**INDOOR AIR QUALITY ASSESSMENT**

**Falls Elementary School**

**2 Jackson Street**

**North Attleborough, Massachusetts**

exterior view of Falls Elementary School
2 Jackson Street
North Attleborough, Massachusetts


Prepared by:

Massachusetts Department of Public Health

Bureau of Environmental Health

Indoor Air Quality Program

October 2021

# BACKGROUND

|  |  |
| --- | --- |
| **Building:** | Falls Elementary School (FES) |
| **Address:** | 2 Jackson Street, North Attleborough, MA |
| Assessment Requested by: | North Attleborough Public Schools (NAPS) |
| **Reason for Request:** | Collaborative effort to perform general indoor air quality (IAQ) assessments throughout the NAPS |
| **Date of Assessment:** | August 17, 2021 |
| **Massachusetts Department of Public Health/Bureau of Environmental Health (MDPH/BEH) Staff Conducting Assessment:** | Cory Holmes, Assistant Director, Indoor Air Quality (IAQ) Program |
| **Building Description:** | The FES is a two-story red brick building constructed in 1949. Two modular classrooms were added in the early 1990s. It appears that the majority of building materials (e.g., floor tiles, heating and ventilation components, ceiling tiles) are original. |
| **Windows:** | Openable |

Although the majority of building components are original to the building, some building improvements have been made, including replacement of windows and portions of the roof. At the time of assessment the building was undergoing a thorough summer break cleaning.

# METHODS

MDPH IAQ staff conducted a series of visual assessments, temperature and relative humidity measurements to identify likely areas that could be prone to condensation in hot, humid weather. Please refer to the IAQ Manual for methods, sampling procedures, and interpretation of results (MDPH, 2015).

# RESULTS and DISCUSSION

The following is a summary of testing results (Table 1):

* ***Temperature*** was within the MDPH recommended range of 70°F to 78°F in areas tested. It is important to note that although the FES is not an air-conditioned building, most areas are equipped with window-mounted units for comfort control.
* ***Relative Humidity*** was above the MDPH recommended range of 40 to 60% in the majority of areas the day of assessment due to outside conditions.

## 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 in the majority of classrooms is supplied by 1940’s vintage unit ventilators (univents, Picture 1). Univents draw air from the outdoors through a fresh air intake located on the exterior wall of the building (Picture 2) and return air through an air intake located at the base of the unit. Fresh and return air are mixed, filtered, heated or cooled and provided to rooms through an air diffuser located in the top of the unit (Figure 1).

Mechanical exhaust ventilation in classrooms is provided by wall-mounted exhaust vents (Picture 3) connected to rooftop motors. The MDPH IAQ Program recommends that supply and exhaust ventilation operate continuously during occupied periods to provide air exchange and filtration. Without sufficient supply and exhaust ventilation, normally occurring environmental pollutants can build-up and lead to indoor air quality/comfort complaints.

It is also important to note that despite ongoing maintenance and replacement of parts/components by NAPS facilities staff, many of the HVAC units are at the end of their life cycle. Efficient function of equipment of this age (> 70 years old) 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) of this type of unit is 15-20 years, assuming routine maintenance of the equipment (ASHRAE, 1991). It was reported that currently two univents were on a repair list.

Mechanical ventilation for modular classrooms is provided by rooftop air handling units (AHUs), (Picture 4). Fresh air is distributed via ductwork connected to ceiling-mounted air diffusers. Return vents draw air back to the AHUs through wall or ceiling-mounted grilles. Thermostats control each HVAC system and have fan settings of “on” and “automatic”. The automatic setting on the thermostat activates the HVAC system at a preset temperature. Once the preset temperature is reached, the HVAC system is deactivated. Therefore, no mechanical ventilation is provided until the thermostat re-activates the system.

To maximize air exchange, the IAQ program recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. To have proper ventilation with a mechanical ventilation system, the systems must be balanced after installation 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).

Room 114 does not contain windows or a mechanical means of ventilation. If this room is to continue to be occupied, a passive vent should be installed and/or the door undercut to allow airflow into the room. Some form of ventilation should be provided.

