INDOOR AIR QUALITY ASSESSMENT

Greenfield Town Hall
14 Court Square
Greenfield, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Lisa Hebert of the Greenfield Board of Health, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality at the Greenfield Town Hall, 14 Court Square, Greenfield, Massachusetts. Reports from building occupants concerning stagnant air and bird infestation prompted this request.

On April 26, 2000, a visit was made to this building by Michael Feeney, Chief of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA, to conduct an indoor air quality assessment. Mr. Feeney was accompanied by Ms. Hebert.

The Greenfield Town Hall is a redbrick and wood building originally constructed in 1848 as a courthouse. An addition was added to the building in 1890. Windows in this building are openable.

Methods

Air tests for carbon dioxide were taken with the Telaire, Carbon Dioxide Monitor and tests for temperature and relative humidity were taken with the Mannix, TH Pen PTH8708 Thermo-Hygrometer.

Results

Over twenty individuals utilize the facilities in the Greenfield Town Hall on a daily basis. The tests were taken during normal operations at the building. Test results appear in Tables 1-2.

Discussion

Ventilation

It can be seen from the table that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in two of three areas surveyed, which is indicative of a ventilation problem in this building.

Fresh air is provided through the use of openable windows. The original building does not have a modern mechanical ventilation system, but uses a gravity/natural ventilation system to provide airflow to rooms in combination with openable windows. This system has been renovated out of existence. Remnants of ventilation ductwork were found in the basement (see Picture 1). A number of exhaust ventilation shafts in the 1848 section of the building were noted (see Pictures 2 and 3). No corresponding vents were found in first or second floor offices, with the exception of two on the first floor (see Tables). Paneling used in renovations in the 1970s appear to have sealed the original fresh air supplies and exhaust vents.

The original system provided ventilation by a series of ducts, louvered vents and iron heating elements in airshafts. The airshafts in the basement are accessible through iron or wooden doors. Rooms were constructed around these shafts to provide exhaust ventilation.

Air movement is provided by the stack effect. The heating elements warm the air, which rises up the hot air ventilation shafts. As the heated air rises, negative pressure is created, which draws cold air from the basement area and fresh air (see Picture 4) into the heating elements.

The air vents near the floor (see Picture 5) provide exhaust ventilation. As the heated air enters the airshaft, it rises. Negative pressure is created in these shafts, which in turn, draws air into the floor level air vents of each room. The draw of air into these cool air vents is controlled by a louver system. A percentage of return air rises up the ventilation shaft to exhaust outdoors.

As previously mentioned, this ventilation system appears to have been renovated out of existence and abandoned. At this time, the only source for fresh air appears to be openable windows or by air infiltration through the front door of this building.

Since there is no mechanical ventilation system, there is no means to provide both a fresh air supply and exhaust ventilation. Therefore these systems cannot be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air.

The Massachusetts Building Code requires a minimum ventilation rate of 20 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 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.

Temperature readings were in a range of 66° F to 68° F, which are below the BEHA recommended range for comfort. The BEHA recommends that indoor air temperatures be maintained in a range of 70° F to 78° F 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.

Relative humidity measured within this building was found within a range of 14-18 percent throughout the building. This range of relative humidity is below the comfort range of 40-60 percent. The sensation of dryness and irritation is common in a low relative humidity environment. Humidity is more difficult to control during the winter heating season. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial Growth/Moisture Concerns

The carpet in the board of health office appears to have been repeatedly moistened by a leak from the heating system. Repeated wetting of carpeting may result in its colonization of mold growth. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that carpeting be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If carpets are not dried within this time frame, mold growth may occur. Water-damaged carpeting cannot be adequately cleaned to remove mold growth.

Several areas had water stained ceiling tiles, which is evidence of historic and/or current roof or plumbing leaks. Ceiling tiles can provide a source of mold and mildew and should be repaired/replaced after a water leak is discovered.

