INDOOR AIR QUALITY ASSESSMENT

Wessagusset Primary School
75 Pilgrim Road
Weymouth, Massachusetts

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

At the request of the Weymouth School Department, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding potential indoor air quality concerns at the Wessagusset Primary School, Weymouth, MA. On December 3, 2002, a visit was made to the school by Cory Holmes, Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) program, to conduct an assessment. Mr. Holmes was accompanied by Thomas Slattery, Director of Buildings and Grounds, for portions of the assessment.

The school is a one-story brick structure built in the early 1970's. A new roof was reportedly installed in 1995. The school contains general classrooms, science classrooms, a computer lab, several resource rooms, library-media center, gymnasium, office space, art room, kitchen and cafeteria. Windows throughout the building are openable.

Methods

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

Results

The school houses students grades K-4. It has a student population of approximately 400 and a staff of approximately 35. Tests were taken during normal operations at the school and results appear in Tables 1-3.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in eighteen of twenty-eight areas surveyed, indicating inadequate ventilation in these areas of the school. Fresh air in classrooms is supplied by a unit ventilator (univent) system. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (see Picture 1) and return air through an air intake located at the base of each unit (see Figure 1). Fresh air and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. School Department officials stated that extensive repair work has been performed over the past two years on the system (e.g. pneumatic controls, actuators and thermostats) to improve ventilation.

Univents were found deactivated or obstructed in a number of classrooms (see Tables/Pictures 2 & 3), which can prevent airflow and lead to increased carbon dioxide levels. In order for univents to provide fresh air as designed, they must remain free of obstructions and allowed to operate.

The mechanical exhaust ventilation system in classrooms consists of grated, wall or ceiling-mounted exhaust vents (see Picture 4). Exhaust vents from individual classrooms are drawn into a common duct above the ceiling in hallways. Exhaust air is expelled from the building by a motorized exhaust vent located on the exterior wall above hall way exterior doors (see Picture 5). The location of exhaust vents can limit exhaust efficiency when the classroom hallway door is open. When a classroom door is open,

exhaust vents will tend to draw air from both the hallway and the classroom (see Picture 4). The open hallway door reduces the effectiveness of the exhaust vent to remove common environmental pollutants from classrooms.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a univent 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. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994).

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 (BOCA, 1993; SBBRS, 1997). 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 measurements ranged from 64^{o} F to 76^{o} F, which were below the BEHA comfort guidelines in some areas. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} 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 16 to 27 percent, which was below the BEHA recommended comfort range. The BEHA recommends a comfort range of 40-60 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

Several classrooms had a number of plants. Moistened plant soil and drip pans can be sources of mold growth. Plants are also a source of pollen. Plants in several classrooms were noted near univent air diffusers (see Picture 6). Plants should be located away from the air stream of ventilation sources to prevent the aerosolization of mold, pollen or particulate matter throughout the classroom.

No gutter/downspout system exists along the roof eave to direct rainwater away from the base of the exterior walls (gutters are only installed over exterior doors) in some areas. Sections of the exterior walls appeared to be saturated with moisture and moss growth (see Picture 7). Moss growth on exterior brickwork is an indication of chronic moisture exposure from rainwater. Moss growth holds moisture against brickwork. North-facing corners and walls of this building are particularly vulnerable to moisture for extended periods of time, since the brick is not dried out by exposure to direct sunlight. Excessive exposure to water of exterior brickwork can result in damage over time. During winter weather, the freezing and thawing of moisture in bricks can accelerate the deterioration of brickwork, which can lead to water intrusion into the interior of the building.

Exterior caulking around windows and frames was crumbling/damaged in a number of areas indicating that the water seal is no longer intact (see Picture 8). Replacement of caulking and repairs of window leaks are necessary to prevent water penetration and subsequent damage to building materials, which can lead to mold growth. School Department officials reported that funds had been allocated and window replacement was scheduled for this winter (2003).

