Worcester Public Schools

Ventilation Assessment
&
COVID-19
Mitigation Strategies

for

University Park Campus / Freemont Street
Worcester, MA

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<u>Prepared by</u>:

Nault Architects Inc
71 Hope Ave
Worcester, MA 10603

Seaman Engineering Corporation
22 West St, Unit C
Milbury, MA 01527

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Worcester Public Schools

A. Preface:

Worcester Public School has as Nault Architects Inc. and their consultant Seaman Engineering Corporation (SEC) to review all of their occupied buildings and comment on existing natural and mechanical ventilation.

The first part of the report is SEC's evaluation of the existing mechanical systems.

The second part of the report is an evaluation of the natural ventilation. The Building Code requires ventilation of each occupied space and that can be achieved either through mechanical of natural ventilation methods. If the natural ventilation path is chosen, there must be a clear opening(s) in the space that meet or exceed the 4% of the total room square footage. After the field survey of each room / window type was complete, the ventilation information was added to a spread sheet for calculation of the 4% and color-coding. The calculations were also color-coded on a floor plans of the building for a better overall understanding of the existing conditions.

The natural ventilation color-coding (on the spreadsheet and plans) is as follows:

- **Green Spaces**: meets or exceed the code minimum natural ventilation.
- **Yellow Spaces**: does **not** meet the code minimum natural ventilation, but does have operable window to allow some natural ventilation.
- **Red Spaces**: does not meet the code minimum natural ventilation and does not have any operable windows.

It should be reiterated that the second part of this report is only measuring natural ventilation. Therefore, newer buildings or buildings with large amounts of fixed windows may have large amounts of red and/or yellow spaces, but that doesn't mean they are not code compliant, they may be relying on mechanical ventilation. However, for this part of the report, were asked to show a baseline for all schools without mechanical equipment.

B. Building Description:

University Park Campus / Freemont School:

University Park Campus / Freemont School located in the South Quadrant of Worcester at 12 Freeland Street. The school was built in 1910, houses grades 7-12, has 12 classrooms and the building is 25,169 square feet. The windows in this building have been replaced.

C. Table of Contents:

1) Mechanical Ventilation Report

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I. EXECUTIVE SUMMARY

This report briefly describes the existing ventilation systems at the University Park Campus School in Worcester, MA as well as their capabilities to support current code required ventilation rates. In addition, we have evaluated the systems ability to support recommendations in accordance with the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) Epidemic Task Force Building Readiness Guidelines (updated 10-20-2020). Several of the ASHRAE recommendations as well as those from the Harvard T.H. Chan School of Public Health and other industry sources have been presented for consideration to assist in further mitigating virus transmission through the buildings heating, ventilation, and air conditioning (HVAC) systems.

Our inspection of the existing systems was limited to visual observations coupled with review of original design drawings, when available. The findings presented in this report presume the systems are operational and delivering air quantities indicated on the original design drawings, if available. Proper operational testing of each piece of equipment and airflow measuring would be required to confirm such operation.

During, our visual inspection we also took several spot measurements of air quality in various locations throughout the school. Measurements taken were limited to Temperature (°F), Relative Humidity (% RH), CO_2 (carbon dioxide in ppm), CH_2O (formaldehyde in ppm) and Total Volatile Organic Compounds (TVOC in ppm).

The results of the readings taken during our inspection were only used to identify areas where possible ventilation issues may exist and/or to identify areas where a source contaminant may be causing elevated levels.

COVID-19 Control Measures:

In line with the current American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) Epidemic Task Force Building Readiness Guidelines (updated 10-20-2020) and those from the Harvard T.H. Chan School of Public Health - 5-Step Guide to Checking Ventilation Rates in Classrooms, as well as other industry recommendations the following HVAC COVID Control Measures (CCM's) are presented for consideration to assist in mitigating virus transmission thru the HVAC systems. The following descriptions are abbreviated with additional detail found later within the report.

As of the writing of this report, the City of Worcester Public Schools (WPS) has already begun implementation of several of the measures noted below where possible. For enhanced measures WPS has begun to incorporate Bipolar Ionization (see ECCM-#3) extensively throughout the University Park Campus School to address the current pandemic condition.

<u>CCM #1 – Pre & Post Purge Ventilation</u> – Pre- and post-purge ventilation of occupiable spaces using outside air introduced thru the HVAC systems for an extended period of time prior to and after occupancy.

