INDOOR AIR QUALITY ASSESSMENT

Old Hampshire Superior Court Building
99 Main 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 John Lillis, Finance Director, Hampshire County Council of Governments, an indoor air quality assessment was done at the old Hampshire Superior Court (HSC), 99 Main St, Northampton, Massachusetts. The assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau for Environmental Health (BEH). The assessment was prompted by general indoor air quality conditions in the building.

On February 27, 2009, the HSC was visited by Michael Feeney, Director, Indoor Air Quality Program and Lisa Hébert, Indoor Air Quality (IAQ) Inspector within BEH's IAQ Program. The HSC is a two-story structure with occupied basement that was constructed in 1886. The uppermost floor is a large, seldom used courtroom (Picture 1). The middle floor contains various Hampshire County offices as well as Hampshire County Housing Court offices. The lowest level contains the Hampshire County Law Library. The building was renovated in the 1970's when the new Hampshire Superior Court building was constructed. During this renovation a modern heating, ventilating and air-conditioning (HVAC) system capable of providing heated and cooled air was installed into the building. The chiller is located in the new Hampshire Superior Court building which is piped into the HSC by pipes located in an elevated walkway that connects the buildings. Various offices have been sub-divided into smaller offices and wall-to-wall carpeting installed. Windows were openable in a number of locations in the building.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken 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.

Results

The HSC has a daily employee population of approximately 10, with up to several hundred individuals visiting on a daily basis. The tests were taken under normal operating conditions. Test 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) parts of air in all areas surveyed, indicating adequate fresh air supply in all areas of the building at the time of the assessment.

The heating, ventilating and air conditioning (HVAC) system for the upper and middle floors consists of three air-handling units (AHUs) located in the attic space of the building (Picture 2), each of which draws fresh air through an outdoor air intake located in attic dormers and distributes it to occupied areas via wall-mounted air diffusers. Return air is ducted back to the AHU via ceiling/wall-mounted grills and is ejected from the building via exhaust vents in attic dormers (Picture 3). The HVAC system for the law library has an AHU located in a

mechanical room in the lower level of the building. The fresh air intake and exhaust vent are located at ground level (Picture 4).

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 date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires the buildings have a mechanical ventilation system with a supply of fresh outside air or have openable windows in each room (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 (OSHA, 1997).

The Department of Public Health 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 ranged from 70 ^{o} F to 75 ^{o} during the assessment, which were within the MDPH recommended comfort range. The MDPH recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} 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. Complaints concerning cold temperatures were expressed by building occupants. This problem is likely related to two issues: the size of the HVAC system installed to supply air for the 2nd floor and the lack of control for HVAC system coolant provided by the chiller in the new Hampshire Superior Court building. It appears that the AHU for the 2nd floor also services large conference rooms on the 3rd floor in the front of the building. These rooms are reportedly used infrequently, unless the court room is occupied. The AHU is designed to provide for the comfort of building occupants for the 2nd and 3rd floor when front rooms are fully occupied. If operating in a fully occupied mode, the HVAC system is providing too much heated or cooled air, which can lead to temperature complaints on the 2nd floor if the 3rd floor courtroom is unoccupied. Since the HVAC system does not appear to have been balanced recently, uneven distribution of heated and cooled air can also occur. In addition, building occupants report that no means exist to regulate HVAC system coolant that is supplied to the HSC AHU coils by the chiller. Without

controls tied to temperatures within the HSC building, coolant to the HVAC system can have a temperature colder than needed for air conditioning, leading to temperature complaints. Colder air than needed can also lead to HVAC system components generating condensation, subsequently moistening building materials and promoting mold growth.

The relative humidity measured in the building ranged from 25 to 35 percent during the assessment, which was below the MDPH recommended comfort range. 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

Several areas had a number of water damaged ceiling tiles and water damaged plaster ceilings, which can indicate leaks from the building envelope and/or plumbing system. Repeated water damage to porous building materials (e.g., ceiling tiles, plaster) can result in microbial growth. 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.

The law library has had repeated instances of flooding due to inadequate rainwater drainage along the southwest facing wall of the HSC (Picture 5). The orientation of the HSC ensures that the southwest exterior wall will be exposed to heavy rain from weather systems with

southwest winds. For this reason, the area must have adequate means to drain water from the roof and base of the exterior wall to prevent water pooling and subsequent penetration through the foundation. The roof edge does not have a gutter or downspout system. Rainwater is designed to run from the roof onto a cement trough, directing water toward a drain. This particular design is prone to creating conditions that allow for water to penetrate into the library. These conditions are:

1. The drain appears to be elevated above the lowest level of the cement trough. This condition can lead to chronic pooling of water which can then pass through seams in the drainage trough to keep soil against the foundation moist.
2. The roof edge does not have a gutter, which allows rainwater to accumulate in the cement trough.
3. Snow from the roof accumulates on the ground to form a dam to hold water against the building.

Each of these conditions can allow water to accumulate along the foundation, leading to penetration through the foundation via capillary action.

