# Background

**INDOOR AIR QUALITY**

**ASSESSMENT**

**Leicester High School**

**174 Paxton Street**

**Leicester, MA**



Prepared by:

Massachusetts Department of Public Health

Bureau of Environmental Health

Indoor Air Quality Program

November 2021

|  |  |
| --- | --- |
| Building: | Leicester High School (LHS) |
| Address: | 174 Paxton Street, Leicester, MA |
| Assessment Requested by: | Marilyn Tencza, Ed. D.,Superintendent,Leicester Public Schools |
| Date of Assessment: | July 9, 2021 |
| Massachusetts Department of Public Health/Bureau of Environmental Health (MDPH/BEH) Staff Conducting Assessment: | Michael Feeney, Director, Indoor AirQuality (IAQ) Program |
| Date of Building Construction/Renovation: | Constructed in 1995 |
| Building Description: | The LHS is a one-story red brick, multi-wing building that contains general classrooms, science classrooms, an auditorium, gymnasium, cafeterias, kitchen, library, computer rooms, art room, café, guidance area, teachers’ room, and office space. |
| Windows: | Openable |

# Introduction/Background

# The IAQ Program assessed the building to identify possible causes of mold growth from condensation and to make recommendations regarding methods that may be used to limit such water damage during hot, humid conditions.

# 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. Floor temperatures were measured in rooms on cement slab in direct contact with soil. 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 or close to the upper end of the MDPH recommended range of 70°F to 78°F in all areas tested.
* ***Relative Humidity*** was above DPH recommended range of 40 to 60% in all areas tested (Table 1). It is important to note that outdoor relative humidity was measured at 81%.

## 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 unit ventilators (univents) installed when the LHS was renovated in 2001. Univents draw air from the outdoors through a fresh air intake located on the exterior wall of the building 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 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 IAQ/comfort complaints.

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).

## Microbial/Moisture Concerns

The LHS has experienced water damage from the following sources:

* Leaks from the building envelope or plumbing;
* Building materials prone to condensation during hot, humid weather;
* Building material prone to water vapor absorption in high humidity environments; and
* Dry drain traps

### Leaks from the building envelope or plumbing

A few water-damaged ceiling tiles were noted in the school (Table 1). Water damage to ceiling tiles indicates a leak from the building envelope or plumbing system. Water-damaged ceiling tiles should be replaced when the source of water is repaired. During ceiling tile replacement, the area above the tiles should be inspected for additional water-damaged materials and cleaned/remediated as needed.

### Building materials prone to condensation

It is important to note that Massachusetts has experienced extended periods of relative humidity during the summer of 2021. This July was the wettest ever recorded in Massachusetts, and the three-month period from June through August, known as the meteorological summer, was the fourth wettest on record, according to the National Oceanic and Atmospheric Administration’s Centers for Environmental Information. The three-month period also was the third warmest ever in the state and was tied for the warmest on record across the United States (HG, 2021, NOAA, 2021).

The building was assessed to determine if floors (cement on soil) were subject to developing condensation during extended (> 24 hours) hot, humid weather. 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. Floor tiles show signs of chronic condensation exposure.

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 for extended periods of time. According to the test results in Table 1, ***all but one of the floors*** on the first floor of the building would appear to be prone to condensation under high-humidity conditions.

### Building material prone to water vapor absorption in high humidity environments

While only a few water-damaged, stained ceiling tiles were noted, ceiling tiles in many classrooms were bowed (Table 1), which is likely the result of chronic elevated relative humidity conditions. No mold growth was observed on ceiling tiles.

According to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), if relative humidity exceeds 70% for extended periods of time, mold growth may occur due to wetting of building materials even in the absence of liquid water (ASHRAE, 2019). In these conditions, porous materials such as ceiling tiles, gypsum wallboard, cardboard and other items may develop mold colonization.

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. If mold-colonized, they should be removed and discarded. Water-damaged porous materials cannot be adequately cleaned to remove mold growth.

### Dry drain traps

The LHS has science labs that contain a number of sink drains, both abandoned and in use. It is highly likely that these drains have dry traps, which can result in significant backflow of water vapor into the building from the drainage system, particularly during times of heavy rains. The purpose of a drain trap is to prevent sewer gasses from entering the building by having water fill the U-bend beneath the drain. Such an airtight seal also prevents excess water vapor from entering into the building. All drains should be wet with water at least once a week. Drains that are no longer needed should be sealed.

# Recommendations

The LHS has a number of issues related to moisture in the building, particularly rooms located on cement slab in direct contact with soil during extended periods of hot, humid weather. Moisture-related problem (bowing ceiling tiles) occurred given the extreme relative humidity and rain over the summer of 2021. Management of buildings in such weather without air conditioning and/or dehumidification can be challenging. The following documents can provide guidance that can be used to reduce the impact of hot, humid weather in buildings.

* Preventing mold growth in Massachusetts schools during hot, humid weather: <https://www.mass.gov/service-details/preventing-mold-growth-in-massachusetts-schools-during-hot-humid-weather>
* Remediation and prevention of mold growth and water damage in public schools and buildings to maintain air quality: <https://www.mass.gov/service-details/remediation-and-prevention-of-mold-growth-and-water-damage-in-public-schools-and>
* Methods for increasing comfort in non-air-conditioned schools: <https://www.mass.gov/doc/methods-for-increasing-comfort-in-non-air-conditioned-schools/download>

In view of the findings at the time of the visit, the following recommendations are provided in addition to the preceding documents regarding water damage and moisture:

### Replace water-damaged ceiling tiles. Inspect the area above the tiles for any additional water damage and clean/repair as needed.

