INDOOR AIR QUALITY ASSESSMENT

Arthur M. Longsjo Middle School
98 Academy Street
Fitchburg, Massachusetts

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

At the request of William Barletta, Facilities Director for the Fitchburg Public Schools, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted an assessment at Arthur M. Longsjo Middle School (LMS) located at 98 Academy Street, Fitchburg, Massachusetts. This assessment was part of an ongoing effort to monitor and improve indoor air quality conditions at Fitchburg schools. On February 12, 2010, Lisa Hébert, Environmental Analyst/Regional Inspector for BEH's Indoor Air Quality (IAQ) Program, made a visit to the LMS to conduct an indoor air quality assessment. On March 10, 2010, Michael Feeney, Director of BEH's IAQ Program and Ms. Hébert returned to the school to complete the assessment. BEH staff were accompanied by Mr. Barletta during most of the assessment.

The LMS is a four-story brick building that was originally constructed as Fitchburg High School in 1936. In 1995, a library addition was constructed. In 2000, the building was converted to Academy Middle School and in 2009, was combined with B. F. Brown Middle School to create LMS. In addition to classrooms, the LMS contains a gymnasium, kitchen, cafeteria, wood shop and administrative offices. Windows are openable throughout the building.

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 school houses 615 students in grades five through eight with a staff of approximately 55. Tests were taken during normal operations and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in 31 of 70 areas indicating poor air exchange in a number of areas surveyed at the time of the assessment. It is important to note that several areas had open windows or were empty/sparsely populated, which can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to increase with windows closed and higher occupancy.

The original building is ventilated by a combination of unit ventilators (univents) and by a large mechanical ventilation system that was originally installed when the building was constructed in 1936. The original system brings fresh air into the building by means of fresh air intakes located on the gable ends of the building (Picture 1). Fresh air is then heated and distributed to classrooms by means of ducted air supply vents (Picture 2). As can be seen in Picture 2, stale air is removed from the classroom via ducted exhaust vents. Exhaust vents are also located in the hallway at the base of the student lockers (Picture 3). From the ducted exhaust vents, the air is expelled from the building via a rooftop cupola (Pictures 4 and 5). Several of the classroom exhaust vents were found obstructed at the time of the IAQ assessment. The vents appeared to be used for storage purposes.

As previously mentioned, fresh air in some classrooms is supplied by unit ventilator (univent) systems (Pictures 6 and 7/Figure 1). A univent draws air from the outdoors through a

fresh air intake located on the exterior wall of the building (Picture 8) 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. Most univent supply and exhaust were original equipment installed when the building was constructed approximately 74 years ago, however some appeared to be less historic. Efficient function of such aged equipment is difficult to maintain, since compatible replacement parts are often unavailable. According to the American Society of Heating, Refrigeration and Air-Conditioning Engineering (ASHRAE), the service life[1] for a unit heater, hot water or steam is 20 years, assuming routine maintenance of the equipment (ASHRAE, 1991). Despite attempts to maintain these univents, the operational lifespan of this equipment has been exceeded. Ventilation is also provided to the library addition by means of a rooftop air handling unit.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of 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 date of the last balancing of these systems was not available at the time of the assessment.

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.

[1] The service life is the median time during which a particular system or component of …[an HVAC]… system remains in its original service application and then is replaced. Replacement may occur for any reason, including, but not limited to, failure, general obsolescence, reduced reliability, excessive maintenance cost, and changed system requirements due to such influences as building characteristics or energy prices (ASHRAE, 1991).

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.

Indoor temperature measurements ranged from 69º F to 78º F, which were within or very close to the lower end of the MDPH recommended comfort range on the day 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 8 to 21 percent, which was below the MDPH recommended comfort range in all areas surveyed during the assessment (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

In October of 2009, several roof repairs were reportedly made, namely, replacement of the rubber membrane roofs over the gym and auditorium. In addition, slate roof shingles were repaired or replaced over fourth-floor classrooms and repairs were made to gutters and downspouts. Water-damaged materials were observed in several locations within the LMS including numerous water-damaged ceiling tiles, plaster ceilings and walls. Much of this damage was beneath the areas where repairs had been made. Based upon these observations it appears that while the leaks have been repaired, the resulting water damage had yet to be addressed. Some of the tiles were severely buckled (Pictures 9 through 11). Water-damaged tiles can provide a medium for mold and mildew growth and should be replaced after a water leak is discovered and repaired.