Other Concerns

Several other conditions that can potentially affect indoor air quality were also identified. Of note was the amount of materials stored inside classrooms. In many areas, items were observed piled on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to the eyes, nose and respiratory tract. Also, dust becomes more readily aerosolized in a low relative humidity environment. For these reasons, items should be relocated and/or cleaned periodically to avoid excessive dust build up.

Cleaning products were found on counter tops in classrooms. Cleaning products contain chemicals (such as bleach or ammonia-related compounds), which can be irritating to the eyes, nose and throat. These items should be stored properly and out of the reach of students.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs. Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and to off-gas VOCs. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix II (NIOSH, 1998).

Finally, several classrooms contained fur-bearing animals. Classroom 18 had a guinea pig located near the air stream of the univent. Porous materials (i.e., newspaper) can absorb animal wastes and can be a reservoir for mold and bacterial growth. Animal dander, fur and wastes can all be sources of respiratory irritants. Animals and animal cages should be cleaned regularly and should be kept away from the air stream of ventilation components to avoid the aerosolization of allergenic materials and/or odors (NIOSH, 1998).

Conclusions/Recommendations

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

1. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation *operate continuously* during periods of school occupancy independent of classroom thermostat control.
2. Consider having the ventilation system balanced by an HVAC engineer every five years (SMACNA, 1994).
3. Remove all blockages from univents to ensure adequate airflow. Clean out interiors of univents regularly.
4. 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. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

5. Remove plants away from univents. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.
6. Continue with plans to replace windows throughout the school.
7. Consider installing downspouts and gutters to areas of the building without them to direct rainwater away from the building.
8. Consider discontinue the use of tennis balls on chairs to prevent latex dust generation.
9. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning of classrooms. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
10. Clean animal cages regularly, relocate animal cages from the air stream of ventilation components.
11. In order to provide self assessment and maintain a good indoor air quality environment on your building, consideration should be give to adopting the US EPA document, "Tools for Schools", which can be downloaded from the Internet at http://www.epa.gov/iaq/schools/index.html.
12. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

