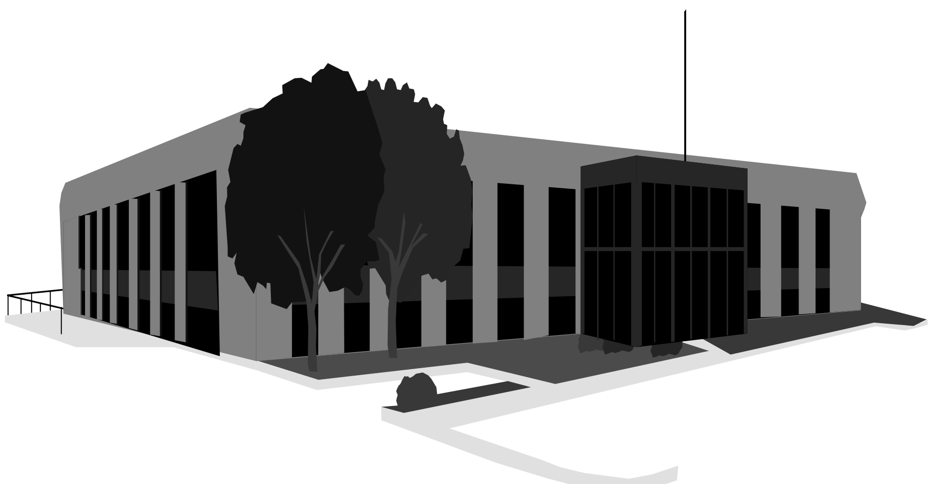
INDOOR AIR QUALITY ASSESSMENT

City of Taunton
Board of Health Building
45 School Street
Taunton, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
June, 2002

Background/Introduction

At the request of Joseph Acevido, City of Taunton, an indoor air quality assessment was done at the Board of Health Building (the site office), 45 School Street, Taunton, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (DPH), Bureau of Environmental Health Assessment (BEHA). Employee concerns about odors in a meeting room on the second floor of this building prompted the investigation. On November 8, 2001, Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ), made a visit to this building. Mr. Acevido accompanied Mr. Feeney during the visit. Mr. Feeney returned on January 9, 2002 to complete the assessment.

The site office is a two-story, red brick building in downtown Taunton. The building appears to have been originally built as school. The date of construction is estimated to be 1890s.

The floor space was originally configured into eight classrooms. Each of the classrooms was remodeled into space for City of Taunton offices. Sash windows are openable in the building. Prior to occupancy by the BOH, the interior of the building was renovated. Suspended ceilings were installed on both floors probably as an energy conservation measure. Within the past several years, the window systems were replaced with energy efficient windows. A ventilation system was installed that services both the first and second floors.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

These offices have an employee population of 17 with approximately one to two members of the general public visiting the space daily. Tests were taken under normal operating conditions and results appear in Tables 1-2.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were above 800 parts per million parts of air (ppm) in seven of thirteen areas sampled, which indicates a ventilation problem in some areas of the building. During the assessment neither air handling unit (AHU) on either floor was operating. The sole source of fresh air in the building during the assessment was air penetrating through cracks and seams in window frames and the periodic opening of exterior doors.

An air-conditioning air handling unit (AC AHU) system was installed in the attic to service Taunton city offices on the second floor of the building. This system is connected by ductwork to ceiling mounted air diffusers. The fresh air intake for this system exists in the roof. Another AC AHU services the first floor. This AC AHU draws air from the side of the building. Air is distributed by diffusers mounted on ductwork.

Two areas on the second floor are not connected to the attic-installed air conditioning system; the ProHome Office and the meeting room. The ProHome office has air conditioning provided by a window-mounted air-conditioning unit.

Ventilation was originally provided by a series of louvered vents that exist on both floors of the building. Each room has an approximately 3’ x 3’ grated air vent in the center of an interior wall near the ceiling, which is connected by an air shaft to one of two boilers in the basement (see Picture 1). A corresponding vent (see Picture 2) exists in each original classroom near the doorways that is connected to an exhaust ventilation shaft that runs from the roof to the basement. These exhaust ventilation shafts are connected by basement chambers that exist on opposite ends of the basement. The building has two of these shafts on either side. Rooms were constructed around these shafts to provide exhaust ventilation. These ventilation shafts exist on either side of the building and terminate in a "hearth"-like opening in the basement.

