INDOOR AIR QUALITY
POST-OCCUPANCY ASSESSMENT

Franklin County Courthouse
101 Munson Street
Greenfield, MA

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
May 2014

Background/Introduction

At the request of Bruce Tebo, Project Manager, Office of Leasing, Division of Capital Asset Management and Maintenance (DCAMM), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted post-occupancy air testing at the Franklin County Courthouse (FCC), 101 Munson Street, Greenfield, MA. The purpose of the post-occupancy testing was to assess environmental conditions in the newly occupied space leased by Massachusetts state agencies. On April 4, 2014, a visit to the FCC was made by Kathleen Gilmore, Environmental Engineer/Inspector within BEH's Indoor Air Quality (IAQ) Program. Mr. Tebo accompanied Ms. Gilmore during the assessment.

The building is a three-story brick building located in an office park constructed in the 1970s. The courts occupy space is on three floors, including one that is partially below-grade. Other portions of the building are occupied by private offices. The court will occupy the building as temporary space for a period of approximately three years while the existing FCC is renovated/ constructed in. The temporary space was completely renovated and court staff have occupied the building since March, 2014. The space contains courtrooms, open work areas, offices, public service areas, hearing rooms, holding cells and storage for files, evidence and other materials. It has suspended ceiling tiles and the majority of areas are carpeted. Windows are not openable.

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. Screening for volatile organic compounds (VOCs) was conducted using a RAE Systems Mini-RAE 2000 Photo Ionization Detector (PID). BEH/IAQ staff also performed visual inspection of building materials for water damage and/or microbial growth.

Results

The FCC has a combined employee population of approximately 70, and up to 100 people may visit the building on a daily basis. Tests were taken during normal operations and 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) in all areas surveyed at the time of the assessment, indicating adequate air exchange in the building. The heating, ventilation and air-conditioning systems (HVAC) consist of air handling units (AHUs) located in mechanical spaces on each floor which draw in outside air and heat/cool it. Fresh air is delivered to spaces via ceiling-mounted supply vents. Return air is drawn into an above-ceiling plenum via ceiling grates and ducted back to the AHUs. Supplemental heating and cooling around the perimeter of the building is supplied by fan coil units (FCUs) which temper and circulate air, but do not supply additional fresh air (Figure 1, Picture 1). These FCUs are original to the building and thus approximately 40 years old. It was reported that these units were cleaned and new filters were installed prior to occupancy, with regular filter changes performed as a part of preventative maintenance.

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). Reportedly, the HVAC system was balanced prior to FCC occupancy.

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 A.

Temperature readings during the assessment ranged from ranged from 70° F to 75° F which were within the MDPH recommended comfort range (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 at the time of the assessment ranged from ranged from 17 to 25 percent (Table 1), 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

No evidence of leaks and/or water-damaged building materials was observed during the IAQ assessment.

Plants were observed in some areas (Table 1; Picture 2). Plants should be properly maintained and equipped with drip pans. Plants should be located away from ventilation sources to prevent aerosolization of dirt, pollen or mold. Plants should not be placed on carpets or other porous materials, since water damage to porous materials may lead to microbial growth.

In Room G22, a mini refrigerator was located on carpeting. These types of appliances can leak or spill, which can moisten carpet. It is recommended that these items be located on a non-porous surface.

Other Indoor Air 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 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, 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. Outdoor carbon monoxide concentrations were non-detect (ND) on the day of the assessment (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, which can result in eye and respiratory irritation if exposure occurs. 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 14 $\mu g/m^3$ (Table 1) on the day of the visit. PM2.5 levels measured indoors ranged from 5 to 10 $\mu g/m^3$ (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 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, 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.

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. Total volatile organic compounds (TVOCs) can result in eye and respiratory irritation if exposure occurs. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In order to determine if VOCs were present, testing for TVOCs was conducted. Background levels of TVOCs were ND and indoor levels were also ND.

There are numerous photocopiers in the building. Photocopiers can be sources of pollutants such as VOCs, ozone, heat and odors, particularly if the equipment is older and in frequent use. Both VOCs and ozone are respiratory irritants (Schmidt Etkin, 1992). Photocopiers should be kept in well ventilated rooms, and should be located near windows or exhaust vents.

Hand sanitizer was found in some offices and common areas areas (Table 1; Picture 3). Hand sanitizer products may contain ethyl alcohol and/or isopropyl alcohol which are highly volatile and may be irritating to the eyes and nose, and may contain fragrances to which some people may be sensitive.

Air fresheners and deodorizing materials were observed in some areas (Table 1; Pictures 4 and 5). Air deodorizers contain chemicals that can be irritating to the eyes, nose and throat of

sensitive individuals. Many air fresheners contain 1,4-dichlorobenzene, a VOC which may cause reductions in lung function (NIH, 2006). Furthermore, deodorizing agents do not remove materials causing odors, but rather mask odors that may be present in the area.