## Microbial/Moisture Concerns

As previously mentioned, this visit included a visual inspection for signs of water damage and microbial growth. Water-damaged ceilings/tiles were observed in a number of classrooms, hallways and common areas (Table 1, Pictures 5 and 6), which can indicate current/historic roof/plumbing leaks or other water infiltration. Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired. It is important to note that ceiling tiles in the FES are of a type that are directly adhered to the ceiling substrate, therefore would necessitate the destruction of the ceiling tile to remove. In addition, replacement tiles are not likely to be available. Ceiling tiles in the modular classrooms are of the suspended type (Picture 6), which can be more easily changed.

In classroom 200, the wooden sink countertop was damaged (Picture 7), which can allow water into the porous material underneath. This can lead to water damage and mold growth.

A perimeter inspection of the building was conducted to identify any breaches/potential pathways for water intrusion:

* Wooden fascia board was damaged near the roof of the modular wing (Picture 8);
* Holes/breaches were noted in exterior walls (Picture 9); and
* Plants were noted along exterior walls (Pictures 9 and 10);

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. These breaches may provide a means for moisture and pests to enter the building.

### Building Materials Prone to Condensation

The key to managing condensation in hot, humid weather indoors is understanding dew point. When warm, moist air passes over a cooler surface, condensation can form. Condensation is the collection of moisture on a surface at or below the dew point. The dew point is the temperature that air must reach for saturation to occur. If a building material/component has a temperature *below the dew point*, condensation will accumulate on that material. Over time, condensation can collect and form water droplets.

A method to locate areas in a building prone to condensation is to measure air and building material temperatures using a laser thermometer (Table 1). If a wide temperature range exists between measurements (>5°F), the building materials at the colder end of the range may be prone to becoming moistened with condensation if exposed to hot, humid weather (70% relative humidity) for extended periods of time. According to the test results in Table 1, a number of areas of the building would appear to be prone to condensation if exposed to hot, humid weather for extended periods of time.

According to American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), if relative humidity exceeds 70%, mold growth may occur due to wetting of building materials (ASHRAE, 1989). It is recommended that porous material be dried with fans and heating within *24 to 48 hours of becoming wet* (US EPA, 2008, ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth.

## Other Issues

Some areas were carpeted. 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). The service life of carpeting is approximately 10-11 years (IICRC, 2002). 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. Several rooms had area rugs, which should also be vacuumed/cleaned on a regular basis. In addition, area rugs should not be placed on top of other carpeting because it can trap moisture beneath and create conditions conducive to mold growth.

It was reported that to supplement mechanical ventilation and filtration, every classroom is provided with a HEPA-filtered air purifier (Picture 11). It is important to note that filters should be changed and these units be maintained in accordance with the manufacturers’ recommendations.

The MDPH recommends that HVAC equipment be outfitted with filters of a Minimum Efficiency Reporting Value (MERV) of 8 *or higher*, which are adequate in filtering out pollen and mold spores (ASHRAE, 2012). In addition, filters should be changed 2-4 times a year or in accordance with the manufacturers’ recommendations. As mentioned previously, many areas had window-mounted air conditioners (Table 1, Picture 12), which have filters that need to be cleaned regularly.

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 AND RECOMMENDATIONS

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

## Ventilation recommendations

1. As previously discussed, the age (> 70 years old), physical deterioration and availability of parts for mechanical ventilation system components and controls should be fully evaluated by an HVAC engineering firm to determine the operational lifespan of existing equipment and/or examining the feasibility of repair vs. replacement.
2. The U.S. Department of Education has released new guidance encouraging the use of American Rescue Plan (ARP) funds to improve ventilation systems and make other indoor air quality improvements in schools. More information can be found at this link <https://www.ed.gov/coronavirus/improving-ventilation>.
3. Operate all supply and exhaust ventilation equipment continuously during occupied periods. Ensure all obstructions are removed from the front and top of the univents.
4. Continue with plans to replace univents that are currently inoperable.
5. Check exhaust vents for draw periodically and repair any non-operating vents.
6. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
7. Continue to change filters for HVAC equipment 2-4 times a year using *the highest* MERV rating a building’s ventilation system can accommodate to improve air filtration as much as possible without significantly reducing airflow.
8. Use openable windows to supplement fresh air during temperate weather. Ensure all windows are tightly closed at the end of the day.
9. Install a passive vent or undercut door to provide make-up air for room 114. Consider providing a mechanical means of ventilation if feasible.

