INDOOR AIR QUALITY ASSESSMENT

Lynn District Court
580 Essex Street
Lynn, 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 Mike Lane, 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 (IAQ) concerns at the Lynn District Court (LDC), 580 Essex Street, Lynn, Massachusetts. The request was prompted by reports of concerns regarding possible impacts of a historic gasoline spill on the indoor air quality of the building as well as general indoor air quality concerns.

On March 22, 2013, a visit to conduct an IAQ assessment was made to the LDC by Mike Feeney, Director of BEH's IAQ Program. BEH staff was accompanied by Mr. Lane. The LDC is a two-story building constructed in the 1970s. The ground floor of this courthouse is occupied. Windows are openable in a limited number of areas of the building.

An underground tunnel previously connected the LDC building to the former Lynn Police Headquarters. The tunnel originally opened into the holding cell area for the LDC. According to court officials, the tunnel was impacted by gasoline leaking from a storage tank at the Lynn Police Headquarters. The building housing the Lynn Police was razed during the 1980s, the tunnel was filled, and the entrance to the LDC was sealed. At that time, the ground floor of the LDC was reconfigured and the holding area was renovated into a jury room. The holding cell control room, holding cells, and offices are also located on the ground floor.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken 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. Air testing for total volatile organic compounds (TVOCs) was conducted using a MiniRAE 2000 photo ionization detector (PID). BEH staff performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The LDC has approximately 200 employees and can be visited by several hundred people daily. Tests in the LDC were taken during normal operations, and results appear in Table 1

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels at the LDC were below 800 parts per million (ppm) in all but one of the 43 areas surveyed during the assessment, indicating adequate air exchange in the building. Some areas were empty or sparsely populated during the assessment. Carbon dioxide levels would be expected to be higher with increased occupancy.

Mechanical ventilation for the original building is provided by air-handling units (AHUs) located in an attic mechanical room. Fresh air is drawn into the AHUs through an air intake located in a pit on the exterior of the building and delivered to occupied areas via ceiling-mounted air diffusers (Picture 1). Exhaust air is drawn into ductwork via grilled vents and returned to the mechanical room. These units were operating at the time of assessment.

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 heating, ventilation and air conditioning (HVAC) systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

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, consult Appendix A.

Temperature readings in the LDC on the day of the assessment ranged from 69ºF to 78ºF, which were within or very close to the MDPH recommended comfort guidelines. The MDPH recommends that indoor air temperatures be maintained in a range of 70ºF to 78ºF 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 LDC ranged from 12 to 22 percent, which was below the MDPH recommended comfort range in all areas surveyed. 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

A number of areas were observed to have water-stained ceiling tiles (Table 1), which may result from roof or plumbing leaks or water penetration from exterior walls. Water-damaged tiles should be replaced once a leak has been repaired. New leaks should be reported to maintenance staff.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials (carpeting, ceiling tiles, etc.) 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.

Plants were noted in several areas (Table 1). Plants should be properly maintained and be equipped with drip pans made of a non-porous material. Drip pans should be cleaned and inspected periodically to prevent mold growth. Plants should be located away from ventilation sources to prevent aerosolization of dirt, pollen or 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 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 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. 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 the assessment, outdoor carbon monoxide concentrations were non-detectable. No measurable levels of carbon monoxide were detected inside the building during the assessment (Table 1).

While no carbon monoxide was measured indoors, the potential for vehicle exhaust to enter the indoor environment exists in the prisoner transport/lock-up area. Transport vans are driven into an underground garage where prisoners are loaded/offloaded. The garage is equipped with a dedicated exhaust system, but this unit was found deactivated at the time of the assessment. The exhaust system for the garage should be activated continuously during use of the cell block. Spaces were observed between the garage doors and the frame/underside. Such breaches can allow vehicle exhaust to penetrate the interior of the building.

Particulate Matter (PM2.5)

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). The NAAQS has subsequently been revised, and PM2.5 levels were reduced. 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 concentrations were measured at 12 μg/m^3 (Table 1). Indoor PM2.5 levels ranged from 4 to 7 μg/m^3 (Table 1), which 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 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 microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

One concern prompting the investigation was the presence of dark particles/black dust observed around fresh air diffusers of the building (Picture 1). Material accumulated on the diffusers is likely dust. Dust particles in a room can become positively charged when they remain in the air stream. Over time, the charged particles can collect on the air diffuser due to attraction of the dust to the negatively charged diffuser and surround ceiling tiles. PM2.5 levels were not elevated at the time of assessment, indicating that there is no aerosolization of dust collecting on the diffuser. These particles appears should be removed through regular building cleaning and maintenance activities.

Volatile Organic Compounds

Volatile organic compounds (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. 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.

Building occupants expressed concerns about a possible chemical exposure, specifically gasoline. As previously mentioned, a tunnel once connected to the LDC to the former Lynn Police Department Headquarters. A gasoline spill had occurred in this tunnel; however, the tunnel was filled in when the Police Department building was razed. Gasoline is a complex mixture of VOCs. In order to determine whether residual contamination was present at the ground level of the LDC, air sampling for the presence of VOCs was conducted.

IAQ staff conducted TVOC sampling in the jury room, the holding cell control room, and adjoining offices on the ground floor (Table 1). Air-sampling was conducted in these areas as they are more likely to be impacted by VOCs. Potential routes for odor and vapors to enter the LDC include wall/floor penetrations (e.g. access ports, drains or cracks). Background (outdoor) TVOC sampling was conducted for comparison. No measurable levels of TVOCs were detected outdoors or inside the LDC on the day of assessment. In addition, no fuel odors were detected indoors. Based on the screening conducted, it does not appear likely that any residual contamination from the gasoline spill is impacting the indoor air.

