INDOOR AIR QUALITY ASSESSMENT

Hanson Senior Center and Library
132 Maquan Street
Hanson, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
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Background/Introduction

At the request of Mr. Richard Edgehille, Hanson Board of Health, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality concerns at the Hanson Senior Center (HSC), located at 132 Maquan Street, Hanson, Massachusetts. The HSC is part of a building complex that includes Hanson Public Library (HPL). The request was prompted by concerns of respiratory irritation and possible mold growth due to chronic water infiltration. On January 29, 2010, Cory Holmes, an Environmental Analyst/Inspector for BEH's Indoor Air Quality (IAQ) Program made a visit to the HSC/HPL to conduct an indoor air quality assessment.

A preliminary report detailing conditions observed in the HPL regarding recommendations for remediation of water damaged gypsum wallboard and repair of rooftop exhaust pipes was previously issued by MDPH (MDPH, 2010). This report focuses on general IAQ conditions throughout both the HSC and HPL.

The HSC and HPL are part of a one-story wooden complex built in the early 1990's. The HSC is connected to the Hanson Public Library (HPL) by a common hallway. The HSC has a large dining/recreation room, a kitchen, office space, living/reading room and storage areas. The HPL consists of a main stack area, circulation desk, a historical room, several offices, storage space and an octagonal-shaped children's library. The complex has a combination of different roof designs consisting of flat rubber-membrane lined roofs, peaked asphalt/fiberglass shingle covered roofs and an octagonal-shaped roof above the children's library. Windows throughout the complex are not fully openable; they contain a slotted opening to allow limited airflow. There is also a concrete-lined unfinished basement that is used for storage.

Method

Air tests for carbon dioxide, temperature, relative humidity and carbon monoxide were conducted with the TSI, Q-Trak, IAQ Monitor, Model 7565. BEH staff also performed a visual inspection of building materials for water damage and/or microbial growth. Moisture content of porous building materials was measured with a Delmhorst, BD-2000 Model, Moisture Detector equipped with a Delmhorst Standard Probe.

Results

The HSC/HPL complex has an employee population of approximately 30 and can be visited by up to several hundred individuals daily. Tests were taken during normal operations 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 8 of 10 areas surveyed, indicating adequate air exchange in most areas of the building at the time of the assessment. The heating, ventilation and air conditioning (HVAC) system consists of air-handling units (AHU) located in mechanical rooms or on the roof (Pictures 1 and 2). Conditioned air is distributed to ceiling or wall-mounted air diffusers (Pictures 3 and 4) and ducted back to AHUs via return vents (Picture 4). BEH staff examined the return vent in the HSC office suite and no draw of air could be detected.

The HVAC system is controlled by digital thermostats (Picture 5). Airflow is controlled using a fan switch that has two settings, *on* and *auto*. When the fan is set to *on*, the system provides a continuous source of air circulation and filtration. The *automatic* setting on the thermostat activates the HVAC system at a preset temperature. Once the preset temperature is reached, the HVAC system is deactivated. Therefore, no mechanical ventilation is provided until the thermostat re-activates the system. This was the case for the thermostat that controls the office area for the HSC. The MDPH recommends that digital thermostats be set to the fan "on" setting to provide continuous air circulation during occupied periods.

Air circulation is facilitated by the use of downdraft ceiling fans. The introduction of fresh outside air is supplemented by the use of openable windows. As previously mentioned, windows do not fully open but have a slotted design which opens at the bottom to introduce air (Picture 6).

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 a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant 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, 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 measurements ranged from 68° F to 70° F, which were slightly below or at the lower end of the MDPH recommended 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 measured in the building ranged from 10 to 18 percent, which was below the MDPH recommended comfort range (Table 1). 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

In order for building materials to support mold growth, a source of water exposure is necessary. As previously mentioned, the complex has had chronic issues with water penetration through the building envelope, mainly in the form of roof leaks and water penetration around the foundation. Roof repairs and drainage improvements have reportedly been conducted in recent years, which have improved conditions; however several areas remain sources of water penetration.