Air movement was 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 into the heating elements. This system is designed to draw air from two sources in the basement: fresh air from a hinged sash window system on the exterior wall of the building and return air from the exhaust ventilation shafts. These sources of air are mixed in the basement prior to being drawn into the heating elements. Opening the sash window to a fixed setting controls the percentage of fresh air to return air. Fresh air in winter is supplied throughout the building by hot air vents.

The floor level air vents provide exhaust ventilation. As the heating elements draw air into the hot air ducts, return air is drawn from the "hearths" at the bottom of the exhaust ventilation shafts. Negative pressure is created in these shafts, which in turn draw air into the floor vents of each original classroom. The draw of air into these cool air vents is controlled by a draw-chain pulley system. A percentage of return air rises up the ventilation shaft to exhaust outdoors.

With the installation of the air-conditioning system, vents on the first floor were sealed. Original vents still exist on the second floor, which are connected to the basement chambers. Since this system is now abandoned, the sole source of fresh air in the building during winter months is the use of openable windows. This system should be properly sealed to prevent drafts and movement of dirt, dusts, molds and particulate matter migrating from the basement to the second floor offices. This would include sealing roof top stacks (where appropriate), room vents and basement passageways. With the lack of a fresh air supply or exhaust ventilation, pollutants that exist in the interior space will not be diluted or removed and can build up and remain inside the office.

In order to have proper ventilation with a mechanical supply and exhaust system, the AC AHUs must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

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. For more information on carbon dioxide see Appendix I.

Temperature readings were within a range of 69° F to 74 ° F, which were very close or within the BEHA recommended comfort guidelines. The BEHA 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. Temperature control is difficult in an old building without a functioning ventilation system.

Relative humidity measurements ranged from 23 to 28 percent throughout the building, which were below the BEHA comfort range. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity measurements would be expected to be near or below the relative humidity outdoors. Relative humidity levels would be expected to drop during the heating season. 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/Moisture Concerns

Mr. Acevido reported that a roof leak had moistened ceiling tiles in the meeting room. Ceiling tiles can be susceptible to mold growth if allowed to remain moist. If mold has colonized ceiling tiles, the addition of moisture can result in increased mold growth. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that ceiling tiles be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If they are not dried within this time frame, mold growth may occur. Water-damaged ceiling tiles cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy ceiling tiles is not recommended.

Other Concerns

Mr. Acevido reported that the odor was isolated to the meeting room. A stale sulfurous odor was detected in this room upon entering. The odor was thought to be emanating from the ceiling tiles. An examination of an opened case of ceiling tiles from the batch installed had a distinct sulfur odor, which was confirmed by Mr. Acevido as the odor reported in the building. The product specification sheet indicates that the ceiling tiles were designed to be used in an area with relative humidity below 70 percent and with a temperature range between 60 ^{o}F to 85 ^{o}F (AWI, Unknown). It is possible that ceiling tile odor is related to the manufacturing process or storage prior to installation.

A new furnace was installed in the basement to replace the original furnace. A furnace vent was installed in the airshaft on the eastern side of the building. The terminus of this vent is installed beneath a rain cap that was installed over this airshaft (see Picture 3). In this configuration, furnace exhaust can build up under the rain cap and possibly re-enter the building by migrating down the eastern airshaft.

An odor of acetone was reported by building occupants. During the assessment, the odor of acetone was detected on the roof. Immediately adjacent to the BOH building is a shop that conducts motor vehicle bodywork and spray painting (see Picture 4). The shop was directly upwind during the assessment, which may indicate that this establishment is the source of the acetone-odor inside the building. The pathway for this odor may be entrainment by the airshaft on the west side of the building, particularly during cold weather early in the morning as cold air sinks down the airshaft.

Conclusions/Recommendations

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

1. Continue with plans to remove and discard odorous ceiling tiles. Install new ceiling tiles and monitor for odor presence.
2. Permanently seal openings on the second floor for the original ventilation system.
3. Since neither airshaft on the roof serves their original purpose as exhaust vents, consideration should be given to sealing these vents at the roof level, as well as in the basement. Sealing the airshafts may prevent paint odors from the shop from penetrating into the building.
4. Extend the furnace vent pipe through the chimney cap.
5. Continue with remediation steps to repair leaks moistening meeting room ceiling tiles.
6. 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. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations). Consider

obtaining a vacuum cleaner equipped with a high efficiency particulate arrestance (HEPA) filter to trap respirable dusts.