## Water Damage Recommendations

1. Ensure roof and plumbing leaks are repaired and replace water-damaged ceiling tiles.
2. Repair/seal holes and breaches in exterior walls/building envelope to eliminate drafts, moisture and pest entry.
3. Repair/replace damaged wooden fascia board near the roof of the modular wing.
4. Remove plants and trees/branches a minimum of 5 feet away from the building.
5. Closely monitor parameters such as temperature, relative humidity and dew point over summer months to prevent condensation on floors/surfaces. Refrain from storing porous items, such as cardboard and paper on floor in these areas. If carpeting is present, consider removing from areas that are prone to condensation.
6. Do not place area rugs on carpeting.
7. Repair damaged sink countertop in classroom 200. Avoid storage of porous materials and large amounts of materials under sinks.
8. Consider using the methods described in the document “Preventing Mold Growth in Massachusetts Schools During Hot, Humid Weather” to help reduce impact of conditions during hot, humid weather. This guideline can be found online at: <https://www.mass.gov/service-details/preventing-mold-growth-in-massachusetts-schools-during-hot-humid-weather>

## Other Recommendations

1. Change filters and maintain HEPA units in accordance with manufacturers’ recommendations.
2. Regularly clean/vacuum supply/exhaust/return vents and personal fans to avoid aerosolizing accumulated particulate matter.
3. Clean AC filters prior to the start of the cooling season and on a regular basis while in use.
4. Reduce use of products and equipment that create irritating volatile organic compounds (VOCs) and only use in well-ventilated areas. Minimize the use of air fresheners, deodorizers and scented products.
5. Keep spray bottles/cleaning products out of the reach of children. Ensure that products are compatible with one another. It is suggested that only school-supplied products be used to avoid product interactions.
6. Clean carpeting annually (or semi-annually in soiled high traffic areas) as per the recommendations of the Institute of Inspection, Cleaning and Restoration Certification (IICRC, 2012).
7. Consider replacing any carpeting that is beyond its service life (i.e., > 11yrs.).
8. 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).
9. 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>.
10. To learn more about radon, review the MDPH’s [Radon in Schools and Child Care Programs](https://www.mass.gov/info-details/radon-in-schools-and-child-care-programs?utm_source=IAQP&utm_medium=reports) factsheet, with additional information at: <http://www.mass.gov/eohhs/gov/departments/dph/programs/environmental-health/exposure-topics/iaq/radon>.
11. Consider forming an IAQ committee in each school building district-wide. Committees should have an IAQ liaison/teacher representative, a member of maintenance/facilities and administration that conduct regular walk-throughs to identify on-going and/or potential environmental issues.
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: <https://www.epa.gov/iaq-schools/indoor-air-quality-tools-schools-action-kit>.
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

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989

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

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).

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.

Lstiburek, J. & Brennan, T. 2001. Read This Before You Design, Build or Renovate. Building Science Corporation, Westford, MA. U.S. Department of Housing and Urban Development, Region I, Boston, MA

MDPH. 2015. Massachusetts Department of Public Health. “Indoor Air Quality Manual: Chapters I-III”. Available at: <https://www.mass.gov/lists/indoor-air-quality-manual-and-appendices#indoor-air-quality-manual->

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.

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>.

US EPA. 2008. “Mold Remediation in Schools and Commercial Buildings”. Office of Air and Radiation, Indoor Environments Division, Washington, DC. EPA 402-K-01-001. September 2008. Available at: <http://www.epa.gov/mold/mold-remediation-schools-and-commercial-buildings-guide>.