Most of the building areas have ventilation limited to operable windows and an old ventilation shaft system which does not appear to be operational. As such, the systems, or lack thereof, are not currently capable of implementing this measure. However, there was a relatively new ventilation unit in the boiler room that appears to be serving a nearby science room. Further review of the design of this system to ascertain its purpose and capabilities would be recommended.

CCM #2 – Increased Ventilation - Increase the quantity of outdoor air ventilation for improved space dilution where systems allow. Disable demand ventilation reset. The Harvard T.H. Chan School of Public Health identifies 3 outdoor air changes per hour (ACH) as the "bare minimum" during a pandemic condition.

Most of the building areas have ventilation limited to operable windows and an old ventilation shaft system which does not appear to be operational. As such, the systems, or lack thereof, are not currently capable of implementing this measure. However, there was a relatively new ventilation unit in the boiler room that appears to be serving a nearby science room. Further review of the design of this system to ascertain its purpose and capabilities would be recommended

CCM #3 – Improved Filtration - Improve filtration to up to MERV-13 or higher on recirculating air handling systems which can support such filtration.

The old ventilation shaft system which does not appear to be operational. As such, this system is not currently capable of implementing this measure. However, there was a relatively new ventilation unit in the boiler room that appears to be serving a nearby science room. Further review of the design of this system to ascertain its purpose and capabilities would be recommended

In addition to the above suggested measures, we have also presented Enhanced HVAC COVID-19 Control Measures (ECCM) which could be considered for implementation. Where the above CCM's cannot be employed, one or more of the ECCM measures outlined herein may be utilized to improve indoor air quality. The following descriptions are abbreviated with additional detail found later within the report:

ECCM #1: Portable Room Purifiers - Portable room air purifiers may be used in select areas to help clean the air within that space. These can be especially helpful where rooms have low outdoor air changes per hour and cannot be supplied with additional outdoor air or where existing systems cannot accommodate improved filtration.

ECCM #2: UV-C Light Sterilization - UV-C lights may be considered for insertion in equipment and ductwork to help neutralize viruses as it is exposed to the light.

ECCM #3: Bipolar Ionization - Air ionizers may be installed in air handling systems or portable units installed in rooms to improve indoor air quality. These systems cause particles and airborne contaminants to bind together thereby increasing their size, so they tend to either drop out of the breathing zone or be better removed by air filtration. Recent studies have also shown Bipolar Ionization may inhibit the COVID-19 viruses' ability to infect.

WPS has begun to incorporate Bipolar Ionization extensively throughout the University Park Campus School to address the current pandemic condition.

Recommendations Summary:

Based on our site inspections, sample air quality readings and review of original drawings we found that a majority of the occupied areas of the University Park Campus School do not comply with current ventilation codes. However, in order to address the pandemic level conditions currently in place the following table summarizes our recommendations, several of which, align with the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) Epidemic Task Force Building Readiness Guidelines (updated 10-20-2020) as well as those from the Harvard T.H. Chan School of Public Health.

WPS has already begun to incorporate Bipolar Ionization (ECCM-#3) extensively throughout the University Park Campus School to address the current pandemic condition.

Space	Exist. O.A. Vent. Systems	Recommendations
General Classrooms & Other Areas	None	ECCM - #1 or #3 (*see note below) Verify science room ventilation as exhaust and vent is required.

*<u>Note</u>: *For individual classrooms and other areas noted, ECCM #1 – Portable Air Filtration and/or ECCM #3 – Ionization, are noted as possible options to improve air cleaning and changeover during pandemic conditions. Regardless, we highly recommend outdoor air of some level be provided in areas having none, even if via windows, as there is no substitute for proper ventilation.*

Inevitably, during a pandemic, the best approach is a multi-faceted one which should include the above HVAC strategies as well as proper housekeeping (cleaning of spaces and surfaces), occupant actions (hand cleaning, wearing masks, social distancing, following recommended CDC guidelines) and other mitigation strategies.

II. HVAC VENTILATION ASSESSMENT

A. GENERAL

Over the last several weeks we performed site inspections of the existing school building to assess the ventilation systems in place. Manufacturer and model information was obtained from the existing ventilation equipment, when available/accessible, and visual conditions were noted.