Peeling paint and efflorescence from water damage was evident in several areas (Pictures 12 and 13). Efflorescence is a characteristic sign of water damage to building materials, but it is not mold growth. As moisture penetrates and works its way through building materials (e.g., plaster), water-soluble compounds dissolve, creating a solution. As this solution moves to the surface, the water evaporates, leaving behind white, powdery mineral deposits.

Some plumbing is also in need of repair, as was evident by the plastic buckets hanging on drain traps in order to catch leakage (Picture 14). A bucket was also observed on a windowsill, behind curtains that had obviously sustained moisture damage (Picture 15). A water cooler was located over a carpeted area (Picture 16). Overflow of the water basin or spills that often occur can moisten carpeting, which can lead to mold growth. It is also important that catch basins of water coolers be cleaned regularly as stagnant water can be a source of odors. Further, materials (i.e., dust) collected in the water can provide a medium for mold growth.

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.

BEH staff examined the exterior of the building to identify breaches in the building envelope and other conditions that could provide a source of water penetration. Several potential sources were identified:

1. Roof shingles appeared to be cracked and in disrepair in some areas.
2. Open utility holes were observed on the exterior of the building.
3. Severe water damage was observed on an exterior door overhang (Picture 17).
4. Peeling paint was observed on the water-damaged overhang and cupola.

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). In addition, these breaches may provide a means for pests/rodents to enter the building.

Other IAQ 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 particulate matter with a diameter of 2.5 micrometers (µm) or less (PM2.5) can produce 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 effects. 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 were non-detect (ND) the day of the assessment (Tables 1). No measureable levels of carbon monoxide were detected in 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 concentrations were measured at 5 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from 2 to 21 $\mu g/m^3$ (Table 1), which were below the NAAQS PM2.5 level of 35 $\mu g/m^3$. 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 in 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 indoor VOC concentrations, BEH staff examined rooms for products containing these respiratory irritants.

Several classrooms contained dry erase boards and dry erase 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.

Cleaning products were also observed in a number of classrooms. Like dry erase materials, cleaning products contain VOCs and other chemicals. These chemicals can be irritating to the eyes, nose and throat and should be kept out of reach of students. Additionally, a Material Safety Data Sheet (MSDS) should be available at a central location for each product in the event of an emergency. Consideration should be given to providing teaching staff with school issued cleaning products and supplies to ensure that MSDSs are available for every product used within the school.

In an effort to reduce noise from sliding chairs and tables, tennis balls were observed 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 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).

The administrative office contained a vintage refrigerator. Older refrigerators may contain hazardous materials within their refrigerants as well as in oils. BEH was informed that removing the refrigerator from the building was currently in process.

Other Conditions

Other conditions that can affect indoor air quality were observed during the assessment. Several batteries, formerly used to power an old generator, were found in the basement (Picture 18). These batteries may contain acid as well as heavy metals such as lead or mercury, and therefore should be disposed of in compliance with all state and federal hazardous materials laws.

LMS contains locker rooms that are no longer in use. These areas, due to lack of use, are prone to having dry drain traps in sinks and shower drains. Dry drain traps can allow sewer gases/odors to migrate from the drainage system into occupied space. These drains should be filled regularly with water or sealed to prevent such occurrences.

Some carpets were observed to have frayed edges that had been temporarily repaired with duct tape. Carpets were also observed to be buckled, worn and stained in some areas. Since the lifespan of a carpet installed in a school facility is typically eleven (11) years, it is likely that the lifespan of some of the carpets in the building has been greatly exceeded (IICRC, 2002).

