**INDOOR AIR QUALITY ASSESSMENT**

**Monument Mountain High School**

**600 Stockbridge Road**

**Great Barrington, MA**



Prepared by:

Massachusetts Department of Public Health

Bureau of Environmental Health

Indoor Air Quality Program

March 2019

# Background

|  |  |
| --- | --- |
| Building: | Monument Mountain Regional High School (MMRHS) |
| Address: | 600 Stockbridge Road, Great Barrington, MA |
| Assessment Requested by: | Steven Soule, Director of Operations, Berkshire Hills Regional School District (BHRSD) |
| Reason for Request: | Concerns regarding poor indoor air quality (IAQ) conditions in windowless classrooms. |
| Date of Assessment: | March 22, 2019 |
| Massachusetts Department of Public Health/Bureau of Environmental Health (MDPH/BEH) Staff Conducting Assessment: | Michael Feeney, Director, IAQ Program |
| Building Description: | The MMRHS is a one-story, brick building on a slab built in 1968. |
| Building Population: | Approximately 860 total students and staff |
| Windows: | Windows are openable |

# BACKGROUND

The assessment was requested by the BHRSD regarding concerns of IAQ conditions in interior classrooms located in F Wing. Parents attending an after-hours parent/teacher night on October 4, 2018 raised concerns regarding the interior classrooms. IAQ staff conducted air sampling in areas that had no openable windows and depended solely on the HVAC system for fresh air. Air measurements in F wing were conducted in F Wing interior classrooms prior to and after the lunch period in order to assess conditions under typical daily use.

Note that this school has been visited previously by the BEH/IAQ program in 2008. A report on that visit is available on the MDPH website at: <https://www.mass.gov/info-details/indoor-air-quality-reports-cities-and-towns-g#great-barrington->

# IAQ Testing Results

Please refer to the IAQ Manual for methods, sampling procedures, and interpretation of results (MDPH, 2015). The following is a summary of indoor air testing results (Table 1).

* ***Carbon dioxide levels*** were above the MDPH guideline of 800 parts per million (ppm) in over half of occupied classrooms tested, indicating inadequate air exchange in those areas.
* ***Temperature*** was within the MDPH recommended range of 70°F to 78°F the day of the assessment.
* ***Relative humidity*** was below the MDPH recommended range of 40 to 60% in all areas the day of assessment as is typical during the heating season.
* ***Carbon monoxide*** levels were non-detectable (ND) in all areas tested.
* ***Fine particulate matter (PM2.5)*** concentrations measured were below the National Ambient Air Quality (NAAQS) limit of 35 μg/m3 in all areas tested.

## Ventilation

A heating, ventilating and air conditioning (HVAC) system has several functions. First it provides heating and, if equipped, cooling. Second, it is a source of fresh air. Finally, an HVAC system will dilute and remove normally occurring indoor environmental pollutants by not only introducing fresh air, but by filtering the airstream and ejecting stale air to the outdoors via exhaust ventilation. Even if an HVAC system is operating as designed, point sources of respiratory irritation may exist and cause symptoms in sensitive individuals.

Fresh air is provided by a combination of attic and rooftop air-handling units (AHUs) that draw fresh air from outdoors then distribute it via ductwork to classrooms. Air is supplied to each classroom by a combination of vents located on either side of the light fixtures or ceiling-mounted diffusers. Exhaust vents located in storage closets remove air from the classrooms. These vents are at the top of the closet and ducted to exhaust motors and vented to the outside.

### IAQ Conditions on October 4, 2018

Two conditions existed that would likely increase occupant discomfort in F Wing on October 4, 2019.

* The HVAC systems do not have the ability to chill air.
* Outdoor temperature on October 4, 2019 were unseasonable warm (high 71°F/ low 53°F) compared to average historical temperature (high 62°F/ low 41°F) experienced in the greater Great Barrington area. At 6PM, the temperature was reported to be 68°F.
* According to weather records, the relative humidity in the greater Great Barrington area was measured as 86%.

According to BHRSD officials the AHU is programmed to be activated for evening events, which would introduce warm, moist air into classrooms during the parent/teacher night. Given the unseasonably warm outdoor temperature combined with high relative humidity and lack of HVAC air chilling capacity, air vented into the interior classroom would be warm and humid, making conditions inside these rooms uncomfortable, particularly if classrooms were heavily populated.

### IAQ Conditions on March 22, 2019

IAQ measurements were taken during typical early spring day, with an outdoor temperature reported to be 37°F and with relative humidity of 34% during a snow squall. The HVAC system was operating in heating mode during the school day. It is important to note that the Massachusetts Building Code required that each room have an operating mechanical ventilation system or have openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. The Massachusetts Building Code does not require buildings to have chilling capacity.

Carbon dioxide levels measured in a number of areas indicate that fresh air supply and exhaust ventilation should be increased. Frequently, fresh air supply dampers are partially or fully closed during cold weather to prevent freezing of heating coils. Control of fresh air dampers can be difficult due to the age of the HVAC system, which was installed when the school was constructed, which is over 50 years old. Efficient function of equipment of this age 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]](#footnote-1) for the various components of the HVAC system is between 20 to 30 years, assuming routine maintenance of the equipment (ASHRAE, 1991). Despite attempts to maintain the equipment, the optimal operational lifespan of this equipment has been exceeded.