Other Concerns

Several other conditions were noted during the assessment which can effect indoor air quality. Examination of the interior of the building found no visible signs of bird infestation. Pigeons were seen perching on top of and under a window-mounted air conditioner on the second floor (see Picture 6). The air conditioner services the DPW Engineer's Office. During the assessment of the public works office, cooing pigeons could be heard at this air conditioner. The top of the exterior surface of the air conditioner had bird wastes (see Picture 7). While the bird wastes are on the exterior of the building, this air conditioner has the ability to introduce fresh air from outdoors. As air is drawn into the air conditioner, bird waste particulate can be entrained into the airstream and introduced into the interior of the building. Bird wastes in a building raise three concerns: 1) diseases that may be caused by exposure to bird wastes, 2) the need for clean up of bird waste and 3) appropriate disinfection.

Certain molds are associated with bird waste and are of concern for immune compromised individuals. Other diseases of the respiratory tract may also result from exposure to bird waste. Exposure to bird wastes are thought to be associated with the development of hypersensitivity pneumonitis in some individuals. Psittacosis (bird fancier's disease) is another condition closely associated with exposure to bird wastes in either the occupational or bird raising setting. While immune compromised individuals have an increased risk of health impacts following exposure to the materials in bird waste, these impacts may also occur in healthy individuals exposed to these materials.

The methods to be employed in clean up of a bird waste problem depend on the amount of waste and the types of materials contaminated. The MDPH has been involved in several indoor air investigations where bird waste has accumulated within ventilation ductwork (MDPH, 1999). Accumulation of bird wastes have required the clean up of such buildings by a professional cleaning contractor. In less severe cases, the cleaning of the contaminated material with a solution of sodium hypochlorite has been an effective disinfectant (CDC, 1998). Disinfection of non-porous materials can be readily accomplished with this material. Porous materials contaminated with bird waste should be examined by a professional restoration contractor to determine if the material is salvageable. Where a porous material has been colonized with mold, it is recommended that the material be discarded (ACGIH, 1989).

The protection of both the cleaner and other occupants present in the building must be considered as part of the overall remedial plan. Where cleaning solutions are to be used, the "cleaner" is required to be trained in the use of personal protective methods and equipment (to prevent either the spread of disease from the bird wastes and/or exposure to cleaning chemicals). In addition, the method used to clean up bird waste may result in the aerosolization of particulates that can spread to occupied areas via openings (doors, etc.) or by the ventilation system. Methods to both prevent the spread of bird waste particulates to occupied areas or into ventilation ducts must be employed. In these instances, the result can be similar to the spread of renovation-generated dusts and odors in occupied areas. To prevent this the cleaner should employ the methods listed in the SMACNA Guidelines for Containment of Renovation in Occupied Buildings (SMACNA, 1993).

Filters in window-mounted air conditioners had significant amounts of accumulated dust and debris. The purpose of air conditioner filters is to remove particulate matter from air drawn into the units. Air conditioner filters need to be cleaned on a regular basis in order to maximize the efficiency of the filter. If not cleaned regularly, the filter can become saturated with dust and become a source of aerosolized particulates when the air conditioner is operating. In order to reduce particulate aerosolization, filters should be cleaned or changed in a manner consistent with the manufacturer's recommendation.

The basement of this building contains a floor drain that appears to have a dry trap, which can allow for sewer gas to back up into the building. Sewer gas can be irritating to the eyes, nose and throat.

Of note are the condition of bricks at the base of each exhaust airshaft (see Pictures 8 through 10). This dust appears to consist of red brick only. In the experience of BEHA staff, brick deterioration is usually attributable to water penetration into the interior of the airshaft. Water penetration over time causes both brick and mortar to disintegrate, resulting in the production of mortar and brick chips; red brick and white mortar dust; water staining and efflorescence. This dust appears to be exclusively red brick, which may indicate a mechanical source (weight shift) that is powdering this brick. Settling/shifting is evidenced by a distinct tilt in the floor of the second floor meeting room. Round objects were found to roll toward the northwest corner of this room when placed on the floor. Also of note is that it appears that at least one weight bearing floor beam in the basement had been cut during a wire installation (see Picture 11). Settling/shifting in a brick building can result in the creation of cracks and spaces in the roof and exterior wall. The development of cracks in these building systems (called the building envelope) can result in water penetration into the building. It is suggested that the Greenfield building inspector examine the integrity of these basement structures.