Large open utility holes and open ended pipes were observed in some rooms and open penetrations on the exterior were also observed (Pictures 19 through 21). Open utility holes can provide a means of egress for odors, fumes, dusts and vapors between rooms and floors. In addition, these materials can migrate into the air handling chambers of unit ventilators and be distributed to occupied areas.

Stuffed pillows were observed in some classrooms. Stuffed pillows can be a point source for dust collection. Close contact with such items can leave behind oils, perspiration, hair and skin cells. Dust mites feed upon human skin cells and excrete waste products that contain allergens. These materials can be irritating to the eyes, nose and respiratory system.

In several classrooms, items were observed on floors, 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 be cleaned periodically to avoid excessive dust build up. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized.

Accumulated chalk dust was noted in several classrooms. Chalk dust is a fine particulate, which can be easily aerosolized and serve as an eye and respiratory irritant. Dust was also observed on personal fans, return vents and on the interior of air supply fans. In one classroom (Room 214), a windowsill was covered with dust and debris.

Damaged floor tiles were observed in several areas (Picture 22). Floor tiles of this type and age often contain asbestos. In addition, a section of pipe with insulation that consists of a torn, white material was found in the attic. Intact asbestos-containing materials (ACM) do not pose a health hazard. If damaged, ACM can be rendered friable and become aerosolized. Friable asbestos is a chronic (long-term) health hazard that can lead to serious lung disease (i.e. mesothelioma). These types of health impacts are very different than those more typically associated with indoor air quality comfort problems (e.g. headaches, fatigue). Where ACM are found damaged, these materials should be removed or remediated in a manner consistent with Massachusetts asbestos remediation laws (MDLI, 1993).

In regard to ACM, schools should be in compliance with the Asbestos Hazard Emergency Response Act (AHERA), which requires inspection of asbestos containing materials every three years. In addition, a semi-annual walkthrough is conducted to determine current conditions of ACM. AHERA requires public and private non-profit primary and secondary schools to inspect

their buildings for asbestos-containing building materials and to develop, maintain and update an asbestos management plan to be kept at the school.

Conclusions/Recommendations

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

1. Operate all ventilation systems throughout the building (e.g., gym, cafeteria, classrooms) continuously during periods of occupancy independent of thermostat control to maximize air exchange.
2. Use openable windows in conjunction with mechanical ventilation to facilitate air exchange. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.
3. Remove all blockages from univents and exhaust vents to ensure adequate airflow.
4. Contact an HVAC engineering firm to inspect and assess the adequacy and efficiency of the current ventilation system components. Repair or replace components as necessary.
5. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
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. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

7. Contract with a licensed plumber to repair leaking plumbing. Once leaks are repaired, remove buckets hanging on traps.
8. Ensure leaks are repaired and replace water-damaged ceiling tiles. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
9. Place water cooler on top of a surface that is impervious to water. Routinely clean reservoir to eliminate stagnant water from collecting therein.
10. Regularly launder curtains and stuffed pillows, if not feasible consider removal/replacement.
11. Repair or replace cracked/broken slate shingles.
12. Seal open utility holes on the exterior of the building.
13. Repair or remove water-damaged overhang.
14. Repair or remove efflorescence and peeling paint on both interior and exterior of the building. Please be advised that all renovation work must be completed in accordance with the Environmental Protection Agency's New Lead Renovation, Repair and Painting Rule (40 CFR 745.80 through 745.92), which became effective on April 22, 2010.
15. Routinely clean particulate accumulation in chalk/dry erase board trays.
16. Store cleaning products properly and out of reach of students. All cleaning products used at the facility should be approved by the school department with MSDS' available at a central location.
17. Consider providing staff with school-issued cleaning products.

18. Remove batteries in basement in accordance with all state and federal hazardous materials disposal regulations.

19. Pour water into all disused sinks throughout the building and floor/shower drains at least twice weekly in order to prevent sewer gasses from entering the facility. If not in use, consider sealing permanently.

