INDOOR AIR QUALITY ASSESSMENT

Leicester Middle School
70 Winslow Avenue
Leicester, Massachusetts

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

At the request of Mr. Carl Wickland, Facilities Manager of the Leicester School Department, an indoor air quality assessment was conducted at the Leicester Middle School (the school) in Leicester, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA).

The school was originally visited by Cory Holmes, Environmental Analyst of BEHA's Emergency Response/ Indoor Air Quality Program, on February10, 1999 to conduct an indoor air assessment and a report was issued (MDPH, 1999). The report showed that there were problems identified and gave recommendations on how to correct those problems. On November 4, 1999 the school was re-visited by Mr. Holmes to conduct a follow-up indoor air quality assessment. Mr. Holmes was accompanied during the evaluation by Archie Suprenant, Supervisor of Grounds Maintenance, Leicester School Department.

The school is a one-story, steel beam and cinder block building built in 1961. Seven classrooms were added in 1978 and bathrooms were renovated in 1995. The school is constructed around a central courtyard and contains general classrooms, science classrooms, an auditorium, gymnasium, cafeteria, kitchen, library, computer room, art room, teacher's room, music room, and office space. The woodshop was converted into the technology classroom.

Actions on Previous Recommendations

BEHA had previously made 11 recommendations to improve indoor air quality at the Middle School, many of these recommendations had been implemented. Several school faculty and staff members reported to BEHA staff that they believe indoor air quality was improved compared to the previous school year. The following is an update on actions taken in response to BEHA recommendations, based on reports from the Leicester School Department and/or direct observation by BEHA personnel during this re-evaluation.

1. A number of inactive univents noted during the previous visit were repaired. A number of other univents, found operating during the previous assessment, had broken down since the previous visit (see Tables). All broken univents are on a work list for repair by the Leicester School Department.
2. School personnel were instructed to allow univents to operate during classroom occupation. Several classrooms had deactivated univents even though these units were operational.
3. Rooftop exhaust ventilation motors that were inoperative and/or missing fan belts during the previous visit were restored to working order. Exhaust ventilation was operating during classroom occupation.
4. Exhaust ventilation for the chemical storage areas had not been repaired.
5. School personnel were instructed to remove all blockages from univents and exhaust vents. While univents throughout the school were free from obstructions, some exhaust vents were still blocked in a number of classrooms.
6. School personnel were instructed to re-locate plants away from univents in classrooms. No plants were observed on univent fresh air diffusers.

7. School personnel have been instructed to store cleaning products properly and out of the reach of students. No cleaning products were observed to be stored improperly.
8. Insulation around pipe in the special needs area had been repaired.
9. School personnel were instructed to properly maintain aquariums to prevent unpleasant odors and/or the growth of bacteria and mold. Aquariums were being maintained and no unpleasant odors were noted during the assessment.

Methods

In addition to evaluating the status of a number of remedial measures taken by the Leicester School Department, BEHA staff also conducted a series of follow up tests. 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. Wind speed and direction were measured with a Davis, Wind Wizard, Wind Speed Indicator.

Results

This school houses grades 6 through 8 with a student population of 448 and a staff of approximately 50. The tests were taken during normal operations at the school. Test results appear in Tables 1-3.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 ppm in eighteen of twenty-seven areas surveyed, indicating a ventilation problem in these areas of the school. It is important to note that in almost all areas where carbon dioxide levels were above 800 ppm, the ventilation systems were either off or obstructed.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (see Figure 1). These univents were functioning in the majority of classrooms surveyed. Univents in classrooms that were not operating were in the process of being repaired or were on a repair list awaiting motors and/or other mechanical components. Several univents were found deactivated; these univents were re-activated by Mr. Suprenant during the assessment.

Mechanical ventilation in the art room is provided by an air-handling unit (AHU) located in an adjacent mechanical room. The system was deactivated by request of the occupant, therefore providing no mechanical ventilation. In addition, ventilation grilles were noted to be blocked by various items (see Picture 1). Mr. Suprenant re-activated the system during the assessment, which BEHA staff verified. The door to the mechanical room is equipped with louvers to provide fresh "make-up " air to the mechanical room. These louvers were blocked with sheet metal which prevents airflow, interfering with the proper function of the system (see Pictures 2 & 3). It is important that the system remains "on" and be allowed to operate un-obstructed to provide mechanical ventilation to the area.

Mechanical exhaust vents for the 1961 addition are located on the outside of closets. The mechanical exhaust ventilation system for the 1978 addition consists of

ceiling mounted exhaust vents. Mechanical exhaust ventilation was operating in all classrooms surveyed, with the exception of room 25. Exhaust ventilation in room 25 is supplied by a ceiling-mounted exhaust vent. The fire damper to this vent was shut, which blocks the exhaust vent draw.