For our review, when available, original design drawings as well as drawings of various modifications over the years for the school were received from school facilities. In addition, we have also received and reviewed the available HVAC control drawings to ascertain current control configuration. Unfortunately, for the University Park Campus School, although there were some limited control drawings, there were no existing HV plans for review so as to compare them to current ventilation codes and standards.

Our inspection was limited to visual assessment of systems and did not include operational testing of each piece of equipment or airflow measuring. We have however, taken some spot measurements of air quality in various locations throughout the school. Measurements taken were limited to:

- Temperature (°F)
- Relative Humidity (% RH)
- CO_2 (carbon dioxide in ppm)
- CH_2O (formaldehyde in ppm)
- Total Volatile Organic Compounds (TVOC in ppm)

These readings were taken at a specific moment in time and may vary during the day based on space occupancy, use and activities as well as the operational state of the HVAC systems. For example, most all spaces surveyed were unoccupied or very lightly occupied and as such most all CO_2 levels were low since space CO_2 is primarily generated by occupants.

TVOC's sources can vary widely and include but are not limited to paints, finishes, adhesives, cigarette smoke, pesticides, personal care products, car exhaust, new furnishings, wall coverings, cleansers, and cooking fuels. The meter used included the following chemicals in its TVOC analysis: Acetone, Ethylene Glycol, Formaldehyde, Xylene, 1,3-Butadiene, Tetrachloroethene, Hydrogen Sulfide, Ammonia, Toluene, Benzene, Methylene Chloride, Perchloroethylene, and MTBE. The meter cannot read every possible VOC nor quantify percentages of various VOC's. In addition, we did notice the TVOC readings tended to drift up during the study, possibly due to a calibration issue, as such, the readings in this report were only used to identify areas where possible ventilation issues may exist and/or to identify areas where a source contaminant may be causing elevated levels.

The report ventilation calculations presume, the existing systems are operating to the levels reflected on the original design drawings. Testing and Balancing by a certified balancer would be required to confirm actual airflows.

For ventilation calculations, data from current codes including the International Mechanical Code (IMC) 2015 and ASHRAE 62.1-Ventilation for Acceptable Indoor Air Quality were used. The outdoor airflow values have been corrected to adjust for the distribution systems ability to get the outdoor air to the space breathing zone with the breathing zone being within 6 feet of the occupied floor. This correction factor also known as the Zone Air Distribution Effectiveness (ZDE), varies based on how and where the air is introduced and removed from the room as well as the temperature of the air entering the room. Some examples of ZDE for various systems are as follows:

Distribution Configuration	ZDE
Ceiling supply of cool air (air below room temp.)	1.0
Ceiling supply of warm air & floor return	1.0
Clg. supply of warm Air >15F above space temp. & clg. return	0.8
Floor supply of warm air & floor return	1.0
Floor supply of warm air & ceiling return	0.7
Displacement cooling floor supply & ceiling return	1.2

For example, a displacement cooling system with a ZDE of 1.2 would require 17% (1.0 / 1.2) less outside air to properly ventilate a space than a system with warm air supplied at the ceiling level being that the displacement system is more effective in getting the outdoor air into the breathing zone. A room with a ZDE of 0.8 would require 25% (1.0 / 0.8) more outdoor air to comply with ventilation standards.

This report contains a brief description of the types of ventilation systems serving the building as well as makes recommendations, where applicable, to improve ventilation of area served by these systems. Our evaluation considered the recommendations made by the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) Epidemic Task Force Building Readiness Guidelines (updated 10-20-2020) as well as those from the Harvard T.H. Chan School of Public Health and other industry sources. All to assist in further mitigating virus transmission through the buildings heating, ventilation, and air conditioning (HVAC) systems.

B. EVALUATION

The following evaluation is based on visual observation of systems and equipment and excludes any operational testing which we understand is on-going by WPS. Evaluation includes information obtained from Worcester Public Schools on current air filters as well as existing building mechanical plans when available. In some cases, equipment was not accessible, and assessment was based only on original design drawings where available.

General Classrooms & Misc. Areas:

A majority of the classrooms in the building are heated with steam radiators. Ventilation is limited to a gravity ventilation shaft system which appears to no longer be active as well as what can be afforded via operable windows.

For a standard classroom, current code would require 10 CFM per person of outside air plus 0.12 CFM per SF. For a system with a presumed zone air distribution effectiveness of 1.0, a room size of 900 SF with 26 occupants (25 students + 1 teacher) would require 368 CFM of outdoor air (460 CFM if ZDE = 0.8).