Conclusions/Recommendations

The renovations of this building have altered the original design of the ventilation system. Therefore, it appears that the restoration of this system would be impractical with the removal of ductwork and sealing of vents throughout the building. In this particular case, the only form of ventilation available within offices is openable windows or window-mounted air conditioners with a fresh air intake capacity. Without a restorable ventilation system, a two-phase approach is required, consisting of immediate measures to improve air quality within the Greenfield Town Hall and long-term measures that will require planning and resources to adequately address the overall indoor air quality concerns within this building.

Short Term Recommendations

1. Clean bird wastes from contaminated materials around the air conditioner. Remove accumulated bird wastes from flat, non-porous surfaces and disinfect with an appropriate antimicrobial agent. Once disinfected, each treated area should be cleaned to ensure the removal of residual bird waste and cleaning materials. Removal of contaminated porous materials (e.g., insulation) may be the only appropriate measure to remove bird wastes from these materials. A copy of an issue of the Centers for Disease Control *Morbidity and Mortality Weekly Report* for July 10, 1998 (see Appendix A), which covers the clinical aspects as well as clean up associated with bird waste has been provided for reference. Dependent on the scale and scope of the contamination,

2. consultation with a professional cleaning company that has had experience in cleaning buildings that have experienced bird infestations should be considered.

3. Examine all other window-mounted air conditioners and disinfect in a manner consistent with the previous recommendations.

4. Install anti-roosting spikes on the top surface of all air conditioners as well as on window ledges.

5. Remove the carpeting from board of health office. Repair the leaking radiator.

6. Use the windows to provide ventilation. Care should be taken to close windows at the end of the day to prevent water pipes from freezing. To increase airflow, consideration can be given to install a two-way fan in a window. If a two-way fan is installed, this fan should not be used when air conditioning is operating to prevent the introduction of humidity into the building.

7. Replace any missing or remaining water-stained ceiling tiles. Locate roof and restroom leaks and repair as needed. Examine the area above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
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 relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
9. Regularly wet floor drain trap in the basement to prevent sewer gas odor penetration.

Long Term Recommendations

Without a ventilation system, control of fresh air supply is difficult. This is a problem that may require renovation or refurbishing of equipment.

1. Consider consulting a ventilation-engineering consultant to examine options for the installation of a mechanical ventilation system.
2. Consider consulting a building engineer to analyze the integrity of the building after consulting with the Greenfield building inspector.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

CDC. 1998. Compendium of Measures to Control Chlamydia psittaci Infection Among Human (Psittacosis and Pet Birds (Avian Chlamydiosis), 1998. *MMWR 47:RR-10. July 10, 1998.*

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1995. IAQ Guidelines for Occupied Buildings Under Construction. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Picture 1

Abandoned Ductwork in Basement Ceiling below Board of Health Office, No Corresponding Vent in the first floor Was Located

Picture 2

Exhaust Vent in Basement Sealed by Steel Door

Picture 3

Exhaust Vent in Basement Sealed by Wooden Door in the 1848 Section

Picture 4

Supply Vent in Floor

Picture 5

Wall Mounted Exhaust Vent

Picture 6

View from Indoors of Pigeon on Top of the DPW Engineer's Office Window-Mounted Air Conditioner Casings

