INDOOR AIR QUALITY ASSESSMENT

Squannacook Elementary School
66 Brookline Road
Townsend, Massachusetts

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

At the request of a parent, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality issues at the Squannacook Elementary School in Townsend, MA. On December 8, 1999, a visit was made to this school by Cory Holmes, Environmental Analyst, Emergency Response/Indoor Air Quality (ER/IAQ), BEHA to conduct an indoor air quality assessment. Tony Reeves, Supervisor of Buildings and Grounds, accompanied Mr. Holmes during the inspection.

The school is a two-story, steel and cement block structure constructed in 1989 and houses 3rd through 5th grade students. The second floor is largely comprised of general classrooms. The first floor consists of general classrooms, library, cafeteria, computer room and office space.

Methods

Air tests for carbon dioxide were taken with the Telaire, Carbon Dioxide Monitor and tests for temperature and relative humidity were taken with a Mannix, TH Pen PTH 8708 Thermo-Hygrometer.

Results

This school has a student population of 488 and a staff of approximately 60. The tests were taken during normal operations. Test results appear in Tables 1-5.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 (parts per million of air) ppm in eighteen of thirty-one areas surveyed, which indicates a ventilation problem in these areas. It should be noted that windows and/or exterior doors were open in several rooms, which can greatly reduce carbon dioxide levels. Of note were rooms 209 and 211, which had carbon dioxide above 800 ppm without occupancy.

Classroom ventilation is provided by a unit ventilator (univent) system (see Figure 1). All univents were capable of operating at the time of the assessment, however they were turned off in several classrooms. The univent in classroom 104 was emitting a "buzzing" noise, which may indicate a mechanical problem. Obstructions to airflow such as books, papers and other items on top of univents; and bookcases, tables and file cabinets in front of univent returns were seen in a number of classrooms. To function as designed, univent air diffusers and return vents must remain free of obstructions. More importantly, the units must be activated and allowed to operate.

Exhaust ventilation is provided by ceiling-mounted exhaust vents. All exhaust vents were functioning during the assessment, with the exception of the restroom exhaust vent in classroom 114. The exhaust vent for classroom 204 was temporarily deactivated. This vent was later re-activated, which BEHA staff verified. Exhaust ventilation for the main office area and nurses' station is also provided by ceiling-mounted exhaust vents, located in each area's restroom. In order to provide proper exhaust ventilation for office areas, the doors to the restrooms are left open. An alternative to this would be to install passive vents in the restroom doors or to undercut the doors to allow for airflow into the

restroom. The exhaust vent in classroom 114's restroom was not functioning. It is important to provide exhaust ventilation in restrooms to remove moisture and to prevent odors from migrating into adjacent areas.

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 also 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.

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). 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 at levels measured in this building. 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 at the school were within the BEHA comfort range in all but one area assessed. The nurse's office measured 84^{o} F. This area has had both complaints of insufficient and excessive heat. Temperature readings in the remainder of the school were in a range of 71^{o} F to 78^{o} F. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F and 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 adequate fresh air supply. The computer room is housed in a general classroom, which contained over 20 computers as well as a number of printers and other associated equipment, which can generate waste heat. To provide comfort in this area two ceiling-mounted air conditioning units were installed and are utilized as needed.

The relative humidity in the building was within a range of 22 to 34 percent, which was below the BEHA recommended comfort range in all areas sampled. 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. In some classrooms flowering plants were observed on univent air diffusers. Classroom 111 contained a number of plants located on the windowsills in jars of standing water. Several classrooms contained plants in window planters, and/or hanging plants suspended above carpeting without drip pans. Window planters are designed to be mounted on the outside of windows and therefore do not have drip pans. The lack of drip pans can lead to water pooling and mold growth on windowsills and carpeting when used indoors. Moistened plant soil, drip pans and standing water can serve as sources of mold growth. Plants should be equipped with drip pans and over watering should be avoided. In addition, plants should be located away from univents to prevent the aerosolization of dirt, pollen or mold.