### Ensure that all plumbing drains are wetted at least once a week or permanently sealed if not to be used. Temporarily sealing shower drains with an appropriate material should be considered if future use may be considered.

1. 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.
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. 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>.

# References

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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

| **Location** | **Air Temp****(oF)** | **Relative Humidity****(%)** | **Dew Point****(oF)** | **Floor Temp****(oF)** | **Water-Damaged/Stained Ceiling Tiles** | **Bowed Ceiling Tiles** | **Ventilation** | **Floor to Air Temp****Difference** **(oF)** | **Comments** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Windows openable** | **Supply** | **Exhaust** |
| Background (outdoors) | 86 | 81 | 70 |  |  |  |  |  |  |  |  |
| Main office | 79 | 61 | 64 |  | N | Y | Y | Y | Y |  |  |
| School psychologist | 78 | 61 | 65 |  | N | Y | Y | Y | Y |  |  |
| 300 | 78 | 71 | 67 |  | N | Y | Y | Y | Y |  |  |
| 302 | 78 | 71 | 67 |  | N | Y | Y | Y | Y |  |  |
| 304 | 78 | 70 | 67 |  | N | Y | Y | Y | Y |  |  |
| 306 | 78 | 70 | 67 |  | N | Y | Y | Y | Y |  |  |
| 308 | 78 | 70 | 67 |  | N | Y | Y | Y | Y |  |  |
| 310 | 78 | 67 | 66 |  | N | Y | Y | Y | Y |  |  |
| 312 | 78 | 69 | 67 |  | N | Y | Y | Y | Y |  |  |
| 314 | 78 | 69 | 67 |  | N | Y | Y | Y | Y |  |  |
| 316 | 78 | 69 | 67 |  | N | Y | Y | Y | Y |  |  |
| 318 | 78 | 69 | 67 |  | N | Y | Y | Y | Y |  |  |
| 320 | 78 | 69 | 67 |  | N | Y | Y | Y | Y |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 319 | 78 | 72 | 68 |  | N | Y | Y | Y | Y |  |  |
| 317 | 78 | 72 | 67 |  | N | Y | Y | Y | Y |  |  |
| 315 | 78 | 72 | 68 |  | N | Y | Y | Y | Y |  |  |
| 313 | 78 | 72 | 68 |  | N | Y | Y | Y | Y |  |  |
| 311 | 77 | 71 | 67 |  | N | Y | Y | Y | Y |  |  |
| 307 | 76 | 70 | 68 |  | N | Y | Y | Y | Y |  |  |
| 303 | 78 | 71 | 68 |  | N | Y | Y | Y | Y |  | PhotocopierSoda vending machine |
| 301 | 78 | 71 | 67 |  | N | Y | Y | Y | Y |  |  |
| 204 | 70 | 70 | 67 |  | N | Y | Y | Y | Y |  |  |
| 206 Library | 77 | 64 | 67 |  | N | Y | Y | Y | Y |  |  |
| 205 | 77 | 64 | 64 |  | N | Y | Y | Y | Y |  |  |
| 207 | 77 | 67 | 64 |  | N | Y | Y | Y | Y |  |  |
| 209 | 77 | 66 | 65 |  | N | Y | N | Y | Y |  |  |
| 211 | 77 | 67 | 65 |  | N | Y | Y | Y | Y |  |  |
| 213 | 77 | 71 | 67 |  | N | Y | Y | Y | Y |  |  |
| 215 | 77 | 73 | 68 |  | N | Y | Y | Y | Y |  |  |
| 214 | 77 | 68 | 66 |  | N | Y | Y | Y | Y |  |  |
| 212 | 77 | 66 | 65 |  | 1 |  | Y | Y | Y |  | Chilled air-conditioned room Condensation on fresh air supply louverLouver temp = 49-55°F |
| 210 | 76 | 64 | 65 |  | 1 |  | Y | Y | Y |  | Chilled air-conditioned room |
| 208 | 74 | 70 | 63 |  | N |  | Y | Y | Y |  | Chilled air-conditioned room |
| 100 | 74 | 80 | 67 | 60 | 1 |  | Y | Y | Y | -14 | 3 missing ceiling tiles |
| 102 | 74 | 80 | 67 | 64 | N |  | Y | Y | Y | -10 |  |
| 104 | 74 | 79 | 67 | 64 | N | Y | Y | Y | Y | -10 | SinksPottery kiln |
| 106 | 74 | 78 | 67 | 66 | N | Y | Y | Y | Y | -8 |  |
| 108 | 74 | 77 | 66 | 64 | N | Y | Y | Y | Y | -10 | Sinks |
| 110 | 74 | 80 | 67 | 64 | N | Y | Y | Y | Y | -10 | Sink |
| 110-112 Rest room | 74 | 78 | 67 | 64 | N | Y | N | N | Y | -10 | Condensation on floorDry floor drain trap |
| 112 | 75 | 78 | 67 | 64 | N | Y | Y | Y | Y | -11 |  |
| 116 | 76 | 77 | 67 | 64 | N | Y | Y | Y | Y | -12 | Carpeting |
| Teachers’ Lounge | 72 | 77 | 67 | 68 | N | Y | N | Y | Y | -4 | Photocopier |
| 101 | 75 | 76 | 67 | 67 | N | Y | N | Y | Y | -8 |  |
| 099 | 75 | 76 | 67 | 67 | N |  | N | Y | Y | -8 |  |
| Auditorium | 76 | 66 | 64 | 62 | N |  | N | Y | Y | -14 | Carpeting |
| Cafeteria | 76 | 77 | 68 |  | N |  | N | Y | Y |  |  |
| Gymnasium | 76 | 78 | 69 |  | N |  | N | Y | Y |  | Floor covered with plastic tarp |