Many rooms contained dry erase boards and related materials (Picture 6). In some areas, dry erase debris was accumulated on the marker tray. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Other Conditions

Most areas in the FCC space are carpeted. The Institute of Inspection, Cleaning and Restoration Certification (IICRC), recommends that carpeting be cleaned annually (or semi-annually in soiled high traffic areas) (IICRC, 2005).

Conclusions/Recommendations

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

1. Operate and maintain HVAC systems in accordance with manufacturer's recommendations, including regular filter changes on all AHUs and FCUs.
2. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
3. 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. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

4. Ensure plants have drip pans and avoid over-watering. Examine drip pans periodically for mold growth. Disinfect with an appropriate antimicrobial where necessary.
5. Consider moving refrigerators to areas with tile floors or place them on waterproof mats to avoid moistening of carpeting.
6. Avoid the use of scented products such as air deodorizers and fresheners.
7. Clean dry-erase marker trays of accumulated dust and debris regularly using a damp cloth.
8. Clean carpeting annually or semi-annually in soiled high traffic areas as per the recommendations of the Institute of Inspection, Cleaning and Restoration Certification (IICRC, 2005). Copies of the IICRC fact sheet can be downloaded at: cleancareseminars.net .
9. Refer to resource manual and other related indoor air quality documents located on the MDPH's website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at: http://mass.gov/dph/iaq.

References

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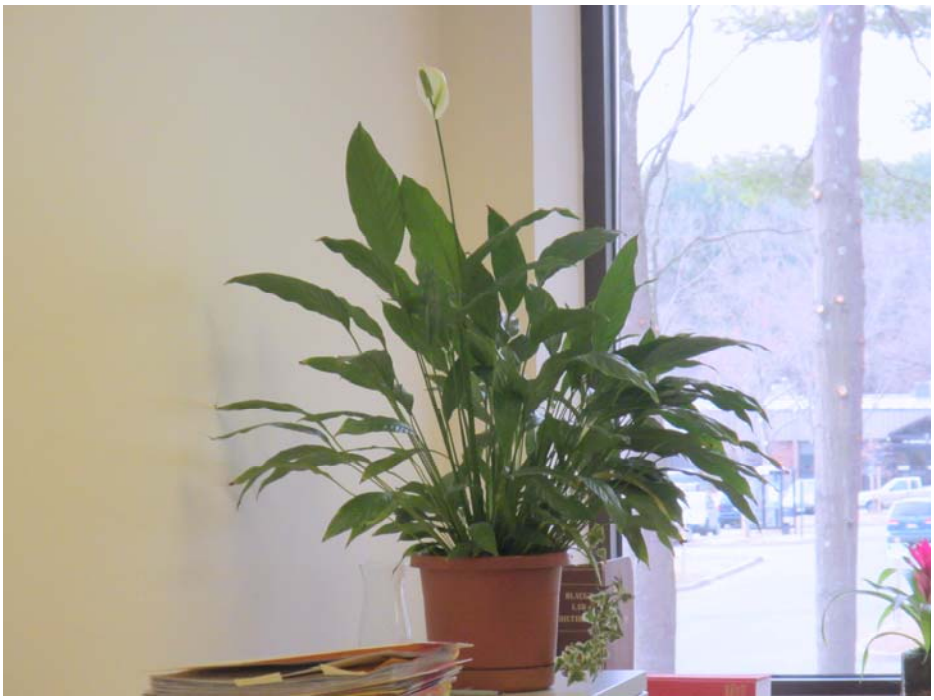
Picture 1

Fan coil unit in perimeter office

Picture 2



Plant in office

Picture 3

Hand sanitizer in office

Picture 4

Air deodorizer in office

Picture 5

Air deodorizers and fresheners

Picture 6

Dry eraser board and markers in courtroom

Location: Franklin County Courthouse **Indoor Air Results**

Address: 101 Munson Street, Greenfield, MA **Table 1** **Date: 4/4/2014**

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp (°F)	Relative Humidity (%)	TVOCs (*ppm)	PM2.5 (ug/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
Background	467	ND	46	65	ND	14					Partly cloudy
100 (Clerk Magistrate)	611	ND	73	19	ND	7	0	Y	Y	Y	
101 (Waiting Room)	588	ND	73	19	ND	8	0	Y	Y	Y	
104 (Work Area)	645	ND	73	18	ND	7	11	N	Y	Y	PCs, plants
105 (Conference Room)	529	ND	75	19	ND	9	0	N	Y	Y	
106 (Active Records)	578	ND	73	17	ND	8	0	N	Y	Y	
112 (Court Magistrate)	569	ND	74	18	ND	8	0	N	Y	Y	Hand sanitizer, AD
114 (Supply Room)	622	ND	73	20	ND	9	0	N	Y	Y	
115 (Conference Room)	545	ND	74	19	ND	7	0	N	Y	Y	DEM

ppm = parts per million AD = air deodorizer DEM = dry eraser materials PC = photocopier

