INDOOR AIR QUALITY REASSESSMENT

Hampshire County Family and Probate Court
33 King Street
Northampton, 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 Ann Schiro, Project Manager, Office of Planning, Design and Construction, Massachusetts Division of Capital Asset Management (DCAM), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted an indoor air quality (IAQ) assessment at the Hampshire County Family and Probate Court (HFPC), 33 King Street, Northampton, Massachusetts. Concerns about general IAQ, pollutants from renovations, water damage and temperature control, prompted the request. The heating, ventilating and air conditioning (HVAC) systems are currently being renovated as a part of building upgrades.

On June 28, 2013, Michael Feeney, Director of BEH's IAQ Program, made a visit to this building. The HFPC is a two-story cement building originally constructed in the 1950s as a parking garage. The building was reportedly converted into office space in 1976. The building contains the Hampshire Family Court, the Hampshire Probate Court, the Hampshire Registry of Deeds and Probation offices. The building does not have a fire suppression system. Windows are not openable in the building.

BEH/IAQ staff previously visited the HFPC on January 19, 2007 and issued a report detailing conditions observed at that time, with recommendations to improve air quality. This report is available by request. Actions taken on recommendations made in that report are listed in Appendix A.

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

Results

The HFPC has an employee population of over 30 with several hundred visitors on a daily basis. 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 generally indicates adequate fresh air supply in a building. Fresh air is supplied by ceiling or wall-mounted fresh air supply vents connected to a rooftop air-handling unit (AHU). Exhaust ventilation is provided by ceiling-mounted exhaust vents, with the exception of the probate court on the second floor. This second floor section of the building has a ceiling plenum exhaust system. It appears that gypsum wallboard (GW) was installed on the underside of the wood roof decking. At the time of this assessment, a significant number of ceiling tiles were removed exposing the ceiling plenum. The GW affixed to roof rafters was water-damaged and missing in some areas, exposing the wood roof decking.

In order to provide an even, well-distributed means for exhaust ventilation, the ceiling plenum return must have all of its ceiling tiles in place. If it is operating with an extensive number of ceiling tiles missing (such as in the probation office), exhaust air will be drawn

through the opening nearest the return duct. This condition will deprive areas further away from the return duct of exhaust ventilation and draw pollutants through hallways in the Probate Court offices.

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). Balancing of the HVAC systems should occur upon completion of installation.

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. **Please note that the MSBC is a minimum standard that is not health-based**. 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, please see Appendix B.

Temperature readings the day of assessment ranged from 72ºF to 76ºF, which were within the MDPH recommended temperature range of 70ºF to 78ºF. Employees expressed concerns about the lack of temperature control in the building (e.g., not enough heat in winter/cooling in hot weather). There are a number of factors that likely contribute to these temperature control difficulties, including:

- The window system consists of a single pane of glass installed in a metal frame. When exposed to direct sunlight the glass and metal of the windows can become a significant heat source.
- Conversely, windows that are not exposed to sunlight but rather to northwesterly winds during cold weather would be expected to result in significantly lowered temperatures in adjacent areas than in the building's interior.

Thus, the location of the room and weather conditions are likely to have significant influence on room temperature. Please note that even without these design and construction issues, fluctuations of temperature in occupied spaces are typically experienced, even in buildings with an adequate fresh air supply.

The relative humidity measurements the day of assessment ranged from 69 to 74 percent, which were above the MDPH recommended range of 40 to 60 percent. It is important to note that these measurements were taken on an unusually humid day with an outdoor relative humidity of 82 percent without precipitation. Excessive humidity indoors can be attributed to the intake of outdoor air. However, air conditioning components in rooftop AHUs were able to reduce humidity levels in a range of 8 to 13 percent below outdoor levels.

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

The ceiling has experienced repeated water damage to GW in the ceiling plenum according to building occupants (Pictures 1 and 2). As previously mentioned, the building does

not appear to be equipped with a fire suppression system. It seems likely that GW has been installed on the underside of wood roof/floor decking to provide a fire barrier. With the ceiling tiles removed and GW missing, the wood roof decking is exposed and has no fire protection.

BEH/IAQ staff conducted a visual inspection of the supply ductwork in the Probation office and did not observe any water damage to duct insulation (Pictures 3 through 5). BEH/IAQ staff did note water staining on an insulated pipe in the ceiling plenum (Picture 6); however no mold growth was observed. It is important to note that similar ductwork was not examined in other areas of the building. Aside from microbial concerns, if insulation is visibly water-damaged, this may result in a reduction of the efficiency of the insulation.

In order to become colonized with mold, a material must be exposed to water and remain moist. If sufficiently moistened, porous materials such as books, paper, insulation covering, and carpeting can support mold growth (US EPA, 2001). The 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 porous materials are 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.

