INDOOR AIR QUALITY ASSESSMENT

Leicester High School
170 Paxton Street
Leicester, MA

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

At the request of Mr. Carl Wicklund, Facilities Manager for Leicester Public Schools, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted an indoor air quality (IAQ) assessment at the Leicester High School (LHS) located at 170 Paxton Street, Leicester, Massachusetts. The request was prompted by general IAQ concerns and deteriorating building conditions. On April 13, 2011, a visit to conduct a general IAQ assessment was made to the LHS by Lisa Hébert and Sharon Lee, Environmental Analysts/Inspectors for BEH's IAQ Program.

The school is a three-story brick building constructed in 1994. The main floor consists of general classrooms, gymnasium, cafeteria, auditorium, library and computer rooms. The upper level contains general classrooms, science classrooms and the chemical storage area. The lower level houses several art rooms, shop areas and special education classrooms.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 7565. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor, Model 8520. BEH staff also performed visual inspection of building materials for water damage and/or microbial growth.

Results

The LHS houses grades 9 through 12, consisting of a student population of` approximately 450-500 and a staff of approximately 50. The tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm) in 63 of 68 areas surveyed, indicating adequate air exchange in the majority of areas in the building. It is important to note, however, that some areas were empty/sparsely populated or had open windows, which can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to increase with windows closed and greater room occupancy.

Fresh air in most classrooms is supplied by unit ventilator (univent) systems. A univent draws air from the outdoors through a fresh air intake located on the exterior wall of the building and returns air through an air intake located at the base of the unit. Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit (Figure 1). It was reported by Mr. Wicklund that extensive repairs to univents were made over the last several years. Univents were found deactivated in a few areas during the assessment (Table 1); therefore, no mechanical means of introducing fresh air was being provided for these areas. Univents in some areas also had items stored on top of them, which can restrict airflow (Picture 1). In order for univents to provide fresh air as designed, intakes/diffusers must remain free of obstructions. Importantly, these units must remain 'on' and be allowed to operate while rooms are occupied.

Exhaust ventilation in classrooms is provided by a mechanical exhaust system. The exhaust vents are located in the upper portion of coat closets (Picture 2). Classroom air is drawn into the coat closet via a grate mounted on the closet door. In some rooms, exhaust ventilation was found blocked either in front of the closet door or within the closet itself (Picture 3). Such blockage can prevent draw of air, reducing the ability of the exhaust system to remove normally-occurring pollutants from the classroom.

Restrooms are equipped with local exhaust vents. The exhaust vent for the first floor women's restroom was not operating at the time of the assessment. Exhaust ventilation is necessary in restrooms to remove excess moisture and to prevent odors from penetrating into adjacent areas.

Ventilation to common areas as well as interior classrooms is supplied by rooftop air-handling-units (AHUs). Fresh air ducted to wall- or ceiling-mounted diffusers provide air to these areas. Air is returned to the AHU via wall- or ceiling-mounted exhausts. These systems were reportedly operating at the time of the assessment.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of building occupancy. In order to have proper ventilation with a mechanical supply 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. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The system has reportedly not been balanced due to budgetary constraints.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows

(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 MDPH 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 concerning carbon dioxide, consult Appendix A.

Temperature measurements ranged from 66°F to 77°F, which were within or close to the MDPH recommended comfort range at the time of the assessment (Table 1). The MDPH 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.

The relative humidity measured in the building ranged from 28 to 36 percent which was below the MDPH recommended comfort range (Table 1). The MDPH recommends a comfort range of 40 to 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

A number of water penetration problems have been reported at the LHS. BEH staff observed a barrel being used to catch water, indicating an active leak. Water-damaged ceiling tiles were observed in several areas within the building (Table 1), further indicating current/historic plumbing and/or roof leaks. A mold-colonized ceiling tile was observed in classroom 210 (Picture 4). In other areas, damaged ceiling tiles had been painted. Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired. Mr. Wicklund and his staff have reportedly made a number of attempts to mitigate/limit water penetration; efforts are on-going.

