Arlington Public Schools

Building Ventilation Assessment – Swanson

March 2021

Final

VENTILATION ASSESSMENT – Swanson

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 middle school is conditioned using two different types of HVAC systems. Each "typical" classroom was reviewed based on system type in the facility. The systems include wall mounted unit ventilator units along with overhead VAV system utilizing air handling units. 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 the Swanson Middle 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, 5 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.

Console style HVAC systems (unit ventilators) are utilized for many of the classrooms at Swanson. 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.

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.

Swanson unit ventilator's HVAC system can provide the Hybrid occupancy, code level ventilation while providing an average room airflow of approximately 12 ACH. This air change rates equates to the air being cycled every 5-6 minutes, reducing stagnation airflow in the room. The hybrid ventilation rates can affect the HVAC's system ability to heat and cool the classrooms when ambient conditions exceed 90°F or is colder than 15°F. Furthermore, when outside dewpoints increase (generally above 65-70°F), the relative humidity in the space can increase.

Central HVAC systems: Swanson Middle School also uses central type HVAC air handling units mainly located in dedicated mechanical room(s). These units condition many classrooms throughout the facility. The ventilation for these units operates using dampers and controls directly connected to the outdoors via ductwork and louvers drawing in outdoor air through the unit. The unit then heat or cools the ventilation air providing the necessary cooling/heating air to the individual classrooms and spaces. Each classroom includes a terminal unit which provides a constant airflow which is temperature controlled to maintain space temperature while meeting the necessary outside air ventilation rates.

The central HVAC system can provide the Hybrid occupancy, code level ventilation while providing an average room airflow of approximately 9 ACH. This air change rates equates to the air being cycled every 6-7 minutes, reducing stagnation airflow in the room. The hybrid ventilation rates can affect the HVAC's system ability to heat and cool the classrooms when ambient conditions exceed 90°F or is colder than 15°F. Furthermore, when outside dewpoints increase (generally above 65-70°F), the relative humidity in the space can increase.

Discussion:
The air handling unit's cooling/heating capacity and associated outside air ductwork/exterior louver were originally designed to deliver the ventilation airflows of around 25 percent of full design airflow. Review of the air handling unit and system operating capacities, based on

hybrid space occupancies, demonstrates that operating the school in a hybrid mode is satisfactory. To increase the ventilation rates, above current operating conditions, the controls and dampers will need to be adjusted and calibrated as necessary to increase the ventilation airflows to approximately 30-35 percent capacity. During this increased ventilation operation, the HVAC's system does not have the ability to heat and cool the classrooms when ambient conditions exceed 90°F or is colder than 20°F. Furthermore, when outside dewpoints increase (generally above 65-70°F), the relative humidity in the space can increase.

Filtration:
The facility utilizes MERV 4-6 filters in the unit ventilators and utilizes MERV 8 filters in the roof top units. These filters are only capable of filtering approximately 20-30 percent of the particles,1 to 3 Micron; with the effective air change rate depending on filtration levels, the use of MERV 13 equivalence is 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 7 ACH, averaging over 6 ACH (or cycled every 10 to 11 minutes). The large technical education classroom is utilizing two filtration units to increase the effective air change rate.

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:

- The controls need to be verified to allow complete control of the outside air dampers for both the unit ventilators and the air handling units.
- Outside air will need to be balanced to the required outside air rates.
- Space airflows may require adjustments to increase supply airflow, thus increasing the overall ventilation rate.
- Maintain exhaust fan operations to help with ventilation rates in the unit ventilators.

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 ventilation units which serve smaller groups of classrooms. The heat pumps units would be smaller, ceiling suspended units with ductwork routed above the classrooms.
- The design/installed capacities of the air handling units do not have the ability to provide adequate heating and cooling utilizing the required ventilation rates. The existing handling unit infrastructure will require modifications necessary to increase higher ventilation rates. It would seem that these spaces should also utilize dedicated outside air units due to current infrastructure issues.

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.