Active roof leaks through the octagonal roof of the children's library were evident by water damaged walls, efflorescence, peeling paint and delaminating bookshelves (Pictures 7 and 8). Efflorescence is a characteristic sign of water damage to brick and mortar, but it is not mold growth. As moisture penetrates and works its way through mortar, brick or plaster, water-soluble compounds dissolve, creating a solution. As the solution moves to the surface of the material, the water evaporates, leaving behind white, powdery mineral deposits. The intricate roofing design of the entire complex, particularly the over the children's library, creates multiple surfaces, peaks, valleys, troughs, and flashing points, which all provide potential entryways for water penetration (Pictures 9 and 10).

Water damaged ceiling tiles were seen in a number of areas other than the children's library, particularly in the community room (Picture 11). Occasional leaks were reported by HSC staff from the lower roof of the dining room. Active leaks were also observed in the storage closet off the community room. This area had previously been remediated by Service

Master, a flooding restoration firm. Water-damaged ceiling tiles indicate leaks from either the roof or plumbing system and can provide a source for mold growth. Water damaged ceiling tiles should be replaced after a water leak is discovered and repaired.

The roofs are reported to be original (~ 19 years old), which puts them toward the end of their useful lifespan (~ 20 years). Although the roof has been patched/repaired in several areas to help prevent further leaking, damaged shingles were noted. As mentioned, the HSC is connected to the Hanson Public Library (HPL) by a common hallway found in several areas and/or appeared to be severely degraded, as evidenced by the accumulation of asphalt granules in the gutter system (Picture 12).

BEH staff examined the outside perimeter of the building to identify breaches in the building envelope and/or other conditions that could provide a source of water penetration. A number of exterior sources for moisture infiltration were identified:

- Plants and trees were observed growing in close proximity to the foundation and building exterior. Plants in close proximity to the building envelope can cause water damage to brickwork and mortar. Water can eventually penetrate the brick subsequently freezing and thawing during the winter. This freezing/thawing action can weaken bricks and mortar, resulting in damage.
- The exterior wall panels of the children's library were also damaged/delaminating. Exposing this material to moisture which can accelerate decomposition (Picture 13).
- Damaged/deteriorating weather-stripping beneath exterior doors was observed (Picture 14). It is also important to note that there is no lip to the doorframe to prevent water penetration; directly inside the door is wall to wall carpeting that can get wet during heavy rain.

- Gutters contained ice and were clogged with debris (Picture 12);
- Also observed were missing/damaged elbow extensions on downspouts, which cause water to empty against the foundation.

These conditions can undermine the integrity of the building envelope and provide a means for water entry by capillary action into the building through exterior walls, foundation concrete and masonry (Lstiburek & Brennan, 2001). In addition, these breaches in exterior areas can provide a means for drafts and pest entry into the building.

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/discarded.

Other IAQ Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the building environment, BEH staff measured carbon monoxide levels within the building.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health effects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. On the day of assessment, outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). No measurable levels of carbon monoxide levels were detected inside the building at the time of the assessment.

Other Conditions

Other conditions that can affect indoor air quality were observed during the assessment. A number of supply diffusers and return vents were observed to have accumulated dust/debris (Picture 3). If return vents are not functioning, backdrafting can occur, which can re-aerosolize dust particles. Dust and allergens can be irritating to the eyes, nose and throat.

Office areas for the HSC and majority of the library contain wall to wall carpeting that is reported to be original to the building (approximately 19 years old). HSC staff could not confirm if a carpet cleaning/maintenance program was in place. 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). Since the average lifespan of a carpet is approximately eleven years, consideration should be given to planning for the installation of new flooring (Bishop, 2002).

Conclusions/Recommendations

The conditions related to indoor air quality at the HSC/HPL complex raise a number of issues. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons, a two-phase approach is recommended. The first consists of **short-term** measures to improve air quality and the second consists of **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns.