BEH staff observed a number of conditions to the building exterior that may be contributing to water/moisture damage in the building. Exterior walls in a number of areas exhibited efflorescence on brickwork (Picture 5). Efflorescence is a characteristic sign of water intrusion. As penetrating moisture works its way through mortar around brick, it leaves behind characteristic mineral deposits. On closer inspection, exterior brickwork in several areas appeared to be bowing (Picture 6); indicating water is likely being retained between the exterior wall and the moisture barrier.

Mr. Wicklund reported a number of issues regarding water leakage near the band room entrance. Measures to address leakage included repairing the roof line and waterproofing brickwork. Please note, waterproofing sealers applied to masonry can cause water vapor to become trapped. Without an immediate means to escape, water will seek alternate routes which can cause damage to masonry similar to the efflorescence and bowing observed.

Moisture retention may also be related to clogged weep holes (Picture 7). Exterior wall systems should be designed to prevent moisture penetration into the building interior. An exterior wall system should consist of an exterior curtain wall (Figure 2). Behind the curtain wall is an air space that allows for water to drain downward and for the exterior cladding system to dry. In order to allow for water to drain from the exterior brick system, a series of weep holes is customarily installed in the exterior wall, at or near the foundation slab/exterior wall system junction. Weep holes allow for accumulated water to drain from a wall system (Dalzell, 1955). Failure to install weep holes in brickwork or improper drainage from clogged weep holes will result in water accumulation at the base of walls, resulting in seepage and possible moistening of building components (Figure 3).

Upon examining the building's roof, BEH staff observed some damage in and around flashing (Picture 8). Further examination of the roof should be conducted to ensure that both the flashing and roof membrane are installed through masonry. A through-wall installation will allow water to divert from the exterior wall and onto the roof for drainage. Additional breaches in the building envelope and other concerns that could provide a source of water penetration include damaged/deteriorated brick and mortar (Picture 9) and cracks in the foundation (Picture 10).

The aforementioned conditions represent potential water penetration sources. Over time, these conditions can undermine the integrity of the building envelope and provide a means of water entry into the building via capillary action through foundation concrete and masonry (Lstiburek & Brennan, 2001). The freezing and thawing action of water during the winter months can create cracks and fissures in the foundation. In addition, these breaches may provide a means for pests/rodents to enter the building.

Breaches were observed between countertops and sink backsplashes in a few classrooms (Picture 11; Table 1). If not watertight, water can penetrate through backsplash seams or can leak from plumbing. Water penetration and chronic exposure of porous and wood-based materials can cause these materials to swell and show signs of water damage.

A safety shower in the chemical storage room lacked drainage. Without proper drainage, use of the safety shower would result in water damage to the building. Measures should be taken to provide a spill mat for this area to contain water if the shower were used.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed and discarded.

Plants were noted in a few classrooms, in some cases placed on top of ventilation equipment (Picture 12). Plants can be a source of pollen and mold which can be respiratory irritants to some individuals. Plants should be properly maintained and equipped with drip pans and located away from univents to prevent the aerosolization of dirt, pollen and mold.

Other Indoor Air Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor, and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and immediate, acute health effects upon exposure. To determine whether combustion products were present in the indoor environment, BEH staff obtained measurements for carbon monoxide and PM2.5.

Carbon Monoxide

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations ranged from non-detect (ND) to 1 ppm at the time of the assessment (Table 1). No measurable levels of carbon monoxide were detected inside the building during the assessment (Table 1).

Particulate Matter

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA established a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 35 $\mu g/m^3$ over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 was measured at 3 μg/m^3 (Table 1). PM2.5 levels measured indoors ranged from 1 to 19 μg/m^3 (Table 1), which were below the NAAQS PM2.5 level of 35 μg/m^3. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur indoors can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, use of stoves and/or microwave ovens in kitchen areas; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Volatile Organic Compounds

Indoor air concentrations can be greatly impacted by the use of products containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to identify materials that can potentially increase VOC concentrations, BEH staff examined classrooms for products that may contain these respiratory irritants.