Several classrooms had water-stained ceiling tiles, which are evidence of historic roof or plumbing leaks. Water-damaged ceiling tiles can provide a source of mold and mildew and should be replaced after a water leak is discovered and repaired. No active ceiling leaks were reported.

Classroom 112 had spaces around the sink countertop and splashboard. Improper drainage or overflow could lead to water penetration of countertop wood and potential damage to the cabinet interior. Water-damaged wood and standing water can provide a potential source of mold growth. A number of classrooms contained aquariums. Aquariums must be properly maintained to prevent bacterial and microbial growth.

Other Concerns

A number of other conditions that can potentially affect indoor air quality were also observed. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Cleaning products were found on countertops and beneath sinks in a number of classrooms. Cleaning products contain chemicals, which can be irritating to the eyes, nose and throat and should be stored properly and kept out of reach of students. In addition, a number of classrooms contained unlabeled spray bottles. Products should be kept in their original containers or should be clearly labeled as to their contents for identification purposes, in the event of an emergency.

The teacher's workroom contained a photocopier and a lamination machine. Lamination machines give off odors. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). These machines also produce heat. Occupants should ensure local exhaust ventilation is activated while this equipment is in use to help reduce odors, pollutants, and excess heat in the workroom.

As mentioned previously, the computer room contains two ceiling-mounted air-conditioning units. Air-conditioning units are normally equipped with filters, which should be changed as per the manufacturer's instructions to avoid the build up and re-aerosolization of dirt, dust and particulate matter. Several classrooms contained feather dusters, which can be a source of allergenic materials for some individuals. In addition, feather dusters do not physically remove dust particles, but can serve to reaerosolize dust.

A bucket labeled "oxidizer – flammable" was noted beneath the sink in classroom 106. BEHA staff consulted the teacher for this room who reported that the bucket contained common beach sand for student activity use. BEHA staff suggested that the contents of the bucket be transferred into an alternate container and that the present container labeled "flammable" be removed.

An inactive wasp's nest was noted in classroom 103, which serves as a learning tool. Insect parts can become dried out and aerosolized and may serve as a source of allergenic material for certain sensitive individuals. A number of classrooms also had excessive amounts of chalk dust. Chalk dust can be a source of eye and respiratory irritation.

Conclusions/Recommendations

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

1. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room and make univent repairs as needed. Check fresh air intakes for repair and increase the percentage of fresh air intake if necessary.
2. Determine origin of "buzzing" noise from univent in classroom 104, make repairs as needed.
3. Inspect exhaust motors and belts periodically for proper function, repair and replace as necessary.
4. Repair/reactivate exhaust vent in classroom 114 restroom.

5. Remove all blockages from univent fresh air diffusers and return vents to facilitate airflow.
6. Operate univents and exhaust ventilation while classrooms are occupied. Consider having the systems balanced by a professional HVAC engineer.
7. 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. Avoid the use of feather dusters, to control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all non-porous surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
8. Repair any water leaks and replace any remaining water-stained ceiling tiles. Examine the areas above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
9. Move plants away from univents and ensure drip pans are placed underneath plants in classrooms. Examine plants in classrooms for mold growth in water catch basins. Disinfect water catch basins if necessary. Ensure drip pans are placed underneath plants in classrooms. Consider discontinuing the use of window planters as well as hanging plants above carpeting in classrooms.
10. Acquire current Material Safety Data Sheets for all products that are used in the building that contain hazardous materials, including office supplies, in conformance with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).

11. Store chemicals and cleaning products properly and out of the reach of students.
12. Change filters for ceiling-mounted air conditioners as per the manufacturer's instructions to prevent the re-aerosolization of dirt, dust and particulate matter.
13. Transfer sand stored beneath sink in classroom 106 into alternate container.
14. Keep wasps' nest away from univents to prevent the aerosolization of potentially allergenic materials.
15. Clean chalkboards and chalktrays regularly to prevent the build-up of excessive chalk dust.

References

MGL. 1983. Hazardous Substances Disclosure by Employers. Massachusetts General Laws. M.G.L. c. 111F.