Construction/Renovation Concerns

Renovation activities can produce a number of pollutants, including dirt, dust, particulate matter, and combustion products such as carbon monoxide from construction equipment. Materials generated from construction activities can settle on horizontal surfaces in offices, particularly when renovations involve roof/HVAC system upgrades such as this project. Dusts can be irritating to the eyes, nose and respiratory tract. At the time of the BEH/IAQ site visit,

construction activities were being conducted above the Probate Court section of the building. Occupants reported accumulation of dust and debris on desks and other office furniture.

The likely reason for the dust/debris accumulation was the lack of a complete set of ceiling tiles in the Probation area. The suspended ceiling system would normally serve as a barrier to prevent dust, dirt and other debris from falling into the Probation office. With missing ceiling tiles, dust and debris from the renovations freely enters the occupied space. As noted previously, in order for a ceiling plenum return system to function as designed, the suspended ceiling system must have all of its ceiling tiles properly in place. If ceiling tiles are missing, air would be drawn from the opening closest to the return air duct and result in environmental pollutants being drawn through the occupied space, rather than through ceiling plenum intake vents (Picture 7). The vents closest to the rooftop AHU are likely located in the main Probation office (Picture 8). In addition, the lack of suspended ceiling tiles in the hallway would affectively reduce/eliminate air drawn from office spaces in the private Probation offices, the courtroom and judge's lobby, which would then result in increased accumulation of normally-occurring as well as renovation-generated pollutants in these areas.

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 were non-detect (ND) (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 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 concentration the day of assessment was measured at 47 $\mu g/m^3$ (Table 1), which was above the NAAQS PM2.5 level of 35 $\mu g/m^3$. These conditions likely reflect elevated background particulates that occur during summer months in New England due to heat/atmospheric conditions and high pollen counts. PM2.5 levels measured indoors ranged from 13 to 22 $\mu g/m^3$ (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 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

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

1. Fully implement the recommendations made in the previous MDPH IAQ assessment (Appendix A) for this building.
2. Replace missing ceiling tiles to restore the integrity of the ceiling plenum return system in the Probation office. If ceiling tiles become moistened/damaged, replace as needed.
3. As reported by DCAM officials, return system ductwork in the Probation office is planned for installation, which would eliminate the ceiling plenum return system. BEH/IAQ staff agree that this plan would render the HVAC system more effective.
4. Increase nightly cleaning of Probation office areas during the course of renovations.
5. Water-damaged GW in the ceiling plenum should be removed/replaced.
6. Examine supply ductwork and pipe insulation and replace if visibly water-damaged.
7. Ensure that the HVAC system operates at an appropriate temperature to prevent condensation.
8. Use window shades/blinds as much as practical to provide thermal comfort.