Several classrooms contained dry erase boards and dry erase board markers. Materials such as permanent markers, dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Air deodorizers were observed in some classrooms (Picture 3; Table 1). Like dry erase materials, air deodorizers contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Many air fresheners contain 1,4-dichlorobenzene, a VOC which may cause reductions in lung function (NIH, 2006). Furthermore, deodorizing agents do not remove materials causing odors, but rather mask odors that may be present in the area.

Although it was reported that the school has made much progress in reducing and removing excess and outdated chemicals, several issues related to chemical storage were noted. Chemical storage concerns included:

- Items labeled with chemical formula rather than name (Picture 13);
- Crystallization observed on one bottle, likely related to leakage;
- Containers sealed with tape;
- Shelves crowded in a manner that prevents container labels from being read without moving bottles; and
- Chemicals stored on shelves without any barriers/guardrails to prevent bottles from falling.

These storage practices can create conditions in these rooms and adjacent areas that can result in IAQ issues. It is highly recommended that a thorough inventory of chemicals in the science department be done to assess chemical storage and disposal in an appropriate manner consistent with Massachusetts hazardous waste laws.

Pyrethrin-based insecticides/outdoor foggers were noted in the chemical store room (Picture 14). Pyrethrins have been associated with cross sensitivity with individuals who have ragweed allergy (US EPA, 1989). Applicators of this product should be in full compliance with federal and state rules and regulations that govern pesticide use including posting and notification requirements (333 CMR 13.10). Under no circumstances should untrained personnel apply this material. This product should not be applied prior to or during school hours. Under current Massachusetts law (effective November 1, 2001), the principles of integrated pest management (IPM) must be used to remove pests in state buildings (Mass Act, 2000). Pesticide use indoors can introduce chemicals into the indoor environment that can be sources of eye, nose and throat irritation.

Other Conditions

Other conditions that can affect indoor air quality were observed during the assessment. BEH staff observed lead and cadmium-containing pottery glazes in the art room (Picture 15). During the pottery firing process, lead fumes can be emitted from kilns. Lead exposure to women of reproductive age poses a number of risks to developing fetuses (ATSDR, 1999). Lead exposure, particularly in the early stages of pregnancy when a woman may not know that she is pregnant, may result in adverse effects from *in utero* exposure to lead. Lead exposure in males has been associated with reduced fertility because of effects on sperm (ATSDR, 1999). It is highly recommended that the use of non-lead containing materials be substituted for lead-containing glazes/materials. A complete inventory of glazes should be conducted to ensure that *all* lead-containing glazes have been removed/replaced by lead-free products.

Dry floor drain traps were observed in restrooms. The purpose of a drain trap is to prevent drainage system gases and odors from entering the occupied space. When water is poured into a trap, an airtight seal is created by the water in the U-bend section of the pipe. These drains must have water poured into the traps regularly (e.g., twice a week) to maintain the integrity of the seal. Without water, the dry trap opens the room to the drainage system. If a mechanical device (e.g., exhaust fan) depressurizes the room, air, gas and odors can be drawn from the drainage system into the room. The effect of this phenomenon can be increased if heavy rains cause an air backup in the drainage system.

In several classrooms, items were observed on the floor, 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. Items should be relocated and/or cleaned periodically to avoid excessive dust build up.

A number of univents, exhaust vents and personal fans were observed to have accumulated dust/debris (Picture 16). These diffusers, vents and fans should be cleaned in order to prevent dust/debris from being aerosolized and redistributed throughout the room.

A build up of chalk dust in chalk trays was observed in several classrooms (Picture 17; Table 1). These materials can be aerosolized by air movement from the ventilation system, doors opening and closing, or foot traffic and may present an eye or respiratory irritant.

Personal food products were stored in a small refrigerator located in the chemical store room. To reduce the potential for cross-contamination with laboratory/science related materials, consumable goods should not be stored in this area. Removal of edible products would also eliminate pest attractants from this area. If the use of the refrigerator is for storage of food and not chemicals, the refrigerator should be relocated to another area.