20. Seal all open utility holes on the interior of the building.

21. Refrain from using plug-in air fresheners or other air deodorizers.

22. Consider replacing tennis balls with latex-free tennis balls or glides.

23. Ensure old refrigerator is removed and disposed of in accordance with applicable state and federal hazardous materials disposal regulations.

24. 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. Clean dust and debris accumulation from windowsill in room 214 and ensure all classrooms are maintained in a clean condition.

25. Routinely clean accumulated dust and debris periodically from the surface of exhaust vents, supply fans and blades of personal fans.

26. Consider establishing a schedule to replace deteriorated carpeting.

27. Determine composition of damaged floor tiles and insulation in attic. If materials are determined to be ACM, remove/remediate in accordance with state and federal regulations.

28. Review LMS' asbestos management plan and maintain compliance with Asbestos Hazard Emergency Response Act (AHERA).

29. 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.

30. 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

Fresh Air Intake (Arrow)

Picture 2

Air Supply (Upper Arrow) and Exhaust Vents (Lower Arrow)

Picture 3

Hallway Exhaust Vent at Base of Lockers

Picture 4

Large Exhaust Vent Terminating Inside Cupola

Picture 5

Stale Air Exits LMS Via Cupola at Top of Building

Picture 6

Front of Unit Ventilator (Univent) Obstructed by Bookcase

Picture 7

1930s Vintage Univent

Picture 8

Univent Fresh Air Intake (Arrow)

Picture 9

Water-Damaged Ceiling Tiles in Hallway

Picture 10

Buckled, Water-Damaged Tiles

Picture 11

Water-Damaged Ceiling Tiles

Picture 12

Water-Damaged Ceiling and Wall

Picture 13

Water Damage and Peeling Paint in Locker Room

Picture 14

Bucket Used to Collect Water from Leaking Plumbing

Picture 15

Water-Damaged/ Stained Curtains; Note Bucket on Windowsill

Picture 16

Water Cooler on Carpet

Picture 17

Building Overhang in Disrepair and Open to the Weather

Picture 18

Several Old Batteries Formerly Used to Power Generator

Picture 19

Open Utility Hole on Exterior of Building

Picture 20

Large Hole in Ceiling Surrounding Utility Lines

Picture 21

Open Pipe Stuffed with Insulation

Picture 22

Floor Tiles Potentially Containing Asbestos Containing Material (ACM)

Location: Arthur M. Longsjo Middle School
Address: 98 Academy Street, Fitchburg, MA

Indoor Air Results
Date: 2/12/10

Table 1

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		48	13	399	ND	5				Sunny, clear, wind 11mph (NW), visibility 10 miles
Room 415	15	75	15	881	ND	3	Y 2/8 open	N	Y	DO, PF, DEM, exhaust blocked
Room 412	0	76	18	628	ND	2	Y	Y	Y	WD CT, dirty carpet
Old FAA Office	8	76	16	819	ND	4	N	N	Y	WD CT, clutter, paper accumulation, exhaust off
Room 427	16	76	16	857	ND	7	Y	Y	Y	DO, Exhaust blocked
Room 426	18	76	18	937	ND	8	Y	Y	Y	DEM, clutter, exhaust blocked
Room 425	23	76	18	1006	ND	8	Y	Y	Y	DEM, clutter, exhaust blocked
Room 424	3	75	16	1009	ND	8	Y	N	N	DEM, AC, open utility holes
Room 423	21	75	16	812	ND	6	Y	Y	Y	DO, DEM

ppm = parts per million
µg/m3 = micrograms per cubic meter
AC = air conditioner+
AD = air deodorizer
AP = air purifier
aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
DO = door open
FC = food container
GW = gypsum wallboard
MT = missing ceiling tile
NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WD = water-damaged
WP = wall plaster

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: Arthur M. Longsjo Middle School **Indoor Air Results**