Swanson - Airflow Calculations

Room Number	Room Use	Area (Sq Ft)	Ceiling Height (Feet)	Number of Students (Hybrid)	Unit Tag	Supply Airflow	AHU Total ACH	UV Total ACH	Year	Exst OA Design Airflow	Room OA ACH	Blue Air 211+ Airflow	Quant	HEPA ACH	"Clean" ACH
101	CLASSROOM	625	9.00	10.00	V1-17/AHU-1	540	5.76		1994	155	1.66	350	1	3.73	5.39
103	CLASSROOM	577	9.00	9.00	V1-16/AHU-1	520	6.01		1994	150	1.73	350	1	4.04	5.77
105	CLASSROOM	813	9.00	14.00	V1-16/AHU-1	640	5.25		1994	184	1.51	350	1	2.87	4.38
106	MATH	641	9.00	10.00	UV (1-20)	1250		13.00	1994	100	1.04	350	1	3.64	4.68
108	SOCIAL STUDIES	568	9.00	13.00	UV (1-19)	1250		14.67	1994	100	1.17	350	1	4.11	5.28
110	MATH	876	9.00	14.00	VAV-3-B/AHU-6	1350	10.27		2003	473	3.60	350	1	2.66	6.26
112	CLASSROOM	783	9.00	13.00	VAV-5-c/AHU-6	800	6.81		2003	280	2.38	350	1	2.98	5.36
114	Consumer Science	1462	9.00	13.00	(2) UV (14-15)	3000		13.68	1994	775	3.53	350	1	1.60	5.13
116	SPED	509	9.00	8.00	UV (1-13))	1250		16.37	1994	375	4.91	350	1	4.58	9.50
118	SPED	507	9.00	8.00	UV (1-12)	1250		16.44	1994	375	4.93	350	1	4.60	9.53
122	Vocal Music	1011	9.00	10.00	(3) UV (8-10)	3250		21.43	1994	875	5.77	350	1	2.31	8.08
124	Band	1029	9.00	10.00	UV (1-7)	1500		9.72	1994	375	2.43	350	1	2.27	4.70
126	Tech Ed	1285	9.00	10.00	V-1-27/AHU-2	1400	7.26		1994	304	1.58	350	**2**	3.63	5.21
126A	Tech Ed	720	9.00	10.00	V-1-28/AHU-2	800	7.41		1994	174	1.61	350	1	3.24	4.85
127	CLASSROOM	637	9.00	10.00	V-1-6/AHU-1	560	5.86		1994	161	1.68	350	1	3.66	5.35
128	CLASSROOM	739	9.00	12.00	V-1-29/AHU-2	600	5.41		1994	130	1.18	350	1	3.16	4.33
129	CLASSROOM	624	9.00	10.00	V-1-5/AHU-1	560	5.98		1994	161	1.72	350	1	3.74	5.46
130	CLASSROOM	874	9.00	14.00	V-1-30/AHU-2	1280	9.76		1994	278	2.12	350	1	2.67	4.79
131	CLASSROOM	629	9.00	14.00	V-1-4/AHU-1	560	5.94		1994	161	1.71	350	1	3.71	5.42
132	CLASSROOM	866	9.00	14.00	V-1-31/AHU-2	1280	9.85		1994	278	2.14	350	1	2.69	4.84
133	CLASSROOM	627	9.00	14.00	V-1-3/AHU-1	560	5.95		1994	161	1.71	350	1	3.72	5.43
137	CLASSROOM	997	9.00	16.00	UV (1-1)	1500		10.03	1994	375	2.51	350	1	2.34	4.85
139	CLASSROOM	985	9.00	16.00	UV (1-3)	1500		10.15	1994	375	2.54	350	1	2.37	4.91
141	SPED	562	9.00	9.00	UV (1-4)	1250		14.83	1994	375	4.45	350	1	4.15	8.60
143	CLASSROOM	550	9.00	9.00	UV (1-5)	1250		15.15	1994	375	4.55	350	1	4.24	8.79
150	CLASSROOM	796	9.00	13.00	VV-13/4-C/AHU-6	1500	12.56		2003	525	4.40	350	1	2.93	7.33
152	CLASSROOM	779	9.00	15.00	VV-12-C/AHU-6	1000	8.56		2003	350	3.00	350	1	3.00	5.99
155	CLASSROOM	730	9.00	15.00	VV-11-C/AHU-6	900	8.22		2003	315	2.88	350	1	3.20	6.07
156	CLASSROOM	955	9.00	16.00	VV-10-C/AHU-6	900	6.28		2003	315	2.20	350	1	2.44	4.64
157	CLASSROOM	733	9.00	15.00	VV-9-C/AHU-6	900	8.19		2003	315	2.86	350	1	3.18	6.05
159	CLASSROOM	743	9.00	14.00	VV-7-C/AHU-6	1000	8.97		2003	350	3.14	350	1	3.14	6.28