Finally, signs of bird roosting and nesting materials were observed in univent intake louvers along the exterior of the building (Picture 18). If the ventilation system is activated, the possibility exists for nesting materials, bird waste and other related particulates to be drawn into the system and be distributed to occupied areas. Birds can be a source of disease, and bird wastes and feathers can contain mold and bacteria, which can be irritating to the respiratory system.

Conclusions/Recommendations

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

1. Operate all mechanical ventilation systems throughout the building (e.g., cafeteria, classrooms) continuously during periods of occupancy.
2. Remove all blockages from univents and closet exhaust vents to ensure adequate airflow.
3. Make repairs to restroom exhaust system as needed.
4. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
5. Use openable windows in conjunction with classroom univents and exhaust vents to facilitate air exchange until repairs that are more permanent can be made. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.
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. To control 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).

7. Work with staff to identify and repair any remaining leaks. Replace any water-damaged ceiling tiles (e.g., room 210). Examine the area above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial, as needed.
8. Remedy all exterior building envelope conditions that contribute to water infiltration into the building, such as:
   - Repair/replace missing/damaged flashing;
   - Make repairs to missing/damaged mortar/brick;
   - Ensure proper drainage of weep holes; and
   - Repair foundation cracks/damage.
9. Consider contacting a structural engineer/building envelope specialist for an examination of the exterior brick work of the building, especially in areas where the exterior wall is "bowing" outwards. This measure should include a full building envelope evaluation.
10. Ensure plants are equipped with drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial, as needed. Move plants away from fresh air supply sources.
11. Seal breaches, seams and spaces between sink countertops and backsplashes to prevent water damage.
12. Pour water into floor drains twice a week (or as needed) to maintain an airtight seal.
13. Locate spill mat near chemical safety shower to prevent water damage during use.
14. Remove any pesticides observed in the school. Have staff report any bugs/pests observed in the building, and contact pest management firm to augment existing integrated pest management program.

15. Continue to conduct regular inventory of chemicals in the science department. Inventory should consist of the name of the chemical, how much, the date the container is opened, and where it is stored. Assess the chemical storage areas and dispose of materials in an appropriate manner consistent with Massachusetts hazardous waste laws.
16. Properly label all chemicals. Labels should include: Chemical name, concentration, target organ, effect, and date prepared; hazards, both physical and health; and, name and address of manufacturer.
17. Consider installing guard rails or barriers on chemical storage shelves.
18. Conduct a complete inventory of pottery glazes to ensure that all lead-containing glazes have been removed/replaced by lead-free products.
19. Refrain from using air fresheners and deodorizers to prevent exposure to VOCs.
20. If the refrigerator is for storage of food and not chemicals, the refrigerator should be removed from the chemical store room and relocated to another area.
21. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning of classrooms. Clean items, including chalk trays, pencil shaving trays and dry erase marker trays regularly with a wet cloth or sponge to prevent excessive dust build-up.
22. Remove birds' nests from fresh air intake vents and clean with an appropriate antimicrobial. Consider installing wire mesh bird screens over air intakes to prevent further roosting as necessary.
23. Consider adopting the US EPA (2000) document, "Tools for Schools", as an instrument for maintaining a good indoor air quality environment in the building. This document is available at: http://www.epa.gov/iaq/schools/index.html.

24. Refer to resource manual and other related indoor air quality documents located on the MDPH's website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at: http://mass.gov/dph/iaq.