Exhaust ventilation for science classrooms 8 and 10 is provided by ceiling-mounted exhaust vents located in a chemical storeroom for each of the science classrooms (see Pictures 4 & 5). Passive grills are mounted on the wall adjacent to the drop ceiling to draw classroom air into the storerooms and out of the building through the exhaust vents (see Picture 6). These systems were not operating during the assessment. Cool air was noted backdrafting through these vents indicating that the system was off or that motors on the roof were inoperable. The assessment occurred on a cold day with moderate wind conditions (10-15 mph). The combination of the inactive ventilation system and wind would explain the occurrence of backdrafting noted on the day of the assessment.

Also noted in several classrooms were exhaust vents found obstructed by boxes, crates and other items. Ceiling mounted exhaust vents in the seven new classrooms are located approximately three feet above storage cabinets. Items were seen stored on top of the cabinets in many classrooms, blocking the vents (see Picture 7). As noted in the previous report, care should be taken to avoid the blockage of these vents by items stored on top of cabinets. Exhaust ventilation in the cafeteria was drawing weakly.

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. Information regarding the date of the last servicing and 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 occurs 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 within a range of 66^{o} F to 77^{o} F, which is slightly below the lower end of the BEHA recommended range. 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. Complaints of excessive heat were reported in classroom 24, which serves as the computer room. No additional ventilation or air conditioning has been installed in this classroom to help remove heat generated by the 30 + computers located in this area. In addition, the univent in this classroom was inoperable, therefore no fresh outside air was being provided, which can exacerbate heat build up.

The relative humidity in this building was below the BEHA recommended comfort range in the majority of areas sampled. Relative humidity measurements ranged from 11 to 20 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40-60 percent. 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 still had a number of plants. Moistened plant soil and drip pans can be a source of mold growth. Plants are also a source of pollen. Plants were re-located away from the air stream of univents and should remain as such, to prevent the aerosolization of mold, pollen or particulate matter.

Along the perimeter of the building, shrubbery and flowering plants were noted in close proximity to a univent fresh air intake outside of one of the classrooms (see Picture 8). Shrubbery and flowering plants can be a source of mold and pollen and should be placed and/or maintained to ensure that fresh air intakes remain clear of obstructions.

Other Concerns

Several conditions that can potentially affect indoor air quality were also identified. As noted in the previous report, the teacher's workroom contains photocopiers and a lamination machine. Lamination machines can give off excess heat and odors. Ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. This room has no mechanical exhaust ventilation to help remove odors.

Several classrooms contained aquariums and hamsters/gerbils. Animal wastes and dander can be a source of irritants to the nose and throat. Animals should be properly maintained and their cages cleaned regularly (NIOSH, 1998). Aquariums must be properly maintained to prevent bacterial and microbial growth.

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. Several classrooms contained excessive chalk dust. Chalk can become easily aerosolized and also serve as an eye and respiratory irritant.

As noted in the previous report, mechanical exhaust ventilation in the chemical storage rooms located in classrooms eight and ten were not operating. Exhaust ventilation should be activated and kept on at all times to prevent the infiltration of chemical odors into occupied areas.

Conclusions/Recommendations

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

1. Continue with activities to improve the building's ventilation system. Continue to operate exhaust ventilation and univents while classrooms are occupied.
2. Inspect exhaust system that services the science rooms and chemical storage areas for proper function. Repair and replace motors and belts as necessary. Once operable, run the system continuously to prevent the infiltration of chemical odors into occupied areas.
3. Remove all blockages from univents and exhaust vents. Inspect periodically to ensure these areas remain free from obstructions.
4. Once univents and exhaust ventilation are running properly, the systems should be balanced.
5. Avoid over-watering and examine plants and drip pans periodically for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial where necessary. Continue to locate plants away from the air stream of univents.
6. Continue to store cleaning products properly and out of reach of students.
7. Examine the feasibility of installing local exhaust ventilation in the teacher's workroom to help reduce lamination machine and photocopier odors. If not feasible, consider relocating odor-producing machinery to an area with local exhaust ventilation.
8. Continue to maintain aquariums properly.
9. Clean chalk boards and chalk trays regularly to avoid the excessive build-up of chalk dust.

10. Inspect shrubbery along outside perimeter of building periodically; trim away from fresh air intakes as needed.

11. Examine the feasibility of providing air conditioning and/or additional ventilation to computer classroom 24 to remove excess heat generated by computer equipment.

