Arlington Public Schools

Building Ventilation Assessment – Barcroft

March 2021

Final

VENTILATION ASSESSMENT – Barcroft

Arlington Public Schools is in the process of doing additional assessment of ventilation systems in the less ventilated schools to improve conditions as recommended to open schools. The assessment is to review the available ventilation systems and include short term and long-term planning to increase the ventilation in the classrooms to accommodate the hybrid in-person learning (short term) and include ventilation rates to meet expected occupancy of the facilities (long term).

The elementary school is conditioned using two different types of HVAC systems. Each "typical" classroom was reviewed based on system type in the facility. The two systems include wall mounted unit ventilator units and centrally located dedicated outside air HVAC unit serving classrooms with unit ventilators. In rooms where the ventilation rate were below the recommendations, these systems were reviewed to determine methods to increase the ventilation in the classrooms. This report addresses Barcroft Elementary school.

The current American Society for Heating, Refrigerating and Air Conditioning (ASHRAE) code 62.1-2010 requires ventilation to be calculated based both on the classroom size (square foot of the room) and classroom occupancy. The classroom ventilation was designed as necessary to meet the current code level ventilation unit. As part of the guidelines for opening buildings, ventilation rates should be increased to the extent possible as a method to dilute airborne contaminants. ASHRAE recommends diluting the room air utilizing ventilation, to the extent possible, while not adversely affecting space air conditioning.

Harvard T.H. Chan's Guidelines for opening schools recommend that facilities verify the outside air ventilation system is operational and provide adequate ventilation. In addition to outside air ventilation, the guidelines also recommend that the building HVAC systems provide adequate air movement in the classrooms by using a combination of outdoor air and recirculating air. The target air movement rate in a classroom is to cycle the air in a room 4 to 6 times per hour [called air change rates per hour (ACH)]. Having a minimum of 5 ACH would mean the air is cycled 5 times in an hour – or every 12 minutes. The recommendation for cycling air in the classroom is to allow the HVAC systems to filter the air.

Both Harvard and ASHRAE recommend increasing filtration efficiencies to the highest allowable by the limits of the HVAC system. This varies by HVAC system, with MERV 13 equivalence being the minimum recommended filtration level due to its ability to remove 85 percent of the particles larger than 1 micron. While the virus is smaller than 1 micron, the general consensus is that the virus transmits in droplet form with the RNA infectious dose most likely in a size range greater than 1 micron. If the HVAC system isn't capable of utilizing MERV 13 filtration, the recommendation is to supplement the room with a fan/filter unit capable of using very high-efficient filters (HEPA) to allow better filtration and to increase the effective, clean air in the room.

Unit Ventilator style HVAC systems are utilized for the classrooms at Barcroft. These systems utilize room located, floor mounted HVAC unit(s) that are located on the exterior wall. The ventilation for these type systems is provided by connecting the unit through the exterior wall to a louver. Outside air intake and ventilation is controlled by a damper which is opened or closed to draw in ventilation air from the outside. The ventilation rate through these units varies by classroom and unit capacity. Note that four of the classrooms are actually served by a dedicated ventilation system instead of having ventilation through the exterior louver.

The unit ventilators utilize a unit mounted, ½" to 1" filter bank with maximum filter efficiency of approximately MERV 4-6. These filters are only capable of filtering approximately 20-30 percent of the particles,1 to 3 Micron.

Discussion:
The unit ventilators damper and the associated exterior louver was adequate to generally deliver the ventilation airflows required; however, the unit ventilators cooling and heating capacity was not designed to accommodate higher outside airflows. In order to increase ventilation airflow rate, outside air temperatures needs to be appropriate to allow the unit ventilator's cooling/heating coils to produce adequate supply air temperatures to meet the classrooms heating and cooling needs.

The hybrid ventilation rates should not affect the HVAC's system ability to heat and cool the classrooms when ambient conditions meet ASHRAE design guidelines. However, when outside dewpoints increase (generally above 65-70°F), the relative humidity in the space can be greatly affected, in which, the humidity levels will exceed ASHRAE guidelines for comfortable conditions.

Barcroft's unit ventilator's HVAC system can meet the hybrid occupancy, code level ventilation of approximately 1.7 to 2.0 ACH, coupled with the HVAC fan to provide an average room airflow over 9 ACH. This air change rates equates to the air being cycled every 6 to 7 minutes, which reduces stagnation in the room. However, the effective air change rate depends on filtration levels, with MERV 13 equivalence being recommended. Therefore, the recommendation to add an auxiliary HEPA filtration unit, increases the effective air change rate for the classroom to approximately 4 to 5 ACH, averaging over 4.6 ACH (or cycled every 13 minutes).

Issues:
- By increasing the ventilation rate, classroom comfort levels become more affected as the exterior humidity levels (and temperatures) increase. When humidity levels (increase in exterior dewpoints), the interior humidity levels can increase to outside normal ASHRAE comfort zones.
- Increased ambient temperatures can also increase indoor conditions to outside normal ASHRAE comfort zones.

- Colder, winter ambient temperatures can decrease indoor conditions to below normal ASHRAE comfort zones (causing the space to be too cold).
- Colder temperatures can cause cold drafts, especially at feet level, thus affecting room comfort levels.

Recommendations:

- In order to utilize the unit ventilator outside air damper and louver, the controls need to be verified to allow complete control of the unit.
- Outside air will need to be balanced to the required outside air rates.
- Maintain exhaust fan operations to help with ventilation rates in the unit ventilators.
- Increase filtration levels to the extent possible.
- Since MERV 13 filtration is not possible, add auxiliary filtration units to increase the effective clean, air change rate.