**Figure 1**

**Unit Ventilator (Univent)**

Mixed Air

Air Diffuser

**Outdoors Indoors**

Fan

Heating/Cooling Coil

Air Mixing Plenum

Filter

Outdoor Return

Air Air

Air

Flow

Control

Louvers

**Air Flow**

= Fresh Air/Return Air

= Mixed Air

**Picture 1**

****

**1940’s vintage univent**

**Picture 2**

****

**Univent air intake**

**Picture 3**

****

**Classroom exhaust vent**

**Picture 4**

****

**Rooftop AHUs for modular classrooms**

**Picture 5**

****

**Water-damaged ceiling tiles adhered directly to ceiling**

**Picture 6**

****

**Water-damaged suspended ceiling tiles in modular classroom**

**Picture 7**

****

**Damaged countertop in classroom 200**

**Picture 8**

**Picture 8

Damaged fascia board in the modular wing**

**Damaged fascia board in the modular wing**

**Picture 9**

****

**Opening in exterior wall, also note plant growth along bottom**

**Picture 10**

****

**Plant growth against the building**

**Picture 11**

****

**HEPA air purifiers in classroom**

**Picture 12**

****

**Window AC in classroom**

| **Location** | **Air Temp**  **(oF)** | **Relative Humidity**  **(%)** | **Dew Point**  **(oF)** | **Floor Temp**  **(oF)** | **Temp at Floor/ Exterior Wall Junction**  **(oF)** | **Water-Damaged Ceiling Tiles-stained**  **(#)** | **Water-Damaged**  **Bowed Ceiling Tile**  **(#)** | **Ventilation** | | | **Floor to Air Temp**  **Difference**  **(oF)** | **Comments** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Windows openable** | **Supply** | **Exhaust** |
| Background (outdoors) | 89 | 79 | 82 |  |  |  |  |  |  |  |  | Hazy, warm, humid |
| 100 | 72 | 67 | 60 | 63 | 63 | 2 |  | Y | Y | Y | -9 | AP, AC |
| 101 | 76 | 64 | 63 | 71 | 72 |  |  | Y | Y | Y | -5 | AP, AC |
| 102 | 76 | 63 | 62 | 71 | 72 | 15 |  | Y | Y | Y | -5 | AP, AC |
| 103 | 76 | 64 | 62 | 71 | 71 | 5 |  | Y | Y | Y | -5 | AP, AC |
| 104 | 74 | 61 | 60 | 70 | 69 |  |  | Y | Y | Y | -4 | AP, AC |
| 105A | 76 | 62 | 63 | 72 | 71 | 2 |  | Y | Y | N | -4 | AP, AC |
| 105B | 77 | 62 | 63 | 71 | 70 | 3 |  | N | N | Y | -4 | AP, PF |
| 106 | 72 | 67 | 60 | 62 | 62 | 4 |  | Y | Y | Y | -10 | AP, AC |
| 114 | 73 | 61 | 58 | 64 | 64 | 2 |  | N | N | Y | -9 | Rec passive vent or undercut door |
| Modular Library | 72 | 65 | 60 |  |  | 7 |  | Y | Y | Y |  | Carpet, AP |
| Modular Kindergarten | 71 | 62 | 58 |  |  | 3 |  | Y | Y | Y |  | Carpet, PF, AP |
| 200 | 73 | 54 | 56 | 71 | 70 |  |  | Y | Y | Y | -2 | AP, AC, WD wood sink |
| 201 | 73 | 55 | 56 | 71 | 71 |  |  | Y | Y | Y | -2 | AP, AC |
| 202 | 73 | 54 | 55 | 71 | 70 |  |  | Y | Y | Y | -2 | AP, AC |
| 203 | 73 | 54 | 55 | 69 | 69 |  |  | Y | Y | Y | -4 | AP, AC, PF |
| 204 | 73 | 53 | 54 | 70 | 69 |  |  | Y | Y | Y | -3 | AP, AC |
| 205 | 73 | 56 | 57 | 73 | 73 |  |  | Y | Y | Y | 0 | AP, AC |
| Teachers’ Lounge | 75 | 65 | 62 | 72 | 72 |  |  | Y | Y | Y | -3 | AC |

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)