Other Conditions

BEH staff observed damaged carpeting. Such carpets should be removed and replaced to prevent aerosolization of fibers. The Institute of Inspection, Cleaning and Restoration Certification (IICRC), recommends that carpeting be cleaned annually or semi-annually in high traffic areas (IICRC, 2005).

An open pipe was noted in the lower vault; the purpose/function of the pipe was unknown to building occupants (Picture 2). Holes observed at regular intervals along the length of the pipe's length suggest that the pipe was designed to support equipment formerly located in the lower vault rather than used for water supply or drainage. Unnecessary pipes/penetrations should be removed/sealed to prevent pathways for odors entering occupied spaces.

Conclusions/Recommendations

In view of the findings at the time of the assessment, the following is recommended:

1. Seal all holes/breaches in the doors of the garage.
2. Consider balancing mechanical ventilation systems every 5 years, 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. Replace water-damaged ceiling tiles and clean affected areas with an appropriate anti-microbial.
5. Ensure that plants are on non-porous drip pans, well maintained and away from ventilation equipment.
6. Clean debris from fresh air diffusers and adjacent ceiling tiles regularly.
7. Remove the pipe in the vault area.

8. Refer to resource manual and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings; these materials are located on the MDPH's website: www.mass.gov/dph/iaq.

References

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Picture 1

Ceiling-mounted fresh air diffuser (note black particles around diffuser)

Picture 2

An open pipe with unknown function in the lower vault

Location: Lynn District Court | **Indoor Air Results**

Address: 580 Essex St., Lynn, MA | **Date: 3/22/2013**

Table 1

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 (outdoors)	389	ND	39	39	ND	12					
100	629	ND	71	17	-	5	0	N	Y	Y	
106	635	ND	73	15	-	4	0	N	Y	Y	2 ajar ceiling tiles
109	631	ND	73	16	-	5	1	N	Y	Y	Door open
110	598	ND	73	16	-	5	0	N	Y	Y	Door open, 1 ajar ceiling tile
111	614	ND	72	17	-	5	0	N	Y	Y	Door open, plants, 1 ajar ceiling tile
115	630	ND	72	17	-	5	0	N	Y	Y	Door open, carpet torn
122	624	ND	71	17	-	5	0	N	Y	Y	Door open
123	677	ND	73	17	-	5	2	N	Y	Y	Door open
124	642	ND	72	17	-	5	1	N	Y	Y	Door open
125	677	ND	72	18	-	4	1	N	Y	Y	Door open

ppm = parts per million
µg/m3 = micrograms per cubic meter
CT = ceiling tile
ND = non-detect
MT = missing ceiling tile
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: Lynn District Court **Indoor Air Results**

Address: 580 Essex St., Lynn, MA **Date: 3/22/2013**

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	
126	628	ND	71	19	-	4	0	N	Y	Y	Door open
134	651	ND	71	16	-	4	2	N	Y	Y	Door open
201	682	ND	72	14	-	5	0	Y	Y	Y	
202	577	ND	72	15	-	5	1	N	Y	Y	Fresh air supply blocked
203	552	ND	72	15	-	5	0	N	Y	Y	Fresh air supply blocked
206	632	ND	74	15	-	5	0	N	Y	Y	Supply blocked
207	582	ND	73	14	-	5	0	N	Y	Y	
211	483	ND	69	13	-	6	0	Y	Y	N	Door open
215	665	ND	74	14	-	5	2	N	Y	Y	Door open
216	596	ND	74	13	-	6	0	Y	Y	Y	Door open

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									Intake	Exhaust	
217	615	ND	74	14	-	5	0	Y	N	Y	2 WD CT, 1 MT
222	656	ND	71	17	-	4	1	N	Y	Y	Door open
225	660	ND	71	16	-	4	2	Y	Y	Y	Door open
227	603	ND	73	14	-	4	1	Y	Y	Y	Door open
229	616	ND	74	16	-	5	4	Y	Y	Y	Fresh air supply blocked with plastic
4	609	ND	73	15	-	4	1	Y	Y	Y	
Admin Office	471	ND	70	12	-	6	0	Y	Y	N	Door open
B18 jury room	558	ND	72	17	ND	4	0	N	N	N	
B20 break room	764	ND	73	20	ND	6	2	N	Y	N	
Cell block control	602	ND	72	19	ND	7	2	N	Y	Y	
Clerk north	691	ND	73	16	-	5	10	N	Y	Y	

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									Intake	Exhaust	
Clerk south	742	ND	72	16	-	5	7	N	Y	Y	
Clerk vault	657	ND	72	15	-	4	0	N	N	N	Door open
DA's Office B23	455	ND	71	18	ND	7	0	N	N	N	
Lobby 2nd floor	481	ND	71	12	-	6	0	Y	Y	Y	Door open
Lower vault	554	ND	78	22	ND	5	0	N	N	N	
Probation clerical	703	ND	72	17	-	6	5	N	Y	Y	Door open
Probation front desk	640	ND	71	17	-	6	2	N	Y	Y	
Probation vault	713	ND	71	19	-	6	0	N	N	N	Door open
Prosecutor's office	867	ND	71	22	ND	4	1	Y	N	N	Window-mounted air conditioner
Session 1	544	ND	70	14	-	4	0	Y	Y	Y	
Session 2	570	ND	74	13	-	4	0	Y	Y	Y	6 WD CT, 2 MT

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									Intake	Exhaust	
Session 3	535	ND	73	14	-	5	0	Y	Y	Y	2 WD CT, 2 MT, door open

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