Address: 98 Academy Street, Fitchburg, MA **Date: 2/12/10**

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	
Room 422	17	76	18	1083	ND	7	Y	Y	N	DEM, PF, dry trap, old vent hood
Room 421	0	75	14	621	ND	3	Y	Y	Y	DEM, PF, pillows, exhaust blocked,
Teachers' Room	0	74	15	665	ND	7	Y	N	N	AD, Copier, refrigerator/micro, bathroom has exhaust
Room 417	9	75	15	842	ND	6	Y	Y	N	WD ceiling
Room 418	21	76	19	1077	ND	7	Y	Y	Y	Exhaust blocked
Room 410	6	76	12	609	ND	3	Y 3/5 open	Y	Y	CD, DEM, exhaust blocked, wall damage
Room 409	23	76	19	934	ND	6	Y 1/5 open	Y	Y	DEM, clutter, exhaust blocked
Room 408	22	76	19	1045	ND	8	Y 1/5 open	Y	Y	DO, DEM, exhaust blocked

ppm = parts per million
µg/m3 = micrograms per cubic meter
AC = air conditioner
AD = air deodorizer
AP = air purifier
aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
DO = door open
FC = food container
GW = gypsum wallboard
MT = missing ceiling tile
NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WD = water-damaged
WP = wall plaster

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: Arthur M. Longsjo Middle School **Indoor Air Results**

Address: 98 Academy Street, Fitchburg, MA **Date: 2/12/10**

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	
Room 407	1	69	20	785	ND	5	Y	N	N	Peeling paint on ceiling
Room 406	20	72	20	787	ND	3	Y 1/5 open	Y	Y	DEM, exhaust blocked
Room 405	17	75	15	903	ND	8	Y 2/7 open	Y	Y	PF, DEM, PFs, WD ceiling
Room 404B	0	77	17	802	ND	13	Y	Y	Y	DO, DEM
Room 404	24	77	19	1101	ND	9	Y	Y	N	DO, DEM
Room 403	18	78	15	747	ND	3	Y 3/5 open	Y	Y	DO, DEM, exhaust blocked
Room 402	18	77	15	728	ND	5	Y 1/5 open	Y	Y	
Room 401	19	77	19	961	ND	7	Y 1/5 open	Y	Y	DO, WD ceiling, exhaust blocked, cloth curtains

ppm = parts per million
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AD = air deodorizer
AP = air purifier
aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
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Comfort Guidelines

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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Arthur M. Longsjo Middle School

Address: 98 Academy Street, Fitchburg, MA

Indoor Air Results

Date: 2/12/10

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	
Gymnasium	19	72	15	593	ND	6	N	Y	Y	DO, WD ceiling
Auditorium	0	73	18	567	ND	6	N	Y	Y	WD ceiling
Cafeteria	130	74	16	801	ND	15	Y	Y	N	WD CT, MT
Kitchen	5	75	17	914	ND	21	N	Y	Y	DO
Room 312	20	76	15	850	ND	12	Y	Y	N	DO, DEM, WD CT, univents blocked with debris
Room 310	17	75	15	826	ND	10	Y	Y	Y	DO, DEM
Room 301	8	76	15	635	ND	8	Y	Y	Y	DEM
Room 206	7	77	15	620	ND	6	Y	Y	Y	CD, exhaust blocked

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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Arthur M. Longsjo Middle School **Indoor Air Results**

Address: 98 Academy Street, Fitchburg, MA **Date: 2/12/10**

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	
Room 205	1	77	9	533	ND	5	Y ½ open	Y	Y	
Room 204	3	75	10	-	ND	6	Y 2/5 open	Y	Y	DO, DEM, exhaust blocked
Library	4	74	9	536	ND	9	Y	Y	Y	
Principal's Office	1	74	10	527	ND	4	N	Y	Y	DO
Room 203	19	76	15	866	ND	6	Y	Y	N	Exhaust was not visible
Room 202	3	76	15	643	ND	6	Y	Y	Y	DO, DEM, exhaust is blocked
Room 201	14	75	14	714	ND	5	Y 2/5	Y	Y	Exhaust blocked
Room 101 (front)	3	76	15	775	ND	6	Y	N	N	DO, WD wall, cooler on carpet