References

NIOSH. 1998. NIOSH Alert Preventing Asthma in Animal Handlers; US Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety; DHHS/NIOSH Publication no. 97-116; January 1998.

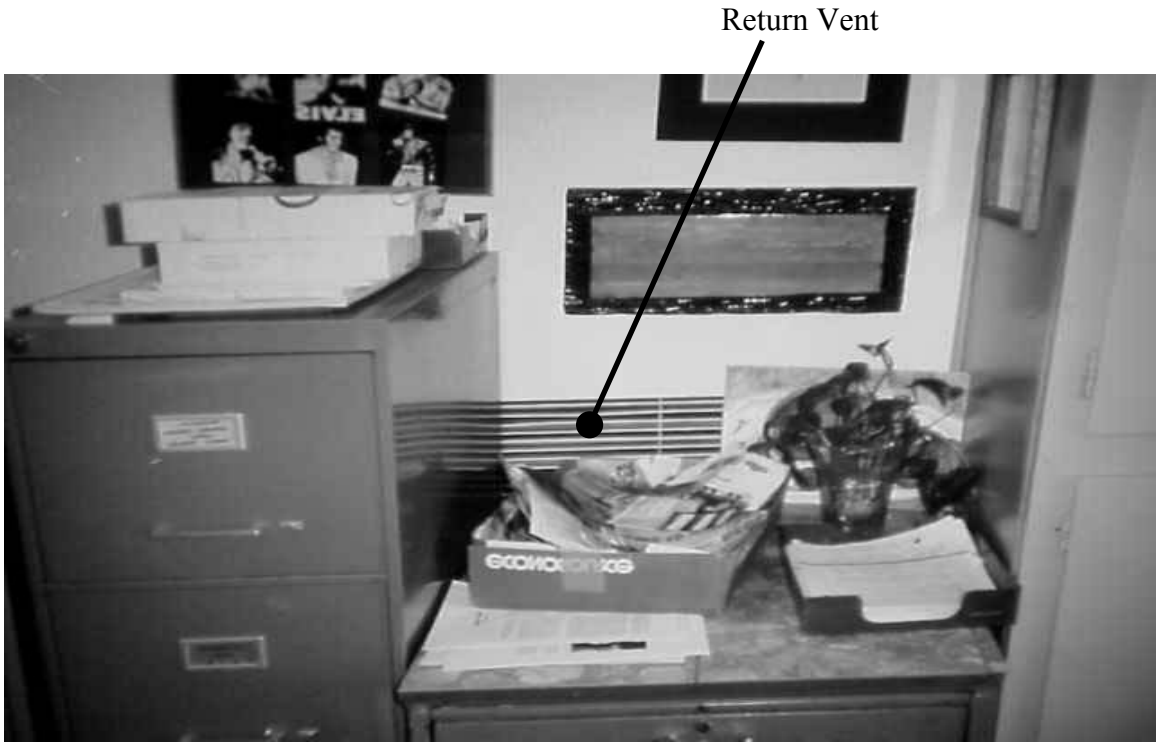
OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

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.

Picture 1



Return Vent Obstructed by Cabinet and Other Items

Picture 2

Exterior Door to Mechanical Room Containing AHU for the Art Room (Exterior View)
Note Fresh-air Intake Louvers

Picture 3

Exterior Door to Mechanical Room Containing AHU for the Art Room (Interior View)
Note Fresh-air Intake Louvers are Covered with Sheet Metal

Picture 4

Inactive Ceiling-mounted Exhaust Vent Located in Science Classroom 8 Chemical Storeroom