Picture 7

Pigeon Waste on the DPW Engineer's Office Window-Mounted Air Conditioner Casings

Picture 8

Crumbled Brick inside Exhaust Vent Shaft

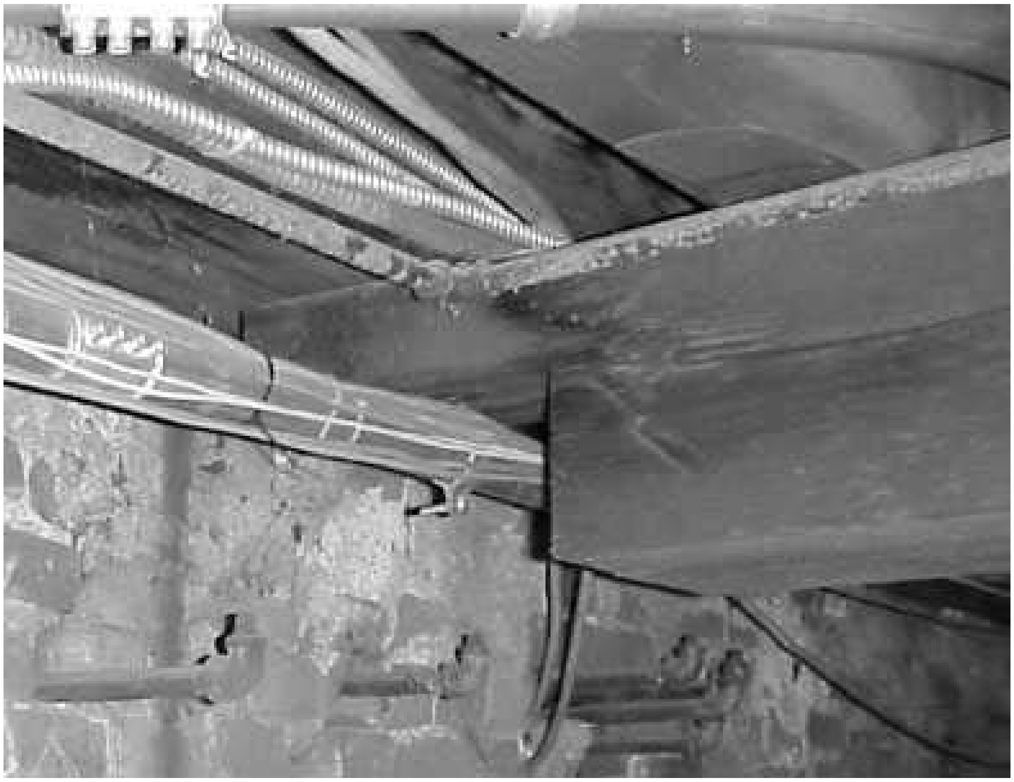
Picture 9

Crumbled Brick and Dust on the Outside of an Exhaust Vent Shaft

Picture 10

Crumbled Brick and Dust on the Outside of an Exhaust Vent Shaft

Picture 11



Floor Support Beam with a Cut Removing 2/3 of Wood

TABLE 1

Indoor Air Test Results –Greenfield Town Hall, Greenfield, MA – April 26, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	459	51	49					
Town Clerk	744	70	25	2	yes	no	no	window mounted air conditioner (A/C)
Town Counsel	648	73	24	1	yes	yes	yes	
Assessor	902	77	21	2	yes	yes	no	window mounted A/C
Assessor's Inner Office	877	77	22	1	yes	no	no	ozone generator
Building Inspector	848	78	16	1	yes	no	no	
Collector's Office	702	77	20	2	yes	no	no	window mounted A/C, 10 computers, 5 CT
Town Manager	752	75	21	1	yes	no	no	window mounted A/C
Meeting Room	966	76	22	0	yes	no	no	window mounted A/C
Town Manager	985	76	19	1	yes	no	no	
DPW Private Office		74	19	1	yes	no	no	8 CT, 1 missing ceiling tile, door open

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

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 2

Indoor Air Test Results –Greenfield Town Hall, Greenfield, MA – April 26, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
DPW-Back Office	930	73	22	1	yes	no	no	
DPW-Engineer's Office	844	74	22	0	yes	no	no	window mounted A/C-pigeons-fresh air intake, plants
DPW-Front Office	713	73	19	0	yes	no	no	window mounted A/C
Accounting	748	76	20	1	yes	no	no	window mounted A/C, door open
2nd Floor Hallway								7 CT, 2 missing ceiling tiles
Retirement	691	76	19	0	yes	no	no	
Board of Health/Recreation	700	77	17	2	yes	no	no	window mounted A/C, 4 computers, refrigerator
Veteran's Office								water damaged ceiling-restroom
1st Floor Restroom								light switch activated exhaust, vehicle exhaust odors reported

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

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