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CD = chalk dust
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design = proximity to door
DO = door open
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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Arthur M. Longsjo Middle School **Indoor Air Results**

Address: 98 Academy Street, Fitchburg, MA **Date: 2/12/10**

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	
Asst. Principal (1)	0	75	11	629	ND	5	Y ½ open	N	N	DO
Asst. Principal (2)	0	75	15	628	ND	4	Y	N	N	DO
Room 116	0	76	12	560	ND	5	N	Y	Y	DO
Room 114	23	76	15	920	ND	12	Y	Y	N	DO, PF, DEM
Room 311	11	76	16	1028	ND	12	Y	Y	Y	DO, DEM
Room 313	17	74	11	768	ND	8	Y 1/6 open	Y	Y	DO, DEM
Room 314	13	75	16	828	ND	9	Y	Y	Y	DO, CD, DEM, TB
Room 315	18	74	13	928	ND	7	Y 1/5 open	Y	Y	DEM, exhaust blocked, cleaning products

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AC = air conditioner
AD = air deodorizer
AP = air purifier
aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
DO = door open
FC = food container
GW = gypsum wallboard
MT = missing ceiling tile
NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Arthur M. Longsjo Middle School **Indoor Air Results**

Address: 98 Academy Street, Fitchburg, MA **Date: 2/12/10**

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	
Room 302	5	74	12	611	ND	4	Y 1/5 open	Y	Y	DO, AC
Room 304	12	75	14	696	ND	5	Y 1/6 open	Y	Y	DEM, AC, PF, CD, exhaust blocked
Room 305	No access (Do Not Disturb)									
Room 306	10	75	14	651	ND	6	Y 1/7 open	Y	Y	DEM, AC, exhaust blocked
Room 307	14	73	13	643	ND	9	Y 2/6 open	Y	Y	DEM, CD, exhaust blocked
Room 308	14	73	17	716	ND	10	Y	Y	Y	DO, DEM, exhaust blocked
Nurse	2	75	13	710	ND	7	Y	Y	N	DO
Exam Room	1	74	8	516	ND	5	Y 1/1 open	Y	N	DO

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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Arthur M. Longsjo Middle School **Indoor Air Results**

Address: 98 Academy Street, Fitchburg, MA **Date: 2/12/10**

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	
Nurse's Waiting Room	0	75	11	554	ND	8	N	N	N	DO
Room 214	15	75	16	899	ND	5	Y	Y	Y	DEM, CD, WD wall, exhaust blocked
Room 213	18	75	15	753	ND	4	Y	Y	Y	DO, AD, DEM, cleaning products
Room 211	19	74	13	864	ND	4	Y	Y	N	
Room 210	10	75	10	557	ND	5	Y 1/6 open	Y	Y	DO, DEM, WD CT, CD
Room 209	12	74	14	714	ND	7	Y	Y	Y	Exhaust blocked
Room 111 (music)	12	73	14	688	ND	5	Y	Y	Y	DO, DEM, CD
Room 110	2	73	21	1144	ND	21	Y	N	N	DEM, numerous WD CTs, plumbing leaks from above

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Location: Arthur M. Longsjo Middle School **Indoor Air Results**

Address: 98 Academy Street, Fitchburg, MA **Date: 2/12/10**

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	
Room 106A	3	74	17	825	ND	6	Y	N	N	DEM, bucket on drain, duct tape on carpet
Room 105	0	74	15	588	ND	6	Y	Y	Y	Exhaust blocked
Room 104 (wood shop)	0	74	12	497	ND	6	Y	Y	Y	WD CT, WD wall
Room 104	23	75	18	1186	ND	6	Y	Y	N	
Room 103	26	74	17	1142	ND	15	Y 1/3 open	N	Y	DO, CD, exhaust blocked
Room 102A	1	75	14	647	ND	5	N	Y	N	DO
Room 113	0	74	12	572	ND	6	N	Y	N	DO
Room 112	8	74	13	660	ND	6	Y	Y	Y	DEM, exhaust blocked

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