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Picture 1

Items placed on univents

Picture 2

Exhaust vent located in closet

Picture 3

Items located in front of closet exhaust grate, note air deodorizers on cabinet

Picture 4

Water-damaged/mold colonized ceiling tile in room 210

Picture 5

Efflorescence (white mineral deposits) on exterior brickwork

Picture 6

Warped/bowing exterior brickwork

Picture 7

Clogged weephole

Picture 8

Damaged roof flashing

Picture 9

Missing/damaged mortar around exterior brickwork

Picture 10

Cracked/damaged foundation

Picture 11

Breach in sink backsplash

Picture 12

Plants on univent

Picture 13

Science chemicals labeled by chemical formula

Picture 14

Pesticides stored in cabinet

Picture 15

Pottery glaze containing lead and cadmium

Picture 16

Personal fan occluded with dust

Picture 17

Chalk dust collected on tray

Picture 18

Bird's nest in vent

Location: Leicester High School **Indoor Air Results**

Address: 170 Paxton Street, Leicester, MA **Table 1** **Date: 4/13/2011**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m³)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Background		53	39	257	ND-1	3				
Biology Storage	1	74	31	562	ND	9	N	Y	Y	DO
Women's Restroom							N	N	Y	Dry floor drain, WD CT
Men's Restroom							N	N	Y	Dry floor drain
Library	21	76	31	732	ND	2	Y	Y	Y	AC in window, WD CTs
VHS	0	76	28	570	ND	3	N	Y	Y	
Front Lobby	2	74	29	491	ND	6	N	N	N	WD CTs
Mrs. Cloutier	0	75	30	538	ND	3	Y	Y	Y	DO, plants
Mr. Bowes	0	75	30	545	ND	3	Y	Y	Y	DO
Mr. Smith	0	75	29	494	ND	2	N	Y	Y	
Cafeteria	17	73	35	536	ND	6	Y	Y	Y	

ppm = parts per million
µg/m³ = micrograms per cubic meter
ND = non detect
AC = air conditioner
AD = air deodorizer
CD = chalk dust
CT = ceiling tile
DEM = dry erase materials
DO = door open
MT = missing ceiling tile
PF = personal fan
UV = unit ventilator
WD = water-damaged

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%

Location: Leicester High School **Indoor Air Results**

Address: 170 Paxton Street, Leicester, MA **Date: 4/13/2011**

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (μg/m³)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Kitchen	3	74	33	544	ND	19	N	*Y	Y	*From cafeteria
Auditorium	3	75	29	260	ND	7	N	Y	Y	Rooftop Heat & AC
Gym	8	75	31	389	ND	5	N	Y	Y	
Teacher's Room	0	73	33	383	ND	1	N	Y	Y	WD CTs
Boiler Room	0	68	34	235	ND	3	N	Y	N	
Custodian	0	73	34	495	ND	2	N	Y	Y	
Boys Locker	0	73	34	349	ND	2	N		Y	
Mr. Tomah	1	73	33	418	ND	2	N	Y	Y	DO
Mr. Lauder	2	74	32	470	ND	2	N	Y	Y	DO
Vice Principal	2	74	32	381	ND	2	Y	Y	Y	
Athletic Director	1	74	32	504	ND	4	N	N	Y	DO, PF, WD CT

ppm = parts per million
μg/m³ = micrograms per cubic meter
ND = non detect
AC = air conditioner
AD = air deodorizer
CD = chalk dust
CT = ceiling tile
DEM = dry erase materials
DO = door open
MT = missing ceiling tile
PF = personal fan
UV = unit ventilator
WD = water-damaged

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Leicester High School

Address: 170 Paxton Street, Leicester, MA

Indoor Air Results

Date: 4/13/2011

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Girls Locker Room	0	70	34	532	ND	2	N	Y	Y	
Women Bathroom	0					3	N	Y	Y	Exhaust off
Main Office	3	74	33	716	ND	3	N	Y	Y	
Conference Room	0	74	32	780	ND	5	Y	Y	Y	DO
309/311	4	72	34	338	ND	4	Y	Y	Y	DO, WD CTs, exhaust in closet
Exam Room 1	0	74	30	489	ND	4	N	N	Y	
Art 1	6	70	33	303	ND	2	Y	Y	Y	
Exam Room 2	0	74	30	519	ND	2	N	N	Y	
Art 2	2	70	34	252	ND	3	Y	Y	Y	Exotic Colorburst Glaze: Lead/Cadmium, exhaust obstructed
100	6	72	32	460	ND	2	Y	Y	Y	DO, DEM
101	1	74	32	365	ND	1	N	Y	Y	

ppm = parts per million
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AD = air deodorizer
CD = chalk dust
CT = ceiling tile
DEM = dry erase materials
DO = door open
MT = missing ceiling tile
PF = personal fan
UV = unit ventilator
WD = water-damaged

