Arlington Public Schools

Building Ventilation Assessment and Recommendations

September 16, 2020

CMTA

MEP Engineering | Performance Contracting | Zero Energy Engineering | Technology | Commissioning

Executive Summary

At the request of Arlington Public Schools (APS) CMTA has completed an engineering assessment of the Heating, Ventilation, and Air Conditioning (HVAC) systems in use throughout the school division to evaluate current operations and propose strategies for maximizing air quality to reduce risk and support the return of APS students to in-person learning.

The APS ventilation assessment process is based on the most current recommendations from the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE), the Harvard TH Chan School of Public Health, and the US Center for Disease Control (CDC). These institutions are recognized for setting industry standards and providing timely guidance to help school divisions, governments, and businesses safely navigate the COVID-19 pandemic.

The ventilation assessment and strategy report is part of an overall framework to help reduce COVID-19 transmission. Currently there are no "zero" risk strategies but guidelines are available to help school systems find the best path to re-open. HVAC improvements are intended to be used as part of an overall risk reduction strategy for reopening schools that includes: PPE, masks, cleaning protocols, reduced class sizes, social distancing, signage, reducing traffic in high traffic areas, touchless services, and others.

Step 1 – Assessment of Existing Ventilation

As the first step in the process APS requested that CMTA's engineers evaluate the existing condition of ventilation systems in APS facilities. This evaluation process was focused on classroom spaces in order to identify how many students (along with a teacher) the ventilation design would optimally support. CMTA evaluated ventilation systems in 38 schools, paying special attention to classrooms, by reviewing the most current electronic design documents and maintenance records for the buildings, and information from the central building automation system.

Findings

Based on APS classroom occupancy criteria, of the 1,527 classrooms reviewed, a majority of the classrooms reviewed would support the basis of design occupancy of 25 students and a teacher. The remaining classrooms were reviewed in additional detail to determine how many occupants the existing ventilation system could support. These room specific occupancy levels are based on the total occupants that can be supported by the current air ventilation rate and maintain the recommended social distancing standard. APS is using these findings to identify the best use for classrooms with lower occupancy rates and to identify ancillary means of improving ventilation and indoor air quality in these spaces. Based on this information, APS has created an in-person hybrid mode of operation and developed a Building Readiness Action plan.

Report Appendix A provides a table summarizing the classrooms that have reduced ventilation rates and occupancies along with an action plan.

Step 2 – Strategies for Improving Air Quality

After documenting the findings of the ventilation assessment, CMTA engineers evaluated possible strategies for implementing HVAC improvements in APS buildings based on the types of systems currently in use in order to improve air quality. Potential strategies are detailed in the full report and include an illustration of the concept and a list of Pro's and Con's.

Improving indoor air quality to reduce the spread of the virus and help maintain clean surfaces is a key strategy that can be incorporated into a layered defense against COVID-19. Current guidance calls primarily for three risk mitigating actions listed here by priority.

- Increase HVAC system outdoor air ventilation
- Add or increase air filtration
- Consider supplementing systems with air cleaning devices and advanced air quality systems

Harvard, SPH - Healthy Buildings HVAC Decision Tree

General Conclusions

The majority of the existing ventilation systems operating in APS buildings were generally designed in compliance with the building codes, standards, and industry best practices that were applicable at the time of their design and construction. However, older systems and some replacement systems may have limited capacity in meeting today's building code standards and some COVID-19 risk mitigation strategies.

As part of this effort APS classrooms that do not meet code level ventilation based on system type and occupancy have been identified and a revised building code compliant occupancy rate for these classrooms has been listed in Appendix A. This will allow APS to maximize the use of more ventilated classrooms and minimize the use of lower ventilated classrooms where only limited measures are available to improve air quality.

If use of these less-compatible spaces is required occupancy should be kept as low as possible and ASHRAE recommends that portable HEPA filtration units or air cleaning technologies such as UVGI (Ultraviolet Germicidal Irradiation) units or bipolar ionization systems be used.

It is recommended that the district focus resources and efforts on the following strategies in prioritized order; increasing outdoor air ventilation, improving system filtration to MERV13 or higher, and using active indoor air cleaning technology where possible.

APS is utilizing this assessment and the recommended strategies to develop and implement a Building Readiness Plan, which will include occupancy planning paired with HVAC improvements. APS will also be conducting HVAC equipment maintenance inspections and verifying system operations to ensure the best possible indoor air quality solution for students and staff.