References

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

AWI. Unknown. Armstrong Suspended Ceiling panels Installation Instructions and Warranty. Armstrong World Industries, Inc., Lancaster, PA.

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

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. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

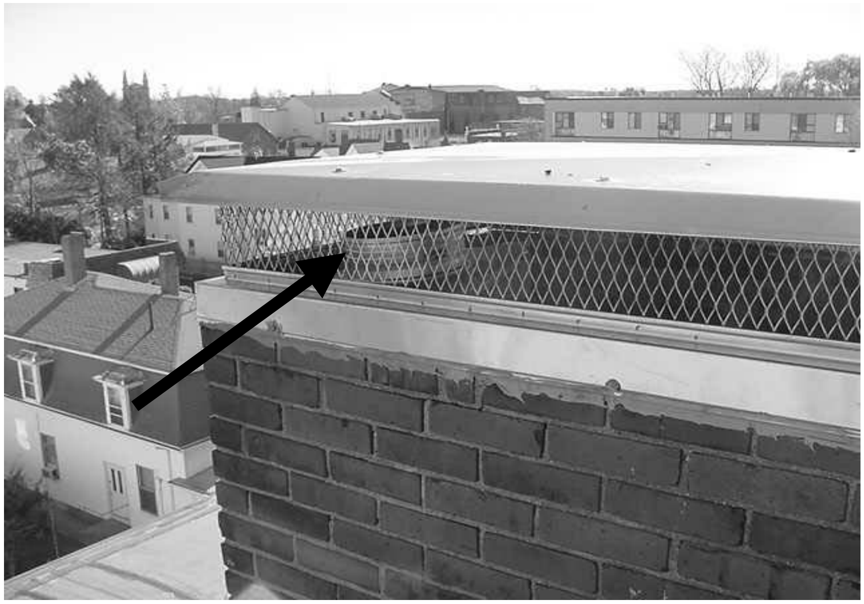
Picture 1

Original Fresh Air Supply Vent in Meeting Room

Picture 2

Exhaust Vent in 2ND Floor Town Offices

Picture 3



Furnace Vent Installed underneath Airshaft Rain Cap

Picture 4

Vehicle Maintenance Garage Believed To Be Source of Acetone Odor

TABLE 1

Indoor Air Test Results – City of Taunton, Board of Health Building, Taunton, MA – January 9, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	397	48	26					
BOH – Common Area	572	73	26	1	Yes	Yes	No	Supply off, photocopier
BOH – Reception Area	673	73	24	2	No	Yes	No	
BOH – File Cabinet Area	595	76	23	1	Yes	Yes	No	Supply off, door open
BOH – Director's Office	598	70	24	1	Yes	No	No	Transom open
Basement	454	69	27	0	Yes			Door open
Acevido's Office MOCD	1152	69	28	1	Yes	Yes	No	Supply off, door open, original space of NE classroom, floor TVOCs = 2
Morris Office MOCD	910	70	26	0	Yes	Yes	No	Supply off, original space of NE classroom, floor TVOCs = 2
Front Desk – MOCD	843	70	25	0	No	Yes	Yes	Supply and exhaust off, door open, original space of NE classroom
Secretary's Office – MOCD	824	70	25	0	Yes	Yes	Yes	Supply and exhaust off, hallway

*** ppm = parts per million parts of air**
CT = 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 – City of Taunton, Board of Health Building, Taunton, MA – January 9, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Meeting Room	839	72	25	0	Yes	No	No	Original space of SE classroom, water damaged CT-odor, transom closed, abandoned vent, door open
ProHome Office	784	73	24	3	Yes	No	No	Original space of SW classroom, window-mounted air conditioner, abandoned vent, transom closed, door open, water damaged CT-no odor, accumulated items
Director's Office – MOCD	677	72	23	0	Yes	Yes	Yes	Abandoned vent, transom closed, door open, original space of NW classroom
MOCD – Common Area	1020	71	25			No	No	Original space of NE classroom, abandoned vent, transom closed, photocopier, door open

*** ppm = parts per million parts of air**
CT = 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%