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%

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
102 Home Ec.	1	72	32	480	ND	2	Y	Y	Y	
104	21	72	35	666	ND	5	Y	Y	Y	DEM, DO
109	0	72	35	434	ND	2	Y	Y	Y	DO, PF
110	6	72	34	363	ND	2	Y 1/2 open	Y	Y	DO, DEM, PF
111	17	72	33	513	ND	2	Y	Y	Y	CD
112	21	72	36	789	ND	3	Y	Y	Y	DO, DEM, exhaust in closet and ceiling
116	7	72	35	688	ND	6	Y 2/2 open	Y	Y	DO, DEM, supply vent in ceiling
200	2	74	32	599	ND	3	N	Y	Y	Exhaust in bathroom
200 Waiting Room	0	74	31	549	ND	5	N	Y	Y	DO
202 Guidance	1	74	31	606	ND	2	N	Y	Y	
207	19	74	36	927	ND	2	Y	Y	Y	CD, exhaust in closet

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Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (µg/m³)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
208	12	77	30	600	ND	3	Y	Y UV off	Y	DO, exhaust in closet
209	14	73	33	664	ND	3	Y	Y	Y	DEM, CD, AD
210	2	--	30	532	ND	4	Y	Y UV off	Y	WD CTs, mold colonization, DEM, exhaust in closet, UV off/obstructed
211	19	73	33	563	ND	3	Y	Y	Y	DO, exhaust in closet
212	0	75	30	675	ND	5	Y 2/2 open	Y	Y	
213	1	66	30	427	ND	2	Y 2/2 open	Y	Y	DO
214	0	75	29	422	ND	3	Y 2/2 open	Y	Y	DEM, exhaust in closet
215	21	76	31	1022	ND	4	Y	Y	Y	DEM
216	12	74	35	831	ND	3	Y 1/2 open	Y	Y	PF, DEM, CD, exhaust in closet
272	20	75	31	389	ND	3	N	Y	Y	WD CTs
300	17	73	32	593	ND	3	Y	Y	Y	WD CTs (painted over), DEM

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								Supply	Exhaust	
301	9	72	34	581	ND	5	Y	Y	Y	CD, WD CTs, exhaust in closet
302	12	72	31	487	ND	2	Y	Y	Y	DO, CD, exhaust in closet
303	16	74	33	818	ND	2	Y	Y	Y	DEM, PF dirty blades
304	10	74	31	537	ND	3	Y 1/2 open	Y	Y	DEM, exhaust in closet
306	20	74	31	638	ND	3	Y	Y	Y	DO, WD CTs, exhaust in closet
307 Teacher Workshop	0	71	32	346	ND	3	Y	Y	Y	DO, WD CTs
308	18	76	31	686	ND	2	Y	Y	Y	DO, WD CTs
310	19	74	30	599	ND	5	Y	Y	Y	DO, WD CTs, hood, PF, MT
312	20	74	32	739	ND	6	Y	Y	Y	DO, WD CTs, DEM, exhaust in closet
313	12	72	34	585	ND	4	Y	Y	Y	DO, DEM, exhaust in closet
314	2	73	29	464	ND	4	Y	Y	Y	DO, DEM, WD CT

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								Supply	Exhaust	
315	17	72	32	512	ND	4	Y	Y	Y	DO, DEM, WD CTs, exhaust in closet
316	21	74	36	940	ND	6	Y	Y	Y	DO, DEM, WD CTs
317	16	72	33	638	ND	5	Y	Y	Y	DO
318	18	72	34	616	ND	4	Y 1/2 open	Y	Y	DO, WD CT, exhaust obstructed
319	14	72	29	548	ND	4	Y	Y	Y	DO, DEM, exhaust in closet
320	22	72	33	767	ND	7	Y 2/2 open	Y	Y	DO, DEM, WD CTs, PF

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