160	CLASSROOM	923	9.00	15.00	VV-6-C/AHU-6	1000	7.22		2003	350	2.53	350	1	2.53	5.06
200	CLASSROOM	551	9.00	11.00	AHU-4/UV-2-12	1375	16.64		1994	375	4.54	350	1	4.23	8.77
202	CLASSROOM	640	9.00	14.00	AHU-4/UV-2-13	1375	14.32		1994	375	3.91	350	1	3.65	7.55
203	CLASSROOM	841	9.00	10.00	VV-2-12/AHU-3	880	6.98		1994	206	1.63	350	1	2.77	4.41
204	CLASSROOM	626	9.00	13.00	AHU-4/UV-2-14	1375	14.64		1994	375	3.99	350	1	3.73	7.72
205	CLASSROOM	836	9.00	14.00	VV-2-11/AHU-3	880	7.02		1994	206	1.64	350	1	2.79	4.44
207	CLASSROOM	768	9.00	12.00	VV-2-10/AHU-3	880	7.64		1994	206	1.79	350	1	3.04	4.83
208	CLASSROOM	631	9.00	14.00	AHU-4/UV-2-16	1375	14.53		1994	375	3.96	350	1	3.70	7.66
210	CLASSROOM	651	9.00	14.00	AHU-4/UV-2-17	1375	14.08		1994	375	3.84	350	1	3.58	7.42
212	CLASSROOM	589	9.00	13.00	AHU-4/UV-2-18	1375	15.56		1994	375	4.24	350	1	3.96	8.21
214	CLASSROOM	1635	9.00	19.00	VV-16-17-C/AHU-5	2400	9.79		2003	864	3.52	350	1	1.43	4.95
215	CLASSROOM	417	9.00	4.00	VV-2-5/AHU-3	500	7.99		1994	117	1.87	350	1	5.60	7.47
218	CLASSROOM	795	9.00	13.00	UV (2-10)	1250		10.48	1994	375	3.14	350	1	2.94	6.08
220	CLASSROOM	781	9.00	14.00	UV (2-9)	1250		10.67	1994	375	3.20	350	1	2.99	6.19
222	CLASSROOM	777	9.00	14.00	UV (2-8)	1250		10.73	1994	375	3.22	350	1	3.00	6.22
223	CLASSROOM	751	9.00	14.00	VV-2-4/AHU-3	880	7.81		1994	206	1.83	350	1	3.11	4.94
224	CLASSROOM	783	9.00	14.00	UV (2-7)	1250		10.64	1994	375	3.19	350	1	2.98	6.17
225	CLASSROOM	837	9.00	15.00	VV-2-3/AHU-3	880	7.01		1994	206	1.64	350	1	2.79	4.43
226	CLASSROOM	785	9.00	14.00	UV (2-6)	1250		10.62	1994	375	3.18	350	1	2.97	6.16
227	CLASSROOM	856	9.00	14.00	VV-2-2/AHU-3	1400	10.90		1994	328	2.56	350	1	2.73	5.28
228	CLASSROOM	778	9.00	15.00	UV (2-5)	1250		10.71	1994	375	3.21	350	1	3.00	6.21
230	CLASSROOM	780	9.00	15.00	UV (2-4)	1250		10.68	1994	375	3.21	350	1	2.99	6.20
232	CLASSROOM	635	9.00	10.00	UV (2-2/2-1)	1500		15.75	1994	265	2.78	350	1	3.67	6.46
234	CLASSROOM	550	9.00	11.00	VV-2-15/AHU-3	800	9.70		1994	188	2.27	350	1	4.24	6.52
236	CLASSROOM	556	9.00	9.00	VV-2-14/AHU-3	800	9.59		1994	188	2.25	350	1	4.20	6.44
251	HILT	733	9.00	14.00	VV-25-C/AHU-5	1140	10.37		2003	410	3.73	350	1	3.18	6.92
252	CLASSROOM	735	9.00	15.00	VV-26-C/AHU-5	1080	9.80		2003	389	3.53	350	1	3.17	6.70
253	CLASSROOM	753	9.00	15.00	VV-24-C/AHU-5	1000	8.85		2003	360	3.19	350	1	3.10	6.29
254	CLASSROOM	948	9.00	16.00	VV-23-C/AHU-5	1000	7.03		2003	360	2.53	350	1	2.46	4.99
255	CLASSROOM	754	9.00	14.00	VV-22-C/AHU-5	1000	8.84		2003	360	3.18	350	1	3.09	6.28
257	CLASSROOM	716	9.00	13.00	VV-19-C/AHU-5	1080	10.06		2003	389	3.62	350	1	3.26	6.88
260	CLASSROOM	730	9.00	12.00	VV-17-C/AHU-5	940	8.58		2003	338	3.09	350	1	3.20	6.29
Averages:		**767.83**	**9.00**				**8.98**	**12.93**			**2.836**			**3.25**	**6.09**