Relative humidity was below the MDPH recommended comfort range the day of the assessment. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity 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. “Extremely low (below 20%) relative humidity may be associated with eye irritation [and]…may affect the mucous membranes of individuals with bronchial constriction, rhinitis, or cold and influenza related symptoms” (Arundel et al., 1986). Low relative humidity is a common problem during the heating season in the northeast part of the United States.

## Other IAQ Evaluations

The filter system in the F Wing HVAC system was found to provide minimal filtration of outdoor air. MDPH recommends tight-fitting filters of a Minimum Efficiency Reporting Value (MERV) of 8, which are adequate in filtering out pollen and mold spores (ASHRAE, 2012). Lack of filtration would likely account for the dust and debris on flat surfaces reported by building occupants.

The school has wall-to-wall carpeting in some areas that was likely installed during the original construction of the building in 1973. Carpeting in schools, if well maintained, is expected to have a service life of 7 to 11 years (IICRC, 2002; Bishop, 2002). Worn carpet can be a source of dust, debris and other pollutants that can become readily aerosolized when trod upon. This condition can be exacerbated by low humidity that will occur during the heating season. Increased PM2.5 can result in eye, nose, and respiratory system irritation. Individuals with a pre-existing respiratory condition such as asthma may experience increased symptoms.

Carpets should be cleaned annually (or semi-annually in soiled/high traffic areas) in accordance with Institute of Inspection, Cleaning and Restoration Certification (IICRC) recommendations, (IICRC, 2012). Regular cleaning with a high efficiency particulate air (HEPA) filtered vacuum in combination with an annual cleaning will help to reduce accumulation and potential aerosolization of materials from carpeting.

Note that the Environmental Protection Agency (EPA) conducted a National School Radon Survey in which it discovered nearly one in five schools had “…at least one frequently occupied ground contact room with short-term radon levels above 4 [picocuries per liter] pCi/L” (US EPA 1993). The BEH/IAQ Program therefore recommends that every school be tested for radon, and that this testing be conducted during the heating season while school is in session in a manner consistent with USEPA radon testing guidelines. Radon measurement specialists and other information can be found at [www.nrsb.org](http://www.nrsb.org) and <http://aarst-nrpp.com/wp>, with additional information at: <http://www.mass.gov/eohhs/gov/departments/dph/programs/environmental-health/exposure-topics/iaq/radon>.

# Conclusions/Recommendations

Based on available weather data, the higher temperature and relative humidity conditions in the greater Great Barrington area likely made parent/teacher night attendees feel uncomfortable. Since the HVAC system in classrooms does not have the capacity to chill air, no means exists to reduce temperature and to reduce humidity.

Control of fresh air supply can become difficult to maintain with HVAC equipment that has exceeded its likely service life. In particular, HVAC systems are recommended to be re-balanced every 5 years to maintain the HVAC system operation as originally designed (SMACNA, 1994). If equipment is beyond its service life, rebalancing the system may not be feasible due to non-functioning of various HVAC system components. The following recommendations are made to assist in improving IAQ:

1. Make necessary adjustments to AHU controls/fresh air louvres to allow an increase in fresh air to the rooms showing elevated carbon dioxide levels (Table 1).
2. Ensure that HVAC equipment is operating in windowless classrooms continuously during occupied periods. Operate all supply and exhaust ventilation equipment continuously during occupied hours.
3. Consult with an HVAC contractor to thoroughly examine all HVAC system components to ensure proper function. Make any necessary repairs to ensure the system is working as designed. Assess whether adjustments can be made to allow more fresh air into the system and the HVAC system can be rebalanced.
4. Temperature/comfort complaints should be made through proper channels and followed up by facilities staff.
5. Use openable windows to supplement fresh air during temperate weather. Ensure all windows are tightly closed at the end of the day.
6. Check exhaust vents classrooms and restrooms for draw periodically and repair any non-operating motors/vents.
7. Change filters for HVAC equipment 2-4 times a year. The MDPH recommends using pleated filters of Minimum Efficiency Reporting Value (MERV) of 8, which are adequate in filtering out pollen and mold spores (ASHRAE, 2012), if these can be used with current equipment.
8. HEPA vacuum carpeting daily and clean carpeting annually (or semi-annually in soiled high traffic areas). Clean area rugs similarly.
9. Consideration should be given to removing wall-to-wall carpeting due to its age. Consider replacing wall-to-wall carpeting with a tile system.
10. 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).
11. The school should be tested for radon by a certified radon measurement specialist during the heating season when school is in session. Radon measurement specialists and other information can be found at: [www.nrsb.org](http://www.nrsb.org/), and <http://aarst-nrpp.com/wp>.
12. Consider adopting the US EPA (2000) document, “Tools for Schools”, as an instrument for maintaining a good IAQ environment in the building available at: <http://www.epa.gov/iaq/schools/index.html>
13. Refer to resource manual and other related IAQ 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>.