In addition to preparing HVAC systems for reopening, plumbing systems that have been left stagnant in unused buildings should be flushed and disinfected to reduce the risk of Legionella contamination before occupants return.

It is important to note that these HVAC strategies are means to improve the air quality and reduce risk but will not prevent all possibility of virus transmission. HVAC improvements are intended to be used as part of an overall risk reduction strategy for reopening schools that includes many aspects including: PPE, masks, cleaning protocols, reduced class sizes, social distancing, signage, reducing traffic in high traffic areas, touchless services, and others.

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 future guidance from health and government experts.

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Assessment of Existing Ventilation

The APS ventilation assessment process is based on the most current recommendations from the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE), the Harvard TH Chan School of Public Health, and the US, Center for Disease Control (CDC). These institutions are recognized for setting industry standards and providing timely guidance to help school systems, governments, and business safely navigate the COVID-19 pandemic.

ASHRAE provides technical guidance for best practices for Heating, Ventilation, and Air Conditioning (HVAC) design, implementation and operations. In the Spring of 2020 ASHRAE established an Epidemic Task Force specifically to develop guidance on the operation of HVAC systems to help mitigate the spread of COVID-19. On July 22, 2020 ASHRAE published a "*Reopening Guide for Schools and Universities*". Current guidance promotes that school systems assess and verify current building ventilation rates and based on those findings make all efforts to increase ventilation levels in buildings both by volume of air and by increasing the hours that the system operates, as well as, adding or increasing filtration of the indoor air.

The ultimate goal of this effort is to improve the indoor air quality in APS schools in order to reduce potential health risks associated with the reopening of school buildings and keep students and staff as safe as possible.

As the first step in the assessment process, CMTA evaluated the design ventilation rates for most of the schools in APS facilities. Thirty-eight of APS' buildings had electronic information available for review. For these schools, the electronic drawings and the central control system were evaluated to determine the ventilation rates for 1,500 classrooms located through the facilities.

The classrooms in these buildings are conditioned and ventilated with multiple types of HVAC systems including heat pump units, roof top units, air handling units, fan coil/unit ventilators, and dedicated outside air delivery units (DOAS). The ventilation is either delivered directly to the space, as is usually the case with dedicated ventilation units, or in other systems, the ventilation is a percentage of supply air (AHUs, RTUs, Unit Ventilators). Even within the same school, many of the classroom areas are conditioned by these different types of HVAC systems.

Current building code requires ventilation requirements to be calculated based on both the size (in square feet) and the occupancy of the classroom. The owner determines typical occupancy of the classroom based on historical occupancy level. APS has determined a preferred design occupancy to be 25 students per classroom (when the classroom is over 750 SF), as documented by the current district design guidance. In smaller classrooms, the occupancy rate is based on the reduced size of the space. APS enrollment is approximately 27000 to 28,000 students, resulting in an average occupancy around 18 students per classroom.

CMTA reviewed over 1,500 classrooms, a majority of these classrooms will support the ideal design occupancy of students including the teacher. The remaining classrooms were reviewed in additional detail to determine how many occupants the existing ventilation system could support. These room specific occupancy levels are based on the total occupants that can be supported by the current air ventilation rate and maintain the recommended social distancing standard. APS is using these findings to identify the best use for classrooms with lower occupancy rates and to identify ancillary means of improving ventilation and indoor air quality in these spaces. Based on this information, APS has created an in-person hybrid mode of operation and developed a Building Readiness Action plan. This building readiness plan summarizes which schools that do not meet basis of design occupancy and is used to develop which classrooms are to be used for In-Person Hybrid Mode.

Appendix A, Table 9 – Building Readiness Action Plan provides a summary of classroom availability at the schools in the district that have lower than basis of design ventilation rates. This table summarizes the quantity of classrooms that meets either the Basis of Design (BOD) or the In-Person Hybrid Mode ventilation rates. Both occupancy types are provided in the table for comparison.

In addition, to assessing existing systems and evaluating the ventilation occupancy levels for classrooms APS has requested that CMTA advise the district on best practices for re-opening buildings. In keeping with the most current guidance from the CDC and ASHRAE next steps should include the following:

- Inspections of the HVAC systems to identify and schedule improvements as needed.
- Developing and implementing a Building Readiness Plan with HVAC strategies that include increasing ventilation, improving filtrations, and utilizing air cleaning devices.
- Maintenance and system checks to verify system operations.