Of note is the carpeting of the library, which appears to be adhered to a tile surface (Picture 6) or to a false floor in the rear of the space (Picture 7). It is not clear whether the floor of the library was provided with a vapor barrier prior to the laying of the carpet. Without a vapor barrier, the floor of the library would be susceptible to condensation during hot, humid weather. Condensation is the collection of moisture on a surface with a temperature below the dew point. The dew point is a temperature determined by air temperature and relative humidity. A building component that is prone to the generation of condensation is the floor of a building that does not have a vapor barrier. Since the HSC was built in 1886, the basement floor does not likely have a

vapor barrier. Therefore, any surface that had a temperature below this range would be prone to generating condensation under temperatures and relative humidity conditions at the time of assessment. Carpeting adjacent to exterior wall appeared to be discolored and brittle, an indication of repeated moistening/drying. Condensation will keep the carpet moist and could then lead to musty odors and/or mold colonization, particularly during hot/humid weather. The combination of the carpeting and the false floor in the rear of the library would tend to trap moisture, resulting in the wetting of carpeting; thus, creating conditions for mold and associated odors to exist.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends 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. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

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 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. 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

assessment, outdoor carbon monoxide concentrations were measured at 2 ppm (Table 1). Carbon monoxide levels measured in the HSC were non-detect (ND).

Particulate Matter (PM2.5)

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 $\mu g/m^3$ 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 concentrations the day of the assessment were measured at 21 $\mu g/m^3$. PM2.5 levels measured inside the HSC ranged from 11 to 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 mechanical devices and/or activities that occur in the indoor environment 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

Indoor air concentrations can be greatly impacted by the use of products containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to identify materials that can potentially increase indoor VOC concentrations, BEH staff examined the HSC for products containing these respiratory irritants.

Dry erase materials were observed within the HSC. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs) (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve), which can be irritating to the eyes, nose and throat (Sanford, 1999).

Other conditions that can affect indoor air quality were observed during the assessment. During the course of the assessment, fresh air supply vents in the library had a heavy, dark discoloration (Picture 8). This discoloration is likely due to unfiltered air drawn into the HVAC system due to an open duct clean out door located in the library level mechanical room (Picture 9). Dust, dirt and other particulate matter can be drawn in through this opening and then be distributed into the library

A pipe in the basement appears to have damaged insulation (Picture 10). This insulation may contain asbestos and, if so, should be remediated in conformance with all applicable State and Federal asbestos abatement and hazardous materials disposal laws.

Conclusions/Recommendations

The conditions observed in the HSC are somewhat complex. In order to address the conditions listed in this assessment, the recommendations made to improve indoor air quality are divided into **short-term** and **long-term** corrective measures. The **short-term** recommendations should be implemented as soon as possible. **Long-term** measures are more extensive and will require planning and resources to adequately address overall indoor air quality concerns. In view of the findings at the time of the visit, the following recommendations are provided:

Short Term Recommendations

1. Remove snow from the base of the exterior walls after snow storms.
2. Ensure that the drain at the southwest exterior wall is functioning to readily drain rainwater without water pooling along the foundation of the building.
3. Repoint all of the seams for the drain trough with an appropriate water resistant sealant.
4. Remove the carpet from the library. Replace the carpeting with a non-absorbent floor covering (e.g. tile, carpet tile. Prior to removal, a determination should be made as the whether the surface beneath the carpeting contains asbestos. If asbestos is found, carpet removal would require compliance with state and federal asbestos remediation and hazardous materials disposal regulations.
5. Replace water damaged ceiling tiles.
6. Have the building's HVAC system rebalanced to reduce the amount of air provided for the building occupants to a volume that is appropriate for the current population of the building. Consider adopting a balancing schedule of every 5 years for all mechanical

ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).

7. Ensure discolored air supply diffusers and exhaust vents are cleaned on a routine basis.
8. 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. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
9. Close the duct clean out door in Picture 9. Ensure that all duct doors are closed.
10. Determine composition of damaged insulating material on pipe in basement. If composed of asbestos, remediate in conformance with State and Federal asbestos abatement and hazardous materials disposal laws.
11. Clean Dry Erase boards and trays on a regular basis to reduce particulate accumulation. Consider using Dry Erase products that emit fewer VOCs.
12. Repair downspouts so that rainwater is delivered onto the ground, instead of running down the exterior wall of the building.

Long-Term Recommendations

1. Examine the feasibility of installing equipment to better regulate coolant supply to the HSC.
2. Examine the feasibility of providing better drainage along the southwest wall of the building.

3. Consider repointing the stonework of the building, particularly in areas with water damaged plaster. Once the stone is repointed, repair the damaged plaster.