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.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

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

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

Figure 1 **Unit Ventilator (Univent)**

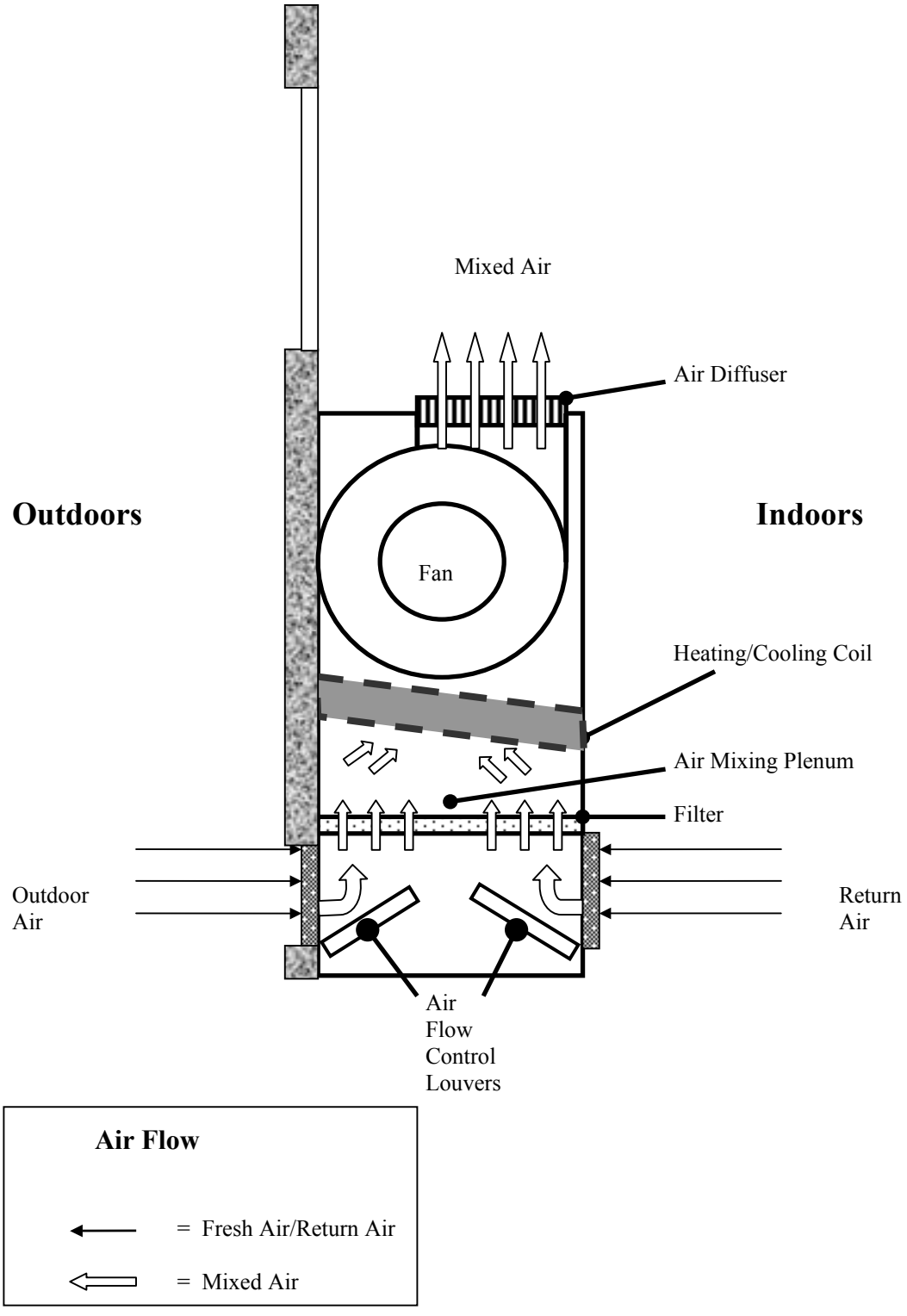

TABLE 1

Indoor Air Test Results – Squannacook Elementary School, Townsend, MA – December 8, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	473	55	24					weather conditions: clear, sunny, light breeze
Room 203	1150	73	17	22	yes	yes	yes	univent partially blocked by file cabinet, cleaning products on sink
Room 201				1	yes	yes	yes	(23) occupants gone ~10 min., window and door open, 4 plants
Room 204	1052	71	19	19	yes	yes	yes	exhaust off, water damaged ceiling, chalk dust
Room 207	1085	73	15	24	yes	yes	yes	paper/items on univent, cleaning products on/under sink, door open
Room 206	963	74	16	22	yes	yes	yes	univent partially blocked by file cabinet and bookcase, 2 plants, 3 feather dusters
Room 208	1030	72	15	15	yes	yes	yes	
Teachers' Workroom				0	yes	yes	yes	photocopier, laminator
Room 210	643	73	14	1	yes	yes	yes	7 plants
Room 209	852	71	17	0	yes	yes	yes	window and 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 – Squannacook Elementary School, Townsend, MA – December 8, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
2nd Floor Boys' Restroom					yes		yes	
2nd Floor Girls' Restroom					yes		yes	
Room 211	814	71	16	0	no	yes	no	
SPED - Main Area	720	73	14	1	no	yes	yes	(4) occupants gone ~5 min., chalk dust
Room 212A	735	73	13	0	no	yes	yes	5 CT
1st Floor Boys' Restroom					yes		yes	
1st Floor Girls' Restroom					yes		yes	
Computer Room	600	76	16	0	yes	yes	yes	21 computers, univent partially blocked by computer cart, 2 ceiling-mounted a/c units, 1 CT, cleaning product on desk
Room 113	705	74	14	19	yes	yes	yes	6 CT

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CT = water-damaged ceiling tiles

Comfort Guidelines

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	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – Squannacook Elementary School, Townsend, MA – December 8, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 115	964	72	19	24	yes	yes	yes	8 plants-some without drip pans-window planter