Based on the results of the facility assessment and recommendations for re-opening, APS has developed a Building Readiness Action Plan for each school which is based approximate classroom sizes and the existing HVAC systems, which is summarized in Appendix A, Table 9. Furthermore, as part of the Building Readiness Action plan, APS is implementing the HVAC strategies listed in this report by improving the ventilation and filtration to the extent possible.

It is important to note that these HVAC strategies are means to improve the air quality and reduce risk but will not prevent all possibility of virus transmission. HVAC improvements are intended to be used as part of an overall risk reduction strategy for reopening schools that includes many aspects including: PPE, masks, cleaning protocols, reduced class sizes, social distancing, signage, reducing traffic in high traffic areas, touchless services, and others.

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 future guidance from health and government experts.

Recommendations for Improved Indoor Air Quality

Improving indoor air quality to reduce the spread of the virus and help maintain clean surfaces is a key strategy that can be incorporated into a layered defense against COVID-19. Current guidance calls primarily for three risk mitigating actions:

- Increase HVAC system outdoor air ventilation
- Add or increase air filtration
- Consider supplementing systems with air cleaning devices

The following sections of this report explore possible strategies for implementing HVAC improvements in APS buildings based on the types of systems currently in use and the findings of the ventilation assessment. Every potential strategy includes an illustration of the concept and a list of Pro's and Con's.

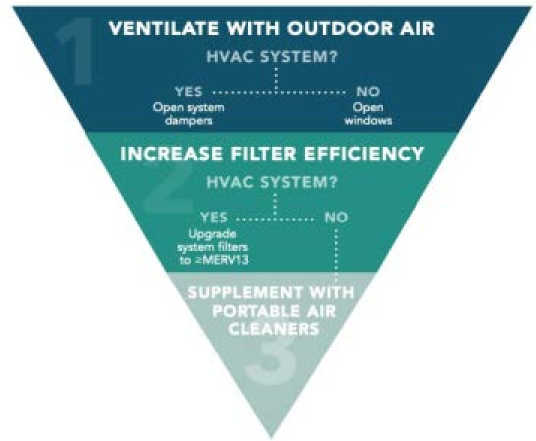


Figure 1 - Harvard Healthy Buildings HVAC Decision Tree

Increasing Outdoor Air Ventilation Rates

ASHRAE building reopening guidelines include a recommendation for increasing ventilation rates. Strategies for increasing classroom ventilation rates have been developed based on the current system type. As ventilation is increased the units heating and cooling capacity is affected. If ventilation is increased too far, the system will not be able to provide adequate cooling, heating, or dehumidification of the space. The ASHRAE guidelines advise increasing ventilation in the space as much as possible without compromising basic thermal comfort levels (ASHRAE Standard 55). The recommended space temperatures are 70 F (winter) and 74 F (summer) with a relative humidity range of 50% to 60% during summer air conditioning operations.

The intent of increased ventilation is to expel indoor air pollutants through an increased supply of fresh out door air.

The following strategies have been developed to address current HVAC types found in APS classroom spaces.

Strategy #1 – Adjusting HVAC Control Sequences to Increased Ventilation Mode

Increasing ventilation time could be accomplished by modifying the controls for central air handling units (AHUs), Roof top units, multizone units, and dedicated outside air systems (DOAS). For buildings that are capable of incorporating an increase in ventilation timeframe, it would be recommended that a control sequence for "INCREASED VENTILATION MODE" be created to allow the central control system operator to easily activate and deactivate these modes of operation.

A Building Flush with outside air ventilation provided from both AHU and DOAS units is recommended before and after occupancy. Steps include:

- "INCREASED VENTILATION MODE"- The building HVAC schedule shall be extended 2 hours before and after occupancy. APS has already implemented this step.
- Ventilation shall be provided during the increased time schedule.
- Exhaust fans shall be on.
- Unoccupied space temperatures shall remain on the optimal start schedule.

- Building with AHUs shall enter occupied setpoints 2 hours before in cooling mode to encourage increased airflow prior to occupancy.

If any system equipment has limited capacity to support a Building Flush immediately before and after occupancy, as described above, the following steps are recommended:

- The building flush could occur at night when the outdoor air temperatures are typically cooler and allowing larger percentages of ventilation
- Continue to operate the equipment with the “INCREASED VENTILATION MODE”- The cooling system should be controlled and the unit outside air, return air and relief air dampers shall modulate to maximize the outside air while maintaining discharge air temperature setpoint of 55°F to 60°F (adj.).