Short-term Recommendations

1. Continue to operate all ventilation systems (e.g., AHUs) throughout the building continuously during occupied periods.
2. Examine return vent in HSC office suite for proper function. Make repairs as necessary to restore function.
3. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
4. Change filters for air-handling equipment (e.g., AHUs) as per the manufacturer's instructions or more frequently if needed.
5. 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).
6. Continue to monitor areas of the building for roof leaks, make repairs and change ceiling tiles as necessary. Disinfect areas of water leaks with an appropriate antimicrobial.
7. Make repairs to gutter and downspout system in order to direct rainwater as far as practicable from the base of the building.
8. Clean gutters periodically of accumulated debris to ensure proper drainage.
9. Replace weather stripping beneath exterior doors.
10. Trim back trees and ensure exterior plants/shrubbery are located at least five feet away

from the building.

11. Repaint or replace delaminating exterior wall panels outside of children's library.
12. Once leaks are repaired in the children's library, scrape off efflorescence, clean and refinish walls.
13. Repair/replace faulty/leaking roof flashing.
14. Clean air diffusers and return vents periodically of accumulated dust.
15. 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). Copies of the IICRC fact sheet can be downloaded at: http://www.cleancareseminars.com/carpet_cleaning_faq4.htm (IICRC, 2005)
16. 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/indoor_air.

Long-Term Recommendations

1. Continue to make repairs of roof leaks as necessary. Consideration should be made to replace the roof to prevent chronic roof leaks and further water damage.
2. Consider a long-term plan to replace all carpeting in the building as funds become available. Consider replacing carpeting with a non-porous surface such as vinyl tile.
3. Work with town officials to develop a preventative maintenance program for all HVAC equipment town-wide.

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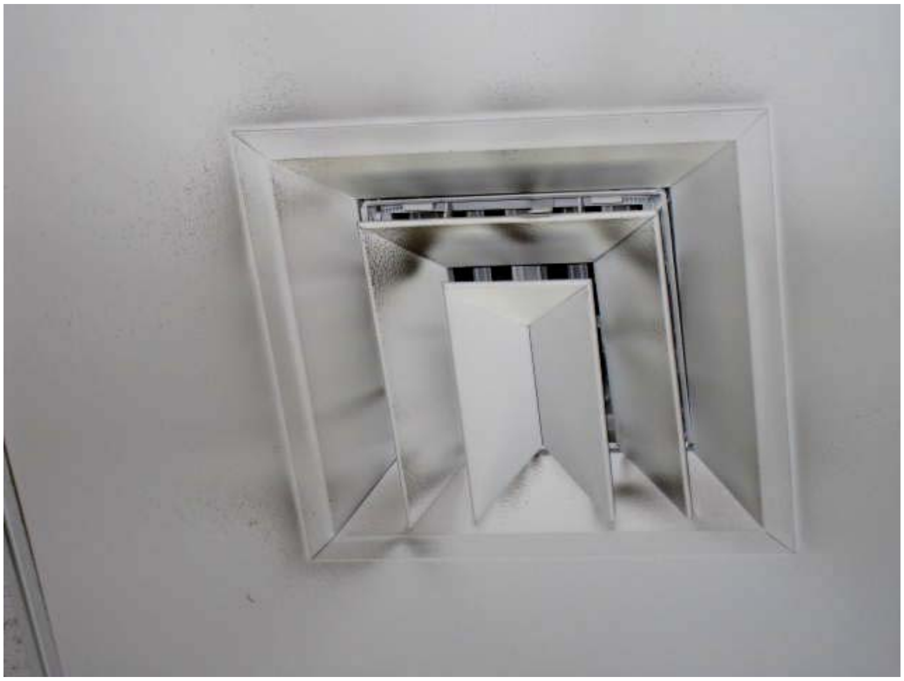
Picture 1