References

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Picture 1

Seldom Utilized Superior Courtroom

Picture 2

Attic Area Houses Air Handling Units

Picture 3

Fresh Air Intake and Exhaust in Attic Dormers

Picture 4

Fresh Air Intake and Exhaust for Library AHU

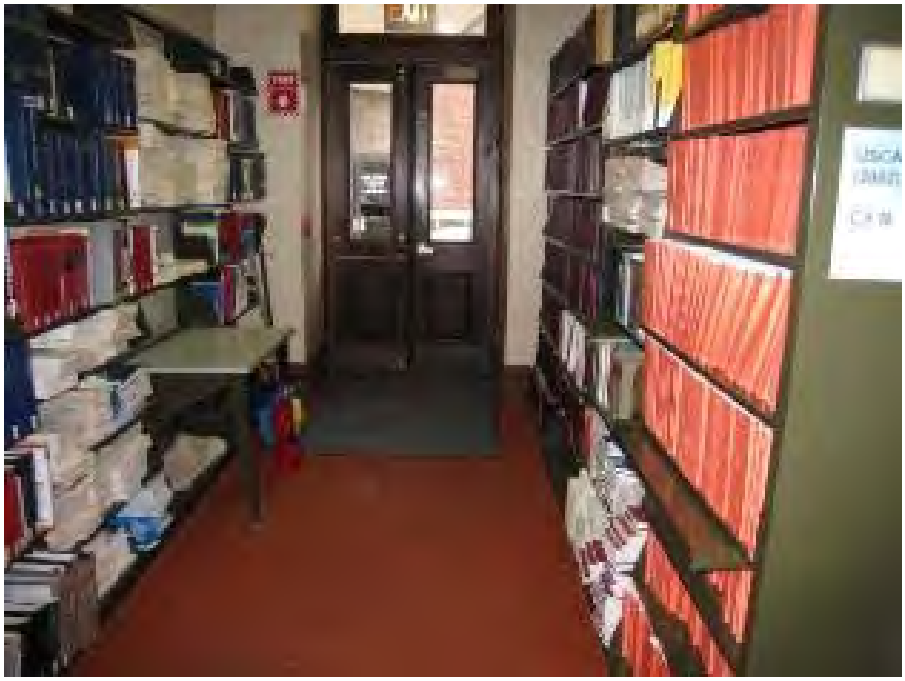
Picture 5

Standing Water in Drainage Trough

Picture 6

Carpeting in Library Appeared to be Covering Tile Beneath

Picture 7



Rear of Library May Have False Floor

Picture 8

Dark Stains on Air Supply Diffusers and Tiles in Library

Picture 9

Open Clean-Out Door

Picture 10

Pipe Insulation

Location: Old Hampshire Superior Court Building **Indoor Air Results**

Address: 99 Main Street – Northampton, MA **Table 1** **Date: 2/27/09**

Location	Occupants in Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Carbon Monoxide (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Outside (Background)	-	366	65	30	2	21				
Third Floor Superior Court	0	395	70	35	ND	15	N	Y	Y	DO
Law Clerk	1	481	72	33	ND	16	N	Y	Y	DO, WDCT
Judge's Lobby	2	401	72	31	ND	15	N	Y	Y	DO
Housing Court Office 1	0	406	72	30	ND	16	N	Y	Y	DO, Peeling paint
Housing Court Office 2	0	387	72	30	ND	16	N	Y	Y	DC, Cracked plaster
Unused office	0	436	71	27	ND	15	N	Y	Y	WD ceiling plaster, Efflorescence
Second Floor Room 210	0	427	71	29	ND	13	N	Y	Y	DO, Plants
Room 208A	0	472	72	30	ND	13	N	N	N	DEM, Walls do not reach ceiling
Room 208B	1	519	73	30	ND	14	N	Y	Y	DO, Plants, Walls do not reach ceiling
Room 206	1	500	73	29	ND	14	N	Y	Y	DO, Plants

ppm = parts per million

AT = ajar ceiling tile
design = proximity to door
DO = door open

DEM = dry erase materials
GW = gypsum wallboard
MT = missing ceiling tile

ND = non detect
PC = photocopier
PF = personal fan

TB = tennis balls
VL = vent location
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%

Location: Old Hampshire Superior Court Building **Indoor Air Results**

Address: 99 Main Street – Northampton, MA **Table 1 (continued)** **Date: 2/27/09**

Location	Occupants in Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Carbon Monoxide (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Copy Room	1	469	73	28	ND	14	N	Y	Y	DO, copier, printer
Bathroom	0	572	73	29	ND	13	N	Y	Y	DO, AD, Plant
Room 201A (front)	1	514	73	29	ND	14	N	Y	Y	DO
Room 201B	0	498	74	28	ND	14	N	N	N	DO, Walls do not meet ceiling
Room 201C	1	558	74	28	ND	14	N	N	N	DO, Walls do not meet ceiling
Room 203	0	461	75	25	ND	13	N	Y	Y	DC, dehumidifier
Room 205	3	549	75	27	ND	15	N	Y	Y	DO, Plants
Room 207	0	441	74	25	ND	13	N	Y	N	DO
Room 209 (Main)	2	501	72	30	ND	14	N	Y	N	DO, PF
Room 209B	0	478	73	28	ND	14	N	Y	Y	DO, Plants

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								Supply	Exhaust	
First Floor Library (Barbara)	2	556	72	32	ND	12	N	Y	Y	DO
Library (Checkout)	0	527	72	31	ND	11	N	Y	Y	DO, PF
Library (Mass Room)	0	472	74	27	ND	11	N	Y	Y	DO, Carpet on window sill

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