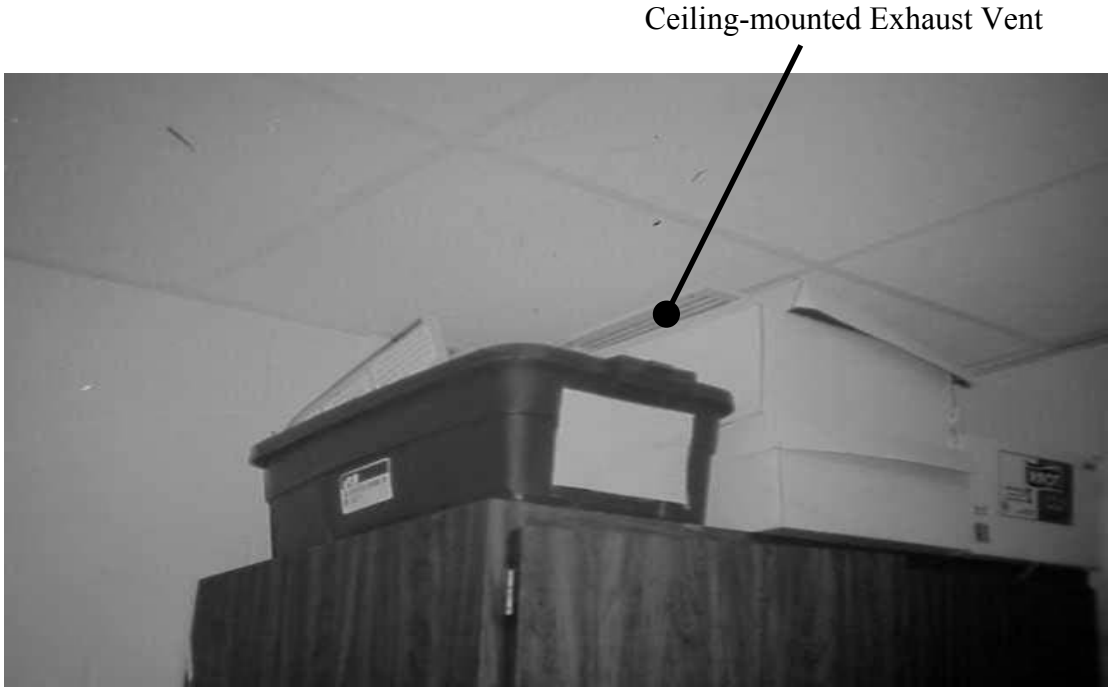
Picture 5

Inactive Ceiling-mounted Exhaust Vent Located in Science Classroom 10 Chemical Storeroom

Picture 6

Passive Vent Providing Exhaust Ventilation to Science Classrooms

Picture 7



Ceiling-mounted Exhaust Vent Obstructed by Boxes

Picture 8

Shrubbery and Flowering Plants near Univent Fresh-air Intake

TABLE 1

Indoor Air Test Results – Leicester Middle School, Leicester, MA – November 4, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	421	48	41					Weather conditions: clear & windy, wind-SE 10-15 mph
Room 2	477	70	20	0	yes	yes	yes	10:20 am – unoccupied
Room 5	720	75	23	21	yes	yes	yes	
Room 6	861	74	23	20	yes	yes	yes	exhaust blocked by items
Room 7	802	72	26	18	yes	yes	yes	univent not operating-seized bearings, runs intermittently-on repair list
Room 8	866	76	23	23	yes	yes	yes	exhaust louver closed, hamsters, aquarium
Room 8 Storeroom						yes		passive air supply, exhaust vent not operating-backdrafting, ductwork exhaust-no opening, chemical storage room vent closed
Room 10	901	74	24	21	yes	yes	yes	plants, aquarium
Room 11	572	72	22	1	yes	yes	yes	
Room 15	703	70	25	18	yes	yes	yes	chalk dust, wall mounted fan

*** 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 – Leicester Middle School, Leicester, MA – November 4, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Teachers' Lounge	714	76	25	1	yes	yes	yes	exhaust off
Tech Room	815	72	28	22	yes	no	yes	2 wall-mounted univents-deactivated
Art Room	1086	66	34	22	yes	yes	yes	AHU-system off by occupant
Room 36	1206	70	29	19	yes	yes	yes	univent on repair list-motor on order
Project A.R.C.	790	71	28	4	no	no	no	passive door vent, burning candle on top of shelf
Room 32	901	73	23	21	no	yes	yes	exhaust blocked by boxes
Room 33	1070	73	27	19	yes	yes	yes	univent needs new motor, exhaust blocked by boxes
Room 24	1226	77	29	22	yes	yes	yes	no a/c, 30+ computers, heat complaints, univent not operating-not able to activate
Room 25	790	75	26	1	yes	yes	yes	exhaust off-fire damper shut
Room 23	820	75	22	16	yes	yes	yes	chalk dust, door open

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CT = water-damaged ceiling tiles

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 3

Indoor Air Test Results – Leicester Middle School, Leicester, MA – November 4, 1999

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 21	810	74	25	23	yes	yes	yes	
Room 19	1152	74	30	20	yes	yes	yes	univent off-activated
Cafeteria	831	74	28	150+	yes	yes	yes	exhaust on-drawing weakly
Room 31	1045	76	27	15	yes	yes	yes	univent not operating
Room 28	790	76	21	15	yes	yes	yes	exhaust blocked by recycle bin & trash can
Room 29	980	77	24	23	yes	yes	yes	univent under repair, door open
Room 26	1043	76	21	24	yes	yes	yes	door open
Room 2	752	76	20	19	yes	yes	yes	1:00 PM

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