The diagrams below are showing ventilating during occupied and unoccupied hours and represent a Building Flush to remove contaminates from indoor spaces by bringing in a high volume of fresh outdoor air and circulating it through the spaces.

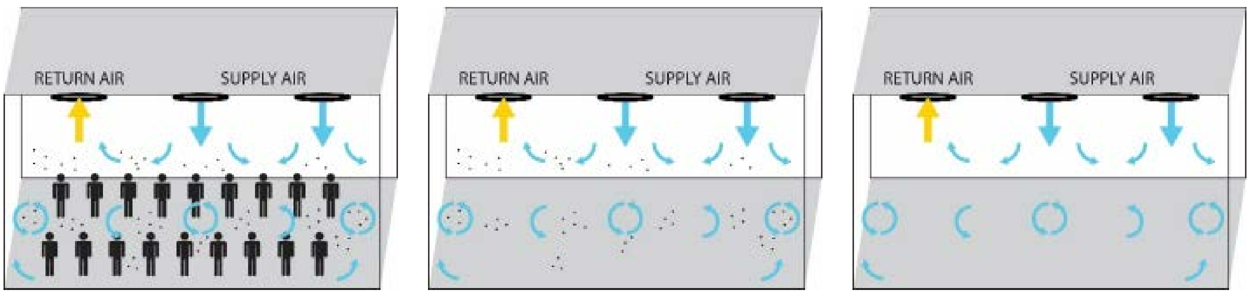


Figure 2 – Building Flush to remove contaminates from indoor space

Table 3 below provides a comparison of the positive and negative results of implementing this strategy.

Table 1 - Increased Ventilation Mode-Building Flush Pro's and Con's

Pro’s	Con’s
▪ Primary ASHRAE Recommendation ▪ Included in Harvard Risk reduction strategies for reopening schools ▪ Included in CDC recommendation to verify proper ventilation. ▪ Can utilize existing equipment	▪ First costs associated with programming changes to the DDC system. ▪ The Building Flush is anticipated to add to the overall building energy costs. ▪ Minimal wear and tear will increase maintenance and reduce system life for the air handling systems, along with heating and cooling equipment. ▪ Limited capacity of the equipment to provide conditioning with a 100% outside air for flushing. Therefore, care must be taken to reduce the potential for increased space humidity which can cause IAQ issues (mold, sagging ceiling tile, condensation). ▪ Requires user intervention to control units for the extended hours or control scheduling for times when weather is permitting.

Strategy #2 – Adjusting CO2 Sensors to allow for Increased Ventilation

Some buildings may utilize demand control ventilation, where the ventilation system is controlled by space CO2 sensors intended to reduce ventilation and energy costs when spaces are not occupied or fewer people are in the area. To increase ventilation the demand control CO2 sensors should be turned off. The following steps are recommended:

- Ideally the CO2 setpoint in the spaces would be set to equal the outdoor air CO2 but with sensor calibration this may not the feasible.
- During "INCREASED VENTILATION MODE"- The space CO2 setpoint could be reset to a lower value (200 PPM or less then outdoor air CO2) which would basically require full ventilation airflow to the space.
- Systems with high levels of diversity: the system capacity will not allow the reduction to low PPM goals. Goal is to have the DOAS fan at 100% to achieve the largest number of air changes. If maintaining duct static and the fan is not 100% then increase airflow to zones with the highest CO2 levels until the fan capacity is maximized.

Figure 3 below illustrates the operation of a CO2 sensor controlling ventilation rates. Common CO2 sensor settings that ensure indoor air does not go over the code maximum of 1200 Parts per Million (PPM) still will not reduce CO2 levels to the common outdoor range of 400 to 450 PPM even when room occupancy is as low as 50%. For this reason, recommendations call for turning the sensors off since during the current crisis increased building air flow is prioritized over energy cost savings.