Room 114	943	73	19	25	yes	yes	yes	7 plants-1 on univent, bathroom exhaust not functioning
Library	518	71	18	23	yes	yes (2)	yes	items on univent, window open, 11 CT, 5 plants
Room 101	1020	72	17	25	yes	yes	yes	univent return blocked by carts, chalk dust
Room 102	1071	75	19	24	yes	yes	yes	window open, chalk dust
Room 104	942	73	19	23	yes	yes	yes	9 plants, buzzing noise from univent, 2 CT
Room 103	1057	73	14	21	yes	yes	yes	"Inactive" wasps' nests (prop)
Room 105	900	72	14	21	yes	yes	yes	musty odor, cleaning products under sink, 3 CT
Room 107	930	71	13	24	yes	yes	yes	items on univent-in front of return
Nurse's Office	718	74	18	4	no	yes	no	exhaust in restroom

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Comfort Guidelines

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	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Squannacook Elementary School, Townsend, MA – December 8, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 110	615	75	18	26	yes	yes	yes	cleaning product on sink, door open, 11 plants-l with drip pans, flowering plants on univent, 7 CT
Room 109	833	73	17	21	yes	yes	yes	plant, air purifier, chalk dust, door open
Room 111	788	73	17	20	yes	yes	yes	6 hanging plants-some over carpet-2 jars standing water with plants-plant hanging over univent, door open, 2 aquariums (1 empty), 7 CT, cleaning products under sink
Room 112	845	73	19	23	yes	yes	yes	boxes on univent, door open, 5 CT, space around sink splashboard, cleaning products under sink
Room 106	690	74	14	14	yes	yes	yes	chalk dust, cleaning products under sink, door open, sand in bucket labeled "oxidizer" under sink
Room 108	441	69	15	2	yes	yes	no	exhaust in closet, window open, 9 CT
Gym	442	70	8		no	yes	yes	

*** ppm = parts per million parts of air**
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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 5

Indoor Air Test Results – Squannacook Elementary School, Townsend, MA – December 8, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Cafeteria	654	71	15	0	yes	yes	yes	~175 occupants gone 35 min.
Room 204	953	75	20	25	yes	yes	yes	

*** 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%