Recommendations (Long term):

- Due to humidity issues that occur when using unit ventilators, the recommended long-term solution is to install dedicated outside air systems which deliver the ventilation, directly to the classroom. By using dedicated ventilation units, the cooling/heating of the room is separated from heating/cooling the ventilation air. This allows the ventilation air to be dehumidified separately from the function of space cooling/heating.

- Due to building design and construction limitations, the recommended method for dedicated outside air systems would need to be concentrated around using small, dedicated heat pump units which serve smaller groups of classrooms. The heat pumps units would be smaller, ceiling suspended units with ductwork routed above the classrooms.

APPENDIX A

Disclaimers

Air change calculations using HEPA filter units.

Disclaimers

- The information in this document is provided as general guidance based on the current information available utilizing the strategies developed by ASHRAE and Harvard. HVAC systems play only a small role in infectious disease transmission, the airflow information provided in these documents are not mitigation strategies. Additional non-HVAC mitigation strategies to be used includes:

  - **Building Occupancy Levels Allowed**
  - **Face mask requirements**
  - **Social distancing between desks, students, teachers, etc.**
  - **Directional flow for movement through the building**
  - **Personal hygiene**
  - **Cleaning requirements**
  - **Touchless services.**

- It is important to note that HVAC strategies are means to improve the air quality and reduce risk but will not prevent all possibility of virus transmission, user should acknowledge that there is a no "zero risk" scenario. HVAC improvements are intended to be used as part of an overall risk reduction strategy for reopening schools. Each building and situation are unique and the guidance provided doesn't not equally apply to all buildings or classrooms.
- The information in this report is based on the very latest recommendations but the COVID-19 crisis remains an ever-evolving situation and this assessment and our recommendations are not intended to override or supersede any current or future guidance from health and government experts. This guidance should be used in conjunction with relevant guidance and research from governmental agencies. This information is not a substitute for guidance as recommended by health care professionals.
- CMTA does not warrant the accuracy or completeness of this guidance, by adopting these recommendations for use, each adopter agrees to accept the full responsibility in connection with their use. CMTA assumes no responsibility for any injury, loss, or damage arising out of or in connection with this guidance.

Barcroft - Airflow Calculations

Room Number	Room Use	Area (Sq Ft)	Ceiling Height (Feet)	Number of Students (Hybrid)	Unit Tag	Supply Airflow	Supply Total ACH	Year	Exst OA Design Airflow	Room OA ACH	Blue Air 211+ Airflow	HEPA ACH	"Clean" ACH
127	GR-1	853	8.58	11.00	UV-C	1,250	10.25	1992	250	2.05	350	2.87	4.92
129	GR-1	853	8.58	11.00	UV-C	1,250	10.25	1992	250	2.05	350	2.87	4.92
130	GR-1	848	8.58	11.00	UV-C	1,250	10.30	1992	250	2.06	350	2.88	4.95
131	kindergarten	840	8.58	11.00	UV-C	1,250	10.40	1992	250	2.08	350	2.91	4.99
132	Kindergarten	1,019	8.58	14.00	UV-D	1,500	10.29	1992	250	1.71	350	2.40	4.12
133	Kindergarten	1,022	8.58	14.00	UV-D	1,500	10.26	1992	250	1.71	350	2.39	4.11
134	Kindergarten	861	8.58	12.00	UV-C	1,250	10.15	1992	250	2.03	350	2.84	4.87
135	GR-1	874	8.58	12.00	UV-C	1,250	10.00	1250	250	2.00	350	2.80	4.80
137	self contained sped	874	8.58	12.00	UV-C	1,250	10.00	1992	250	2.00	350	2.80	4.80
208	GR-5	848	8.58	14.00	UV-D/DOAS	1,750	14.43	1992	250	2.06	350	2.89	4.95
209	GR-5	1,032	8.58	17.00	UV-D/DOAS	1,750	11.86	1992	250	1.69	350	2.37	4.06
211	GR-5	963	8.58	16.00	UV-B/DOAS	1,250	9.07	1992	250	1.81	350	2.54	4.36
213	GR-2	857	8.58	14.00	UV-C/DOAS	1,500	12.24	1992	250	2.04	350	2.86	4.90
215	GR-2	861	8.58	14.00	UV-C	1,250	10.15	1992	250	2.03	350	2.84	4.87
218	GR-2	861	8.58	14.00	UV-C	1,250	10.15	1992	250	2.03	350	2.84	4.87
219	GR-3	861	8.58	14.00	UV-C	1,250	10.15	1992	250	2.03	350	2.84	4.87
221	GR-3	804	8.58	13.00	UV-C	1,250	10.87	1992	250	2.17	350	3.04	5.22
222	GR-3	819	8.58	13.00	UV-D	1,500	12.80	1992	250	2.13	350	2.99	5.12
224	GR-3	810	8.58	13.00	UV-C	1,250	10.78	1992	250	2.16	350	3.02	5.18
228	GR-4	924	8.58	15.00	UV-C	1,250	9.46	1992	250	1.89	350	2.65	4.54
229	GR-4	877	8.58	14.00	UV-C	1,250	9.96	1992	250	1.99	350	2.79	4.78
Unit Ventilator Averages:		**874**				**1294**	**10.37**		**250**	**2.01**		**2.81**	**4.82**
UV/DOAS Averages:		**925**				**1563**	**11.90**		**250**	**1.90**		**2.66**	**4.57**