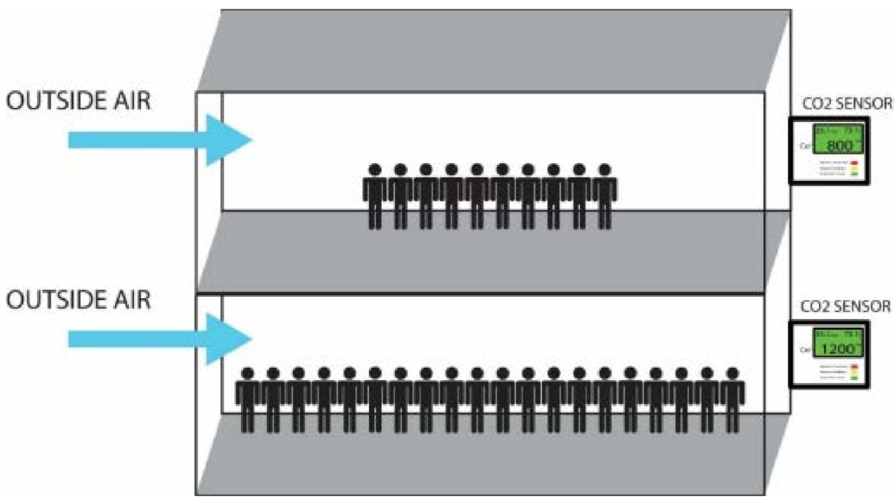


Figure 3 - CO2 Sensor Controlled Airflow

Table 2 below provides a comparison of the positive and negative results of implementing this strategy.

Table 2 - Adjusting CO2 Sensors Pro's and Con's

Pro's	Con's
▪ ASHRAE recommended ▪ Included in Harvard Risk reduction strategies for reopening schools ▪ Can utilize existing equipment	▪ First costs associated with programming changes to the DDC system. ▪ The building flush is anticipated to add to overall building energy costs.

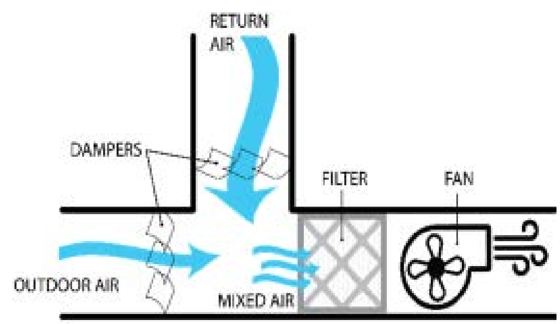
Pro's	Con's
	▪ The ventilation system operating at full airflow constantly is anticipated to add to the overall building energy costs. ▪ Minimal wear and tear will increase maintenance and reduce system life for the air handling systems, along with heating and cooling equipment.

Strategy #3 – Increasing Outdoor Air Intake

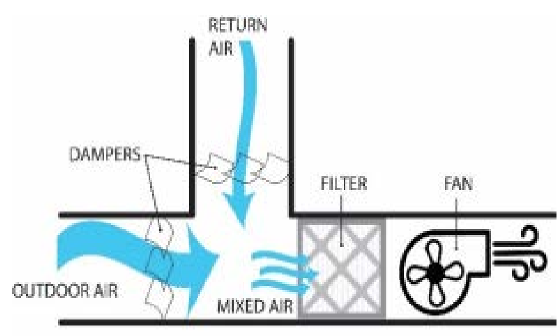
Increased intake of outdoor air into the HVAC system can be utilized temporarily when coupled with reduced occupancy. Reducing the occupancy allows for additional ventilation per person, which allows for a reduced load on the cooling equipment. At this time ASHRAE recommends prioritizing increased outside air over concerns about indoor humidity, as long as the indoor air humidity can be maintained in the range of 40%-60%. Steps for this strategy include:

– "INCREASED VENTILATION MODE"- The cooling system should be controlled and the unit outside air, return air and relief air dampers shall modulate to maximize the outside air while maintaining a discharge air temperature setpoint of 55°F-60°F (adj.).
– Revise the economizer sequences to compare the outside air to the return air to enable economizer sooner and longer. Open the outside air damper to the maximum position that allows the unit to maintain discharge air temperature setpoint.
– Note when the outdoor air temperature is equal to or less than the return air temperature and the outdoor enthalpy is 27 BTU/lb or less than, the unit can enter economizer mode with minimal impact on cooling system capacity.

The illustration in Figure 4 is a diagram showing the typical operation of the heating and air conditioning system that brings less outside air and more return air compared with a system running with increased outside air and reduced the return air for increased ventilation.



Typical Operations



Increased Outside Air

Figure 4 - Increased Outdoor Air Intake

Table 3 below provides a comparison of the positive and negative results of implementing this strategy.

Table 3 - Increasing Outdoor Air Intake Pro's and Con's

Pro's	Con's
▪ Can utilize existing equipment ▪ Utilize economizer strategies sooner to increase ventilation ▪ Preferred ASHRAE Recommendation ▪ Included in the IWBI (International Well Building Institute) strategy for improved air quality	▪ First costs associated with programming changes to the DDC system. ▪ Limited to the capacity of the cooling coil to provide increased ventilation and not introduce humid air into the building ▪ Depending on the ability to implements anticipate an increase in the overall building energy costs. ▪ Minimal wear and tear will increase maintenance and reduce system life for the air handling systems, along with heating and cooling equipment.

