2-656, and water-damaged building materials in Room 2-656 were repaired. At the time of the assessment, no remaining water-damaged materials were observed nor were any musty/mold-like odors detected.

In an effort to ascertain whether building materials had water content that could create conditions leading to mold growth, moisture sampling of gypsum wallboard (GW), wooden window frames, doorframes, wainscoting, and FCU cabinets was conducted using a non-invasive moisture meter. For comparison, moisture samples of similar building materials were taken in the hallway outside of Room 2-656. Moisture content of building materials using the Tramex Non-Destructive Moisture Meter is considered normal if measurements are below the following parameters: ≤ 0.5 percent in GW and carpeting; ≤ 85 percent for plaster; or ≤ 15 in wood. All moisture testing of building components in Room 2-656 and the hallway outside were below moisture content guidelines (Table 2), indicating that these materials were dry[1].

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials (e.g., ceiling tiles, carpeting) 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/discarded. Based on observations made in Room 2-656, it appears that remediation was conducted as recommended in the US EPA mold remediation guidelines.

Plants were noted on the FCU. Plants can be a source of pollen and mold which can be respiratory irritants to some individuals. Plants should be properly maintained and equipped with drip pans. They should also be located away from mechanical ventilation components to prevent the aerosolization of dirt, pollen and mold.

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

[1] Moisture content is detected as a real time measurement of the conditions present in the building at the time of the assessment. The building was evaluated on a cloudy day, with an outdoor temperature of 55 ^{o} F and relative humidity of 52 percent. Moisture content of materials may increase or decrease depending on building and weather conditions. During tnormal operation of a heating, ventilating and air-conditioning (HVAC) system, moisture is introduced into a building during weather with high relative humidity. As indoor relative humidity levels increase, porous building materials, such as GW, plywood or carpeting, can absorb moisture. The moisture content of materials can fluctuate with increases or decreases in indoor relative humidity.

products were present in the building environment, BEH staff obtained measurements for carbon monoxide and airborne particulates.

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, 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 9 $\mu g/m^3$ (Table 1). Indoor PM2.5 levels were measured at 1 $\mu g/m^3$ (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.

Conclusions/Recommendations

At the time of the assessment, the remediation of Room 2-656 was completed, as demonstrated by the lack of water-damaged building materials and musty/mold related odors. The room appeared well ventilated with carbon dioxide and temperature measurements within acceptable comfort ranges. Air sampling for carbon monoxide and PM2.5 indicated no unusual levels of these contaminants in areas tested. Lastly, moisture sampling indicated that building materials were dry and would not be prone to developing mold growth. Based on these observations and measurements, Room 2-656 does not appear to have issues related to indoor air quality.

However, the location of the AHU above this room could present problems associated with water damage to building materials in the future, should a leak develop in the drain system or if the coils freeze again. If water damage is noted, immediate notification of the CFB would help to rapidly evaluate, arrest and remediate a moisture damage issue quickly while minimizing the potential for building materials to become mold colonized.

Based on these observations, the following recommendations are made.

1. If water damage recurs, notify the CFB as soon as practicable.
2. Move plants from the surface of FCUs.
3. Establish a communication plan for more rapid notification should this type of incident recur.

References

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Location: John Adams Courthouse **Indoor Air Results**

Address: 1 Pemberton Square, Boston, MA **Table 1** **Date: 5/11/2011**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (μg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Background	393	ND	55	52	9					
2-656	625	ND	71	43	1	1	Y	Y	N	Fan Coil Unit
Hallway	477	ND	71	39	1	0	N	Y	N	Fan Coil Unit

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

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	Material	Moisture Measurement (%)	Comments
2-656	Wooden Wainscoting	5-12	
	Fan Coil Unit/Wood	9-13	
	Wooden Window Frame	8-13	
	Gypsum Wallboard	0.3-0.5	
	Wooden Door Frame	5-12	
Hallway	Wood	5-12	
	Fan Coil Unit/Wood	9-13	
	Wooden Door Frame	8-13	
	Wooden Window Frame	8-13	
	Gypsum Wallboard	0.3-0.5	