Rooftop Air Handling Units

Picture 2

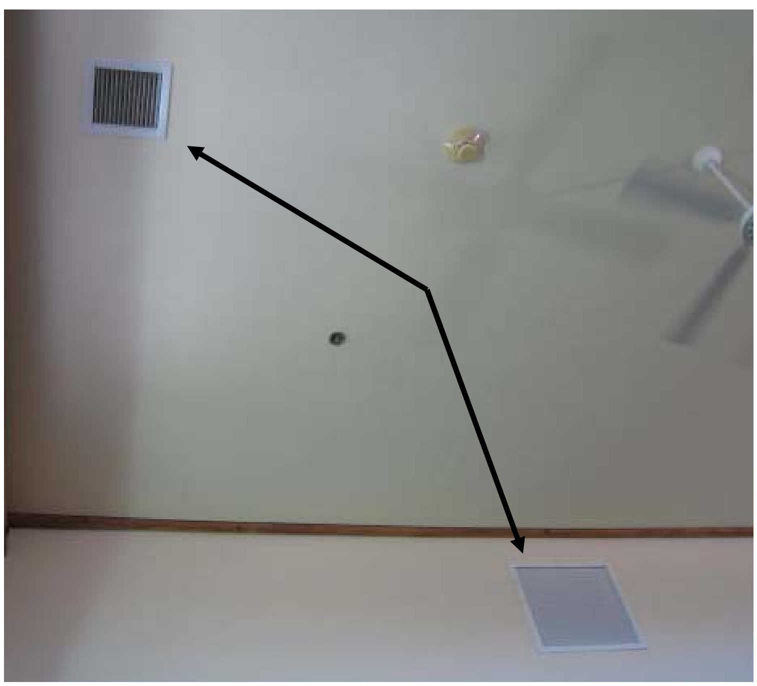
Rooftop Air Handling Units

Picture 3



Ceiling-Mounted Supply Vent, Note Dust/Debris Accumulation

Picture 4



Wall-Mounted Supply Vent (Bottom) and Ceiling Mounted Return Vent

Picture 5

Digital Wall-Mounted Thermostat

Picture 6

Slotted Window Opening

Picture 7

Efflorescence on Children's Library Octagonal Walls

Picture 8

Peeling Paint on Children's Library Octagonal Walls

Picture 9

Multiple Roof Surfaces of the HSC/HPL Complex

Picture 10

Octagonal Roof of the Children's Library

Picture 11

Water Damaged Ceiling Tiles

Picture 12

Asphalt Shingle Granules Accumulated in Gutter System

Picture 13

Delaminating Exterior Paint Exposing Exterior Wall Panels

Picture 14

Deteriorating Weather Stripping on Exterior Door

Hanson Senior Center and Library **Indoor Air Results**

132 Maquan Street, Hanson, MA **Date: 1/29/10**

Table 1

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	Occupants in Room	Windows Openable	Ventilation		Remarks
							Supply	Exhaust	
Background (outdoors)	< 32	23	350	ND					Bitterly cold, clear skies, winds WSW 15-21 MPH, gusts up to 50
Senior Center									
Kitchen	68	18	868	ND	0	N	Y	N	Gas stove, not vented to outside, spaces under exterior door
Dining Room	69	12	606	ND	24	Y	Y	Y	Ceiling fans, occasional leaks reported along the South wall/lower roof
Living Room	69	11	534	ND	1	Y	Y	Y	
Office	69	11	622	ND	1	Y	Y	Y	Return vent no draw, carpet 20+ years old
Director's Office	70	10	509	ND	1	Y	Y	N	
Community Room	70	16	871	ND	10	Y	Y	Y	WD CTs-Dry, WD GW-Dry
Storage Area									Active leaks, Standing water, WD materials (GW, CTs) removed by Service Master

ppm = parts per million parts of air **CT = ceiling tile** **DO = door open** **WD = water damage**

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%

Table 1 (continued)

Library									
Child's Room	70	15	596	ND	2	Y	Y	Y	Broken window, WD GW, peeling paint, leaking octagonal roof/flashing, delaminating bookcase, All materials dry
Circulation Desk	70	15	673	ND	2	Y	Y	Y	Water penetration reported during wind driven rain
Main Library Area	69	15	459	ND	15-20	Y	Y	Y	WD GW-wet in Mystery Section, recommend removal, plumbing/heating system leak
Historical Room	70	16	389	ND	0	Y	Y	Y	WD GW, peeling paint
Basement									WD/Mold colonized GW removed

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