Strategy #4 – Constant Use of Exhaust Systems

Building exhaust systems are an integral part to the overall ventilation system. Many spaces in schools, such as restrooms and janitors' closets, require exhaust. In response to COVID-19 it is recommended that exhaust fans be run 24 hours a day or to the maximum extent possible to help flush air out of the building. Exhaust fans controlled by local switches should be switched on to run continuously. During these operations humidity levels should be monitored. If excessive relative humidity levels result, outside the range of 50% to 60% during summer, then exhaust systems can be turned off until conditions improve or weather allows.

Exhaust fans should run in conjunction with the ventilation systems, on the same continuous schedule. This includes the systems in all restrooms, janitors' closets, kitchenettes, and similar spaces.

Table 4 - Constant Use of Exhaust System Pro's and Con's

Pro's	Con's
▪ ASHRAE recommended ▪ Included in Harvard Risk reduction strategies for reopening schools ▪ Can utilize existing equipment	▪ Running exhaust systems at full airflow constantly is anticipated to add to the overall building energy costs. ▪ Minimal wear and tear will increase maintenance and reduce system life for the exhaust systems.

Strategy #5 – For Buildings without Central HVAC systems – Open Windows

The guidelines for opening buildings include decisions trees for improving building ventilation to mitigate COVID-19 risks. If a building does not have adequate or centralized mechanical ventilation then opening windows and using window fans to promote airflow through the building are recommended.

Table 5 - Open Window Pro's and Con's

Pro's	Con's
▪ ASHRAE recommended ▪ Included in Harvard Risk reduction strategies for reopening schools ▪ Inexpensive	▪ Weather implications. ▪ Heat and cold cannot be controlled while also increasing ventilation.

Increasing Indoor Air Filtration

Indoor air filtration can reduce risk of viral transmission by removing particles from any air that is recirculated within a building.

MERV ratings, developed by ASHRAE, indicate the percentage of particles and the sizes of particles that filters can remove from air passing through them

Strategy #1 – Increasing Centralized Air Filters

The target filtration level recommended for building central HVAC systems is MERV13 or higher. MERV 13 filters are rated to capture 50 percent of small particles (0.3 to 1 micron), 85% of medium particles (1 to 3 microns), and 90 percent of large particles (3 to 10 microns).

The diagram in Figure 6 show typical filter arrangement. Figure 7 illustrates efficiency comparison of MERV filters. While the SARS-CoV-2 virus (the virus responsible for COVID-19) is less than 0.3 microns, the virus is usually suspended in water droplets, which are of a larger size that can be caught by high efficiency filters. MERV 13 filters are readily available in 2-inch pleated media sizes. HVAC units commonly come with 2-inch or thicker filter banks that are capable of accommodating MERV 13 filters. The clean pressure drop of a MERV 11, 2-inch pleated filter is approximately 0.2 inches of water column while the pressure drop of MERV 13, 2-inch pleated filter is approximately 0.3 inches of water column. Filters are recommended to be replaced at approximately 1- inch of static pressure. The main impact of upgrading to MERV 13 filters is that they start at a higher pressure drop and will achieve -inch of static pressure sooner; the MERV 13 filter is more efficient; therefore, it will collect more particles and reach the final (dirty) resistance sooner. This strategy would require the following steps:

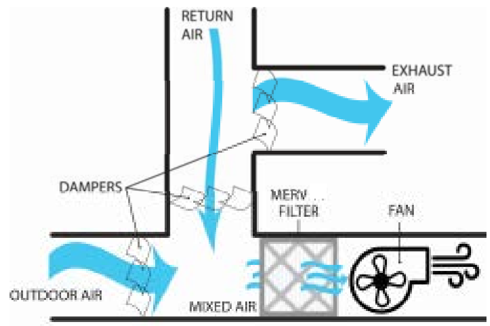


Figure 5 – MERV Filter

- Changing the filters in the central air handling units (AHUs), space level air conditioning units (for example, heat pumps), and dedicated outside air systems (DOAS) to a minimum of MERV 13 or highest MERV rated filter compatible with the existing filter rack and the seal edges of the filter, which limit air from bypassing the filter.
- Making sure the air handling systems and fans can overcome the additional pressure drop of the new filters and still maintain air flow at acceptable levels.