Science Rooms:

There is a science room in the building as confirmed by a fume hood located within the room. Per the current code, science rooms require higher ventilation levels than general use classrooms with a driving factor being required exhaust air. For science laboratories 1 CFM per SF of exhaust is required along with the associated make-up air. If a room were dedicated to one of these uses, these ventilation levels would apply. There is an existing fume hood which is vented to an unknow location.

The boiler room has a ventilation unit which appears to service the science room and may be related to the hood exhaust as well. Further review of this configuration would be recommended to verify design intent as no existing design drawings are available.

Controls:

No control drawings were made available to us for review and as such we cannot comment on how systems are currently controlled.

C. IAQ & Ventilation Summary

IAQ Summary:

During our inspection we obtained spot measurements of air quality in various locations throughout the school. Measurements taken were limited to:

- Temperature (°F)
- Relative Humidity (% RH)
- CO_2 (carbon dioxide in ppm)
- CH_2O (formaldehyde in ppm)
- Total Volatile Organic Compounds (TVOC in ppm)

The readings were taken at a specific moment in time and may vary during the day based on space occupancy, use and activities as well as the operational state of the HVAC systems. For example, most all spaces surveyed were unoccupied or very lightly occupied and as such most all CO_2 levels were low since space CO_2 is primarily generated by occupants.

In addition, we noted some elevated TVOC levels and/or formaldehyde levels in areas which would not generally be expected to have such elevated levels. Although TVOC's (which includes formaldehyde) may come from varied sources such as cleaners, air fresheners and such, formaldehyde levels are often from off-gassing of furnishings or building materials. It is important to note that elevated levels of TVOC's may have been partially caused by recent enhanced cleaning measures or due to ventilation systems that were not in full operation at the time.

Measurements taken included space humidity. Humidity levels has been found to play a role in the controlling the spread of COVID-19. ASHRAE recommends winter humidity levels be kept between 40% to 50% and summer humidity levels between 50% and 60% with a summer target of 50%. Maintaining humidity levels within the above ranges has been found to limit the growth and transmission of certain bacteria and viruses as well as supports respiratory function. The below chart is taken from the 2020 ASHRAE Handbook – HVAC Systems and Equipment and reflects the impact of space humidity on the increase or decrease of effect on various space contaminants. This chart only reflects increase or decrease of effect from humidity and does not intend to imply that there is zero growth or impact of a certain contaminant when the sloped bar graph zero's out.

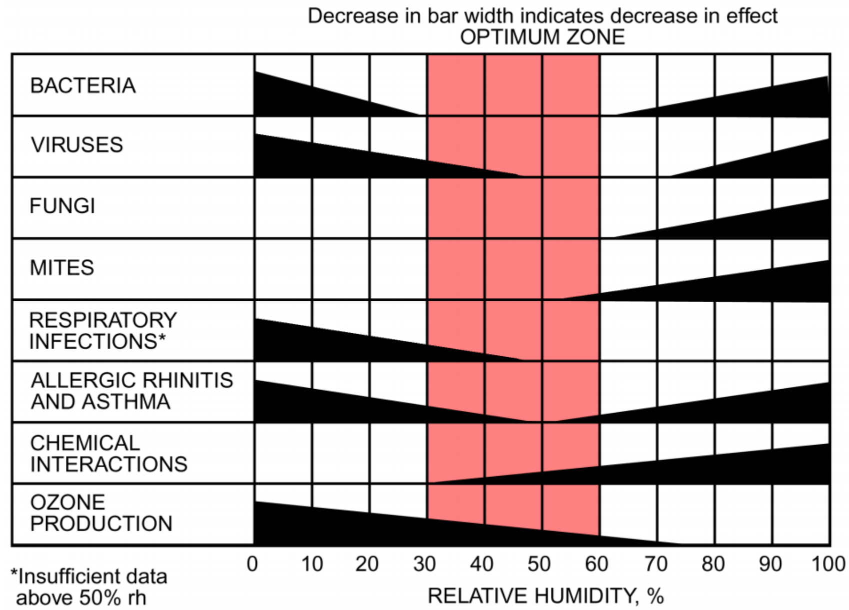

Fig. 1 Optimum Humidity Range for Human Comfort and Health
(Adapted from Sterling et al. 1985)

The University Park Campus School HVAC systems have no active humidity control. Space dehumidification is limited only to those areas which have air conditioning cooling. However, this dehumidification is not actively controlled by a humidity setpoint. Moisture removal only occurs when these systems are operating in the cooling mode. As such, space humidity may climb above 60% during periods when low thermal loads require less cooling (i.e., a cool damp day) or swing above and below 60% as the systems cycle based on space temperature.