9. 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

Water damage to GW in the ceiling plenum above the Probation office

Picture 2

Water damage to GW in the ceiling plenum above the Probation office

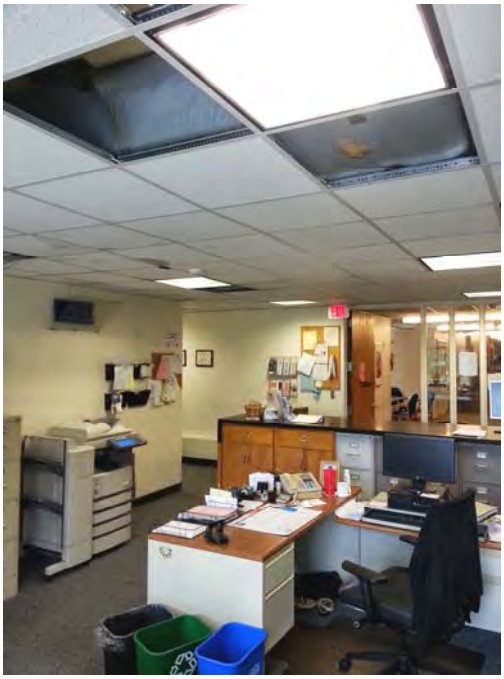
Picture 3

Duct insulation

Picture 4

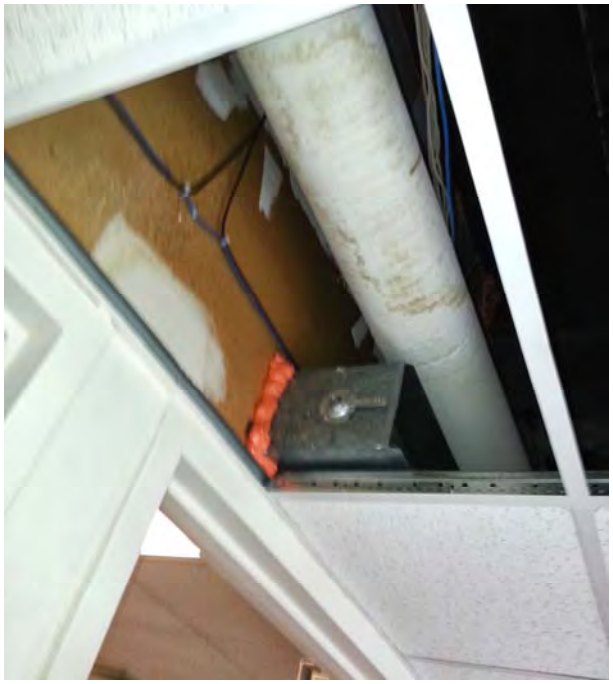
Duct insulation

Picture 5



Duct insulation

Picture 6



Water staining on insulated pipe in the ceiling plenum

Picture 7

Ceiling plenum intake vents

Picture 8

Likely location of vent closest to the rooftop AHU in the main Probation office

Location: Hampshire County Family and Probate Court **Indoor Air Results**

Address: 33 King Street, Northampton, MA **Table 1** **Date: 6/28/2013**

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 (Outdoors)	361	ND	80	82	47					
Probation Hallway	559	ND	74	69	21	1	N	Y	Y	2 WD CTs, 10+ missing CTs
Probation Office	586	ND	74	71	22	2	N	Y	Y	Portable fan
Chief Probation	504	ND	72	74	17	1	N	Y	Y	DO
Probation Main Office	498	ND	73	73	18	0	N	Y	Y	Photocopier
Lunch- Room Probation	519	ND	73	71	19	0	N	Y	Y	Microwave, refrigerator, WD carpeting, WD window sill
146	478	ND	73	69	20	0	N	Y	N	
266	656	ND	74	70	19	2	N	Y	Y	DO
267	555	ND	74	72	18	0	N	Y	N	
Registry of Probate 2nd Assistant	579	ND	74	72	19	0	N	Y	Y	DO
Registry of Probate store Room	561	ND	74	71	19	0	N	Y	Y	

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

WD = water-damaged CT = ceiling tile DO = door open

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: Hampshire County Family and Probate Court **Indoor Air Results**

Address: 33 King Street, Northampton, MA **Table 1 (continued)** **Date: 6/28/2013**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Conference Room	561	ND	74	72	19	0	N	Y	Y	
Jill's Office	635	ND	76	70	15	1	N	Y	Y	
Registry of Probate Main Office	590	ND	74	70	13	7	N	Y	Y	WD window sills, portable fan
Closing Room	472	ND	73	70	21	0	N	Y	N	DO
Registry of Deeds main office	536	ND	72	73	16	11	N	Y	N	DO
Lobby	604	ND	73	73	16	1	N	Y	N	

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Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Appendix A

Actions on MDPH Recommendations, Hampshire County Family and Probate Court, Northampton, MA

The following is a status report of action(s) taken on MDPH recommendations made in the 2007 MDPH report (**in bold**) based on reports from maintenance staff, documents, and MDPH staff observations.

- Ensure leaks are repaired and replace any remaining water-damaged ceiling tiles. Examine the space above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
- **Action Taken:** Ceiling tiles were removed as part of HVAC system renovation.
- Consider either raising the exhaust vent and vent pipe for restroom (approximately 6-10 feet from the AHU air intake), or extending ductwork for AHU air intake away from exhaust and vent pipe to reduce/prevent entrainment of exhaust odors into the mechanical ventilation system.
- **Action Taken:** It was not possible to evaluate the roof during this assessment. BEH recommends that this remediation be completed if not already done.
- **Consider discontinuing the use of the ozone generating air purifier.**
- **Action Taken**: No ozone generators were observed during the assessment.
- **Examine the feasibility of installing exhaust ventilation for rooms with multiple photocopiers.**
- **Actions Taken:** HVAC system upgrades should improve airflow in these locations.
- Consider balancing mechanical ventilation systems every 5 years, as recommended by ventilation industrial standards.

Appendix A

- **Action Taken:** The HVAC system is being upgraded and should be balanced once installation is complete.
- Replace missing ceiling tiles to prevent the egress of dirt, dust and particulate matter into occupied areas.
- **Action Taken:** Ceiling tiles were observed missing in a number of areas in the Probation office.
- Consult with a building engineer to examine the roof and make recommendations to establish a functional, insulated roof to eliminate water leaks and improve temperature control.
- **Action Taken**: Roof was replaced prior to this visit.
- Consideration should be given to replacing the existing window system with an energy efficient, double-paned type in order to eliminate heat/cold transmission into exterior walls.
- **Action taken:** Window systems remain in place and are not part of the current building renovations.
- Examine the feasibility of installing dedicated exhaust vents for all areas with cooking equipment.
- **Actions Taken**: The cooking area on the first floor was eliminated.