Figure 6 – MERV Filter Efficiency Curve

Increased filtration, higher MERV rated filters, can be used temporarily, or in some cases permanently when coupled with reduced occupancy, allowing the systems fans to operate at lower speeds to reduce strain on the system. The use of higher efficiency filtration needs to be reviewed, case by case, for each unit type. Every system has different operating characteristic and filter system designs that need to be investigated to determine the best method for increasing filtration while maintaining the fan systems.

Another potential issues with increased filtration is reduced cooling airflow to rooms. School buildings are typically designed and maintained at a temperature range of 74F-76F in the summer months. This is on the low end of ASHRAE thermal comfort recommendations and temperatures can be allowed to rise to 78F while still meeting thermal comfort parameters as shown in Figure 8. This means that a higher room temperatures might need to be considered acceptable in order to achieve the overall goal to increase the percentage of outside air to the air handling unit and better filter the return air prior to returning to the space.

Table 6 below compares the pro's and con's of increasing filtration levels.

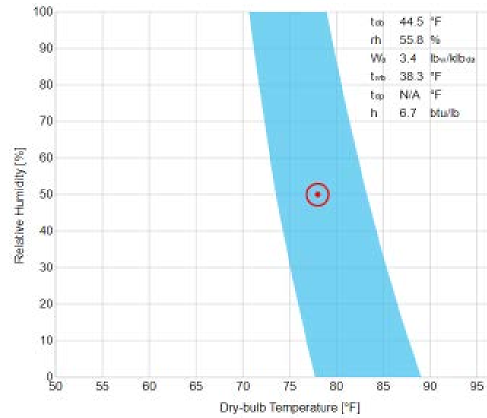


Figure 7 – Temperature and Thermal Comfort

Table 6 - Increased Filtration Pro's and Con's

Pro's	Con's
▪ ASHRAE Recommended ▪ Included in Harvard Risk reduction strategies for reopening schools ▪ Air handling equipment is typically selected for 1" dirty filter pressure drop. Utilizing a MERV 13 with an initial pressure drop of 0.27" or MERV 14 at 0.31" can be utilized for many HVAC air handling units and potentially heat pumps.	▪ Increased maintenance for filter replacement during an event due to better capture and increased pressure drop. ▪ Increase filter costs ▪ Higher MERV rating filters, should anticipate a minor increase in overall building energy costs. ▪ Maintenance Procedures for changing to protect the person serving the equipment.

Strategy#2 –For Buildings without Central HVAC systems – Portable HEPA Filters

If central system filtration is not possible in some buildings or spaces, which could be the case with unit ventilators or small unitary HVAC equipment serving individual spaces, then building filtration should be provided or supplemented with portable air cleaners which utilize HEPA filters.

Table 7 - Portable HEPA Filter Pro's and Con's

Pro's	Con's
▪ Portable HEPA Efficiency. Efficiency is simply the percentage of particles that are removed by the filter. The Department of Energy (DOE)has a technical definition for HEPA that defines it as removing 99.97% (efficiency) of particles sized at 0.3 microns. ▪ ASHRAE Recommendation ▪ Can be utilized in areas where central IAQ strategies are not available.	▪ Effectiveness based on space and location installed. ▪ Could be noisy. ▪ Increase filter costs ▪ Increased energy costs ▪ Potentially a limited resource to obtain.

Advanced Air Quality Improvement Systems

There are additional more advanced techniques for improving air quality that can be considered when opportunity is available and the conditions are right. Installing air cleaning technologies such as bipolar ionization or ultraviolet light (UV-C) systems can be considered as supplementary measures when feasible. These air cleaning technologies have a similar effect in that they can potentially reduce the virus present in recirculating air.

Strategy #1 – Ultraviolet Light Systems

Ultraviolet germicidal irradiation (UVGI) systems using ultraviolet light have been shown to eliminate coronaviruses with the appropriate intensity and exposure time. Usually this technology is used in the supply air ducts, to focus the technology on recirculating air and prevent the building occupants from being exposed to UV light. UV lights also reduce bacteria build up in the air handling equipment. However, to be effective there must be adequate exposure time between the virus and UV-C, which is challenging in a system with constantly moving air. It is impossible to ensure that UV-C lights in HVAC equipment are removing all virus.