Caution must be taken when considering adding active humidification to existing buildings as it is imperative that the buildings thermal envelope and vapor barriers be reviewed. Older structures, such as University Park Campus School often have poor vapor barrier the varying wall and window construction and thermal characteristics may limit the ability for active humidification. Adding humidity in the wintertime without consideration of the building construction could result in moisture condensation on windows and within wall assemblies which may create a damaging and unhealthy condition for the building and its occupants. Review of the building envelope should take place prior to consideration of the addition of any humidification system. As such, our recommendations contained with this report exclude active humidification control until such time as the envelope can be reviewed.

The IAQ readings taken during the time of the inspection are contained within the table below. In addition, the table reflects the outdoor air exchange rate in the rooms based on design data from existing plans.

The document entitled “5-Step Guide to Checking Ventilation Rates in Classrooms” from the Harvard T.H. Chan School of Public Health recommends a target outdoor air exchange rate during these pandemic conditions. The document identifies 5 air changes per hour (ACH) and above as "excellent" down to a 3 ACH being considered "bare minimum". Many of the general classrooms in the University Park Campus School have a design outdoor air exchange rate presumed to be well below 3. When the outdoor air exchange rate is lower than the target 5 ACH, the document recommends the following strategies:

1. Increase outdoor air (see CCM #2)
2. Use MERV 13 filters (or greater) on recirculated air (see CCM #3)
3. Add portable air cleaners with HEPA filters to the classroom (see ECCM #1)

It should be made clear however, that a room that has less that what this document considers the bare minimum outdoor air exchange rate may meet or exceed the most current ventilation standards dependent on the pace occupancy and therefore may not be considered under ventilated by code standards. The 5 ACH or greater recommendation is meant to address the pandemic conditions being experienced as this level of ACH would equate to nearly 100% outside air requirement for a conventional mixed air cooling & heating system.

The following tables describe areas and systems where the above measures as well as others presented in this report may be applied.

University Park Campus School IAQ Sampling Summary

Space Tested	Temp. °F	Humidity % RH	CO2 %	TVOC ppm	HCHO ppm	Room Area SqFt	Room Ht. Ft	Volume Cubic Feet	Design OA CFM	OA Air ACH	Notes
Basement											
Teachers Lounge	72.1	32.6	444	1.33	0.14	402	7.42	2983	na	na	
Mens Room	70.5	35.8	482	1.57	0.17	604	8.42	5086	na	na	
Middle Room	72.5	34.9	456	1.38	0.14	548	8.5	4658	na	na	
Cafeteria	68	37.1	450	1.77	0.17	836	8.5	7106	na	na	
TV/Studio Computer Room	69	38.7	459	1.51	0.15	857	8.5	7285	na	na	
First Floor											
Computer Room (old room 3)	75.8	24.4	464	1.38	0.17	908	11.42	10369	na	na	
Middle Room	73.1	30.5	476	1.47	0.22	549	11.42	6270	na	na	
Science (old room 2)	72.7	26	438	1.35	0.14	915	11.42	10449	na	na	
Normal Classroom (old room 4)	75.5	23.8	446	1.36	0.14	907	11.42	10358	na	na	
Nurse Office	75.9	24.9	488	1.36	0.17	121	11.42	1382	na	na	
Second Floor											
Room 6 (typical of floor)	75.2	24.7	452	1.37	0.18	910	11.25	10238	na	na	
Nurse (old guidance)	75.8	29.1	466	1.42	0.18	124	10.08	1250	na	na	
Third Floor											
Room 11 (typical of floor)	77.7	23.1	465	1.37	0.18	848	9.58	8124	na	na	
New Office (old storage)	73.8	35.6	491	1.41	0.18	164	11.58	1899	na	na	
Storage	71.3	31.7	493	1.39	0.17	81	11.58	938	na	na	

Note: As noted previously, the TVOC readings tended to drift up during the study, possibly due to a calibration issue, as such, the readings in this report were only used to identify areas where possible ventilation issues may exist and/or to identify areas where a source contaminant may be causing elevated levels.