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Picture 1

Univent Air Intake

Picture 2

Classroom Items on and around Univent Obstructing Airflow

Picture 3

Classroom Furniture set up around Univent Inhibiting Airflow

Picture 4

Classroom Exhaust Vent Note Open Door

Picture 5

Exhaust Terminus Exterior of Building

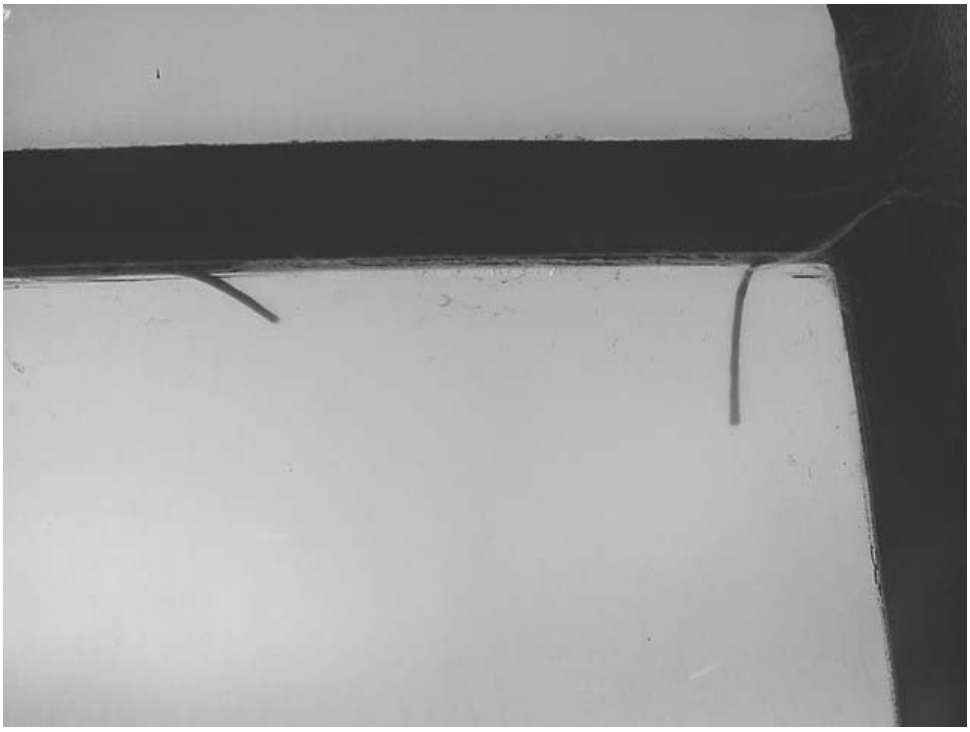
Picture 6

Plants in Classroom around Univent

Picture 7

Water Staining and Moss Growth on Exterior Brick

Picture 8



Failing Window Caulking

TABLE 1

Indoor Air Test Results –Weymouth – Wessagusset Elementary School December 3, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
(Outside) Background	377	22	16					Weather cold, clear, wind 15-20, easterly, freezing temperatures
Mrs. Nestor	833	67	27	17	Y	Y	Y	Door open, hanging plants Exhaust vent dusty
Ms. Palinso	843	70	23	18	Y	Y	Y	UV deactivated by occupant, door open, spray product on sink
Room 1	728	70	18	16	Y	Y	Y	Door open Items on/around univent
Gym	594	64	20	0		Y	Y	
Room 6	1052	76	27	19	Y	Y	Y	Tennis balls, cleaning product on sink, UV – motor repaired
Room 2	1223	71	20	22	Y	Y	Y	Items on/front of UV Cleaning product on sink
Room 3	1050	72	21	18	Y	Y	Y	Door open Items on/front of UV
Room 4	1028	73	21	15	Y	Y	Y	UV cycling on/off
Room 5	659	71	16	1	Y	Y	Y	Class at gym 19 occupancy gone 20 min.
Book Room	754	71	20	1	N	N	Y	Large photocopier

*** ppm = parts per million parts of air**
UV = Univent

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%

(1 Story – Red Brick)

TABLE 2

Indoor Air Test Results –Weymouth – Wessagusset Elementary School December 3, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 7	1180	71	21	14	Y	Y	Y	UV off – obscured by desk file cabinets, door open, fur bearing animals
Room 8		72	20	17	Y	Y	Y	Cleaning product on sink Door open
Nurses Office	880	72	20	4	N	N	Y	Door open
Room 9	885	73	19	12	Y	Y	Y	Cleaning product on sink Items on/around UV
Library	684	72	18	22	Y	Y	Y	Door open
Art Room # 10	648	69	21	0	Y	Y	Y	Door open, plants on/around UV, carpet
Room 11	1290	75	23	25	Y	Y	Y	Door open, cleaning product on sink, items on UV, plants on/around UV, musty odors
Room 12	1438	73	24	25	Y	Y	Y	Door open
Room 13	961	71	19	22	Y	Y	Y	Many plants on/around UV Flowering plants, window open, exhaust vent partially blocked - on wall

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TABLE 3

Indoor Air Test Results –Weymouth – Wessagusset Elementary School December 3, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Mrs. Abbrazzese	611	68	17	0	Y	Y	Y	
Room 14	1018	74	21	18	Y	Y	Y	Door open, items on UV Cleaning product on sink
Cafeteria	796	72	19	150+	Y	Y	Y	
Room 15	994	73	20	0	Y	Y	Y	Door open, items on UV 22 occupants gone 5 min.
Room 16	1060	71	20	22	Y	Y	Y	Items on UV
Room 17	1290	73	23	22	Y	Y	Y	Items in front of UV return Cleaning product on sink
Room 18	670	76	17	0	Y	Y	Y	Flowering plants, door open Guinea pigs on/near UV
Mrs. Argeris	821	75	18	2	Y	N	N	
Teachers Lounge	711	71	17	7	Y	Y	Y	Door open
Room 6	846	73	18	19	Y	Y	Y	

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