# References

Arundel et al. 1986. Indirect Health Effects of Relative Humidity on Indoor Environments. Env. Health Perspectives 65:351-361.

ASHRAE. 1991. ASHRAE Applications Handbook, Chapter 33 “Owning and Operating Costs”. American Society of Heating, Refrigeration and Air Conditioning Engineers, Atlanta, GA.

Bishop. 2002. Bishop, J. & Institute of Inspection, Cleaning and Restoration Certification. A Life Cycle Cost Analysis for Floor Coverings in School Facilities.

ASHRAE. 2012. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 52.2-2012 -- Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ANSI Approved). 2012.

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL.

IICR. 2000. IICR S001 Reference Guideline for Professional On-Location Cleaning of Textile Floor Covering Materials Institute of Inspection, Cleaning and Restoration Certification. Institute of Inspection Cleaning and Restoration, Vancouver, WA.

IICRC. 2002. Institute of Inspection, Cleaning and Restoration Certification. A Life-Cycle Cost Analysis for Floor Coverings in School Facilities.

IICRC. 2012. Institute of Inspection, Cleaning and Restoration Certification*. Carpet Cleaning: FAQ*.

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

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors’ National Association, Inc., Chantilly, VA.

US EPA. 1993. Radon Measurement in Schools, Revised Edition. Office of Air and Radiation, Office of Radiation and Indoor Air, Indoor Environments Division (6609J). EPA 402-R-92-014. <https://www.epa.gov/sites/production/files/2014-08/documents/radon_measurement_in_schools.pdf>

US EPA. 2000. Tools for Schools. Office of Air and Radiation, Office of Radiation and Indoor Air, Indoor Environments Division (6609J). EPA 402-K-95-001, Second Edition. <http://www.epa.gov/iaq/schools/index.html>.

| **Location** | **Carbon**  **Dioxide**  **(ppm)** | **Carbon Monoxide**  **(ppm)** | **Temp**  **(°F)** | **Relative**  **Humidity**  **(%)** | **PM2.5**  **(µg/m3)** | **Occupants**  **in Room** | **Windows**  **Openable** | **Ventilation** | | **Remarks** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Supply** | **Exhaust** |
| Background (outdoors) | 300 | ND | 37 | 34 | 1 |  |  |  |  |  |
| H hallway | 1050 | ND | 70 | 39 | 3 | 0 | N | Y | Y |  |
| H04 | 1024 | ND | 70 | 36 | 2 | 3 | Y | Y | Y |  |
| H12 | 1153 | ND | 71 | 36 | 6 | 6 | N | Y | Y |  |
| H13 | 1111 | ND | 73 | 34 | 1 | 13 | N | Y | Y |  |
| H11 | 954 | ND | 72 | 30 | 4 | 2 | N | Y | Y |  |
| H18 | 931 | ND | 73 | 30 | 4 | 0 | Y | N | N |  |
| F12 AM | 732 | ND | 72 | 28 | 1 | 1 | N | Y | Y |  |
| F15 AM | 789 | ND | 72 | 28 | 0 | 0 | N | Y | Y |  |
| F14 AM | 721 | ND | 73 | 28 | 1 | 1 | N | Y | Y |  |
| F hallway | 758 | ND | 73 | 30 | 0 | 2 | N | Y | Y |  |
| F16 | 755 | ND | 73 | 29 | 0 | 0 | N | Y | Y |  |
| F10 | 773 | ND | 73 | 28 | 1 | 5 | N | Y | Y |  |
| B14 | 1211 | ND | 73 | 31 | 2 | 0 | N | Y | Y |  |
| B13 | 1109 | ND | 73 | 30 | 3 | 1 | N | Y | Y |  |
| B12 | 1064 | ND | 73 | 29 | 3 | 1 | N | Y | Y |  |
| B11 | 1072 | ND | 73 | 29 | 3 | 1 | N | Y | Y |  |
| B hallway | 1086 | ND | 73 | 29 | 3 | 0 | N | Y | Y |  |
| Library | 1059 | ND | 74 | 29 | 3 | 30+ | N | Y | Y |  |
| Auditorium | 602 | ND | 73 | 24 | 1 | 7 | N | Y | Y |  |
| B09 | 735 | ND | 74 | 26 | 0 | 0 | N | Y | Y |  |
| Cafeteria | 500 | ND | 73 | 25 | 1 | 0 | Y | Y | Y |  |
| Hallway cafeteria | 740 | ND | 73 | 26 | 5 | 0 | N | Y | Y |  |
| C hallway | 748 | ND | 73 | 26 | 2 | 0 | N | Y | Y |  |
| F14 PM | 1111 | ND | 74 | 29 | 1 | 18 | N | Y | Y |  |
| F15 PM | 953 | ND | 74 | 28 | 1 | 6 | N | Y | Y |  |
| F16 PM | 1088 | ND | 74 | 30 | 1 | 26 | N | Y | Y |  |
| Gym | 448 | ND | 72 | 25 | 1 | 30+ | N | Y | Y |  |

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). [↑](#footnote-ref-1)