Strategy #2 – Bipolar Ionization Systems

There is a lot of discussion in the industry about bipolar ionization technology and ASHRAE has identified its possibility to improve indoor air quality. Recent studies suggest this technology can reduce coronavirus, with one manufacturer actually publishing test data which shows an impact on SARS-CoV2, the COVID-19 virus; however, there is no definitive recommendation for using bi-polar ionization specifically for COVID-19 at this time.

Table 8 - Advanced Air Quality System Pro's and Con's

Pro's	Con's
▪ Improves indoor air quality. ▪ Can be utilized in areas where central IAQ strategies are not available. ▪ Can be used in systems where filtration options are limited. ▪ Some test result indicates effective at inactivating viruses located on surfaces.	▪ Effectiveness based on unit and space installed. ▪ Increase in first costs to install. ▪ Requires careful consideration in type to prevent creating Ozone in the space. ▪ Care must be taken with UV treatment to avoid harmful effects to people and equipment. ▪ Bipolar ionization has not been fully proven effective.

References

ASHRAE

- ASHRAE COVID-19, Response Resources: https://www.ashrae.org/technical-resources/resources
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- COVID-19 Response: https://www.hsph.harvard.edu/coronavirus/
- Risk reduction strategies for reopening schools: https://schools.forhealth.org/risk-reduction-strategies-for-reopening-schools/

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- Operating Schools during COVID-19: https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/schools.html

Appendix A

APS has developed the following Action Plan for each school location based approximate classroom sizes and existing HVAC systems.

Table 9 - Building Readiness Action Plan

	Number of Classrooms Meeting Ventilation Occupancy			
School	**BOD** (25 Students)	**In-Person Hybrid Mode**	**Approximate Classroom Size (SF)**	**Action Plan**
Abingdon	19 of 35	35 of 35	900	Review for full in-person; confirm classrooms and make adjustments
Arlington Traditional	17 of 23	23 of 23	850	Review for full in-person; confirm classrooms and make adjustments
Arlington Traditional	21 of 23	23 of 23	1000-1200	Review for full in-person; confirm classrooms and make adjustments
Ashlawn	20 of 37	37 of 37	900	Review for full in-person; confirm classrooms and make adjustments
Barcroft	1 of 22	19 of 22	825	Evaluate, adjust and upgrade controls or equipment
Dorothy Hamm	12 of 46	46 of 46	700-1000	Review for full in-person; request design engineer review
Drew	22 of 32	32 of 32	800-1000	Review for full in-person; review main equipment and make adjustments
Drew	31 of 32	31 of 32	800	Evaluate, adjust and upgrade equipment where needed
Gunston	35 of 66	66 of 66	750-1000	For full in-person, request design engineer review; evaluate, adjust and upgrade equipment
Jamestown	11 of 35	11 of 35	800	In field evaluation; adjust and upgrade equipment
Montesorri Public School	15 of 20	15 of 20	900	In field evaluation; adjust and upgrade equipment
Montesorri Public School	15 of 20	20 of 20	900	Review for full in-person; in field evaluation; adjust and upgrade equipment
Montesorri Public School	15 of 20	15 of 20	450	In field evaluation; adjust and upgrade equipment
Oakridge	33 of 34	34 of 34	785	Review for full in-person; identify room, in field evaluation; adjust and upgrade equipment
Oakridge	33 of 34	33 of 34	600	Identify room, in field evaluation; adjust and upgrade equipment
Swanson	43 of 63	43 of 63	725	In field evaluation by 3rd party engineer; adjust and upgrade equipment
Taylor	12 of 36	36 of 36	600-1000	Review for full in-person; in field evaluation; adjust and upgrade equipment
Thomas Jefferson	41 of 49	41 of 49	600	In field evaluation by 3rd party engineer; adjust and upgrade equipment
Thomas Jefferson	11 of 49	11 of 49	700	In field evaluation by 3rd party engineer; adjust and upgrade equipment
Wakefield	31 of 106	106 of 106	900	Review for full in-person; In field evaluation by design engineer; adjust and upgrade equipment

	Number of Classrooms Meeting Ventilation Occupancy			
School	**BOD** (25 Students)	**In-Person Hybrid Mode**	**Approximate Classroom Size (SF)**	**Action Plan**
Washington-Liberty	76 of 90	76 of 90	800	In field evaluation by 3rd party engineer; evaluate, adjust and upgrade if needed
Washington-Liberty	26 of 90	90 of 90	800	Review for full in-person; in field evaluation by 3rd party engineer; evaluate, adjust and upgrade if needed
Williamsburg	9 of 51	38 of 51	700-1000	In field evaluation; adjust and upgrade equipment