µg/m3 = micrograms per cubic meter DO = door open ND = non detect

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Franklin County Courthouse

Address: 101 Munson St Greenfield, MA

Indoor Air Results

Date: 4/4/2014

Table 1 (continued)

Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp (°F)	Relative Humidity (%)	TVOCs (*ppm)	PM2.5 (ug/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
122 (Evidence Room)	555	ND	74	18	ND	7	0	N	Y	Y	
123 (Witness Advocate Room)	622	ND	73	20	ND	9	0	N	Y	Y	
125 (Drug Testing)	566	ND	71	21	ND	8	5	N	Y	Y	
128 (Storage)	558	ND	72	18	ND	8	0	N	Y	Y	
130 (Restroom)	631	ND	73	20	ND	7	3	N	Y	Y	Hand sanitizer
131 (Restroom)	599	ND	73	19	ND	9	0	N	Y	Y	Hand sanitizer
132 (Interview Room)	546	ND	74	17	ND	7	0	N	Y	Y	
134 (Probation)	619	ND	74	19	ND	8	12	N	Y	Y	PC
139 (Records)	533	ND	73	19	ND	9	0	N	Y		
143 (Lobby)	633	ND	70	23	ND	10	3	N	Y	Y	Main door entrance with scanner

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Location	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Temp (°F)	Relative Humidity (%)	TVOCs (*ppm)	PM2.5 (ug/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
200 (Court Lobby)	543	ND	70	23	ND	5	24	N	Y	Y	
201 (Interpreter's Room	622	ND	71	23	ND	5	0	M	Y	Y	
204 (Court Room)	609	ND	70	23	ND	6	0	N	Y	Y	DEM
205 (Court Room)	668	ND	70	23	ND	6	0	N	Y	Y	DEM
206 (Court Room)	602	ND	70	22	ND	7	0	N	Y	Y	
207 (Administrative Office)	581	ND	70	22	ND	5	9	N	Y	Y	PCs, Plants
209 (Judge's Lobby)	504	ND	71	24	ND	6	0	N	Y	Y	DO
210 (Judge's Lobby)	577	ND	71	23	ND	6	0	N	N	Y	DO
212 (Conference Room)	564	ND	70	23	ND	5	3	N	Y	Y	DEM
214 (Jury Deliberation)	655	ND	70	24	ND	7	0	N	Y	Y	

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									Intake	Exhaust	
215 (Restroom Vestibule)	637	ND	70	23	ND	7	2	Y	Y	Y	
217 (Restroom)	598	ND	71	24	ND	6	4	N	Y	Y	Hand sanitizer, AD
222 (Supply Room)	609	ND	70	23	ND	5	0	N	Y	Y	
225 (Trap)	604	ND	71	22	ND	7	3	N	Y	Y	PC
233 (Alternate Jurors)	634	ND	70	25	ND	5	0	N	Y	Y	
240 (Mechanical Room)	489	ND	70	24	ND	6	0	N	Y	Y	
242 (Jury Pool)	503	ND	71	22	ND	7	14	N	Y	Y	
248 (Break Room)	537	ND	71	23	ND	5	3	N	Y	Y	
255 (Storage Room)	619	ND	70	23	ND	6	0	N	Y	Y	
257 (Active Records)	654	ND	70	24	ND	7	0	N	Y	Y	

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									Intake	Exhaust	
262 (Work Area)	577	ND	71	25	ND	6	9	N	Y	Y	PCs, plants
264 (Registration)	589	ND	70	23	ND	5	2	N	Y	Y	
267 (Conference Room)	590	ND	70	22	ND	6	0	N	Y	Y	
G7 (District Attorney Office)	573	ND	72	22	ND	7	0	N	Y	Y	PCs, microwave, plants
G12 (Probation Waiting Room)	530	ND	71	20	ND	7	8	N	Y	Y	
G13	599	ND	72	24	ND	8	0	N	Y	Y	
G14 (Probation Office)	545	ND	72	23	ND	7	0	N	Y	Y	
G16 (Interview Room)	577	ND	70	22	ND	6	0	N	Y	Y	
G22 (Conference Room)	619	ND	71	23	ND	8	0	N	Y	Y	Refrigerator on carpet, DEM
G23 (Grand Jury)	583	ND	71	24	ND	9	0	N	Y	Y	

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									Intake	Exhaust	
G25 (Attorney)	564	ND	70	24	ND	8	0	N	Y	Y	
G32 (Chief Court Officer's Office)	599	ND	71	25	ND	8	0	N	Y	Y	
G33 (Trap)	576	ND	72	22	ND	7	4	N	Y	Y	Hand sanitizer, AD
G49 (Break Room)	561	ND	72	25	ND	8	2	N	Y	Y	Refrigerator, drink dispensers, microwave
G51 (Law Library)	687	ND	71	24	ND	9	0	N	Y	Y	
G52 (Storage)	557	ND	71	23	ND	8	0	N	Y	Y	
G53 (Administrative Office)	601	ND	71	22	ND	7	0	N	Y	Y	Plants, PC

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