Ventilation System Summary & Recommendations:

The following table is based on original design drawings and reflect most of the systems which provide ventilation air to the building. The units ID tag, area served, ventilation data and filter efficiencies are listed. The table also reflects possible COVID Control Measures (CCM) and Enhanced COVID Control Measures (ECCM) described later in this report which may apply to such systems to improve performance either during pandemic conditions and/or post pandemic conditions.

University Park Campus Ventilation System Summary

Unit ID	Area Served	Exist. Supply CFM	Exist. O.A. CFM	Exist. O.A. %	Exist. Filter Qty & Size	Exist. Filter MERV Rating	Exist. Filter Vel. (FPM)	Proposed CCM #	Proposed ECCM #	Notes
	Science Room	N/A	N/A	N/A	20x25x2	8	N/A	see c	#1, #3	a, b, c
	Classrooms +	N/A	N/A	N/A	none	N/A	N/A	N/A	#1, #3	a, b

Ventilation System Summary Notes:

a. *For individual classrooms and other areas noted, ECCM #1 – Portable Air Filtration and/or ECCM #3 – Ionization, are noted as possible options to improve air cleaning and changeover during pandemic conditions.*

b. *We highly recommend outdoor air of some level be provided in areas having none, even if via windows as there is no substitute for proper ventilation regardless of other measures employed.*

c. *Confirm science room ventilation system complies with code required 1 CFM per SF of air exchange. Verify fume hood exhaust is properly vented.*

II. COVID-19 HVAC MITIGATION MEASURES

A. HVAC COVID-19 CONTROL MEASURES

In line with the current American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) Epidemic Task Force Building Readiness Guidelines (updated 10-20-2020) and those from the Harvard T.H. Chan School of Public Health - 5-Step Guide to Checking Ventilation Rates in Classrooms, as well as other industry recommendations the following HVAC COVID Control Measures (CCM's) are presented for consideration to assist in mitigating virus transmission thru the HVAC systems.

The ASHRAE Epidemic Task Force recommends several measures to assist in COVID-19 mitigation with more aggressive action with epidemic conditions in place (ECiP) and post-epidemic conditions in place (P-ECiP). For ECiP conditions in place the HVAC COVID-19 Control Measures (CCM) that could be readily applied to the University Park Campus School surveyed are outline herein. Refer to the Ventilation System Summary Table for applicable CCM recommendations.

It is imperative that all systems be maintained and checked to confirm proper operation in line with their original design, adjusted where applicable, as described herein. In addition, a Testing and Balancing company should be enlisted to adjust and confirm all systems are properly achieving their design outdoor air, supply air and exhaust air levels.

<u>CCM #1</u> – Pre & Post Purge

Pre- and post-purge ventilation of occupiable spaces using outside air introduced the HVAC systems. This would be accomplished by starting the ventilation systems in occupied mode (i.e., OA at design or higher) 4 hours prior to schedule building occupancy and maintain the occupied mode for 4-hours after occupancy ends.

Most of the building areas have ventilation limited to operable windows and an old ventilation shaft system which does not appear to be operational. As such, the systems, or lack thereof, are <u>not</u> currently capable of implementing this measure. However, there was a relatively new ventilation unit in the boiler room that appears to be serving a nearby science room. Further review of the design of this system to ascertain its purpose and capabilities would be recommended.

<u>CCM #2 – Increased Ventilation</u>

Increase outdoor air ventilation for improved space dilution where systems allow. This would entail increasing the minimum outdoor air damper positions on all mixed air style systems within the limits of the equipment capacity and overriding any demand ventilation reset schemes (i.e., CO_2 reset). A control sequence would need to be implemented for the respective air handlers which would limit the outdoor air volume to the unit's respective capability such that proper control of the discharge air can be maintained as well as freeze protection of coils. In addition, sequence would need to include limitation based on boiler plant and cooling system capabilities and summertime moisture limitations. For buildings which have anti-freeze in water-based heating and/or cooling systems concern of unitary coil freeze up is reduced.

Most of the building areas have ventilation limited to operable windows and an old ventilation shaft system which does not appear to be operational. As such, the systems, or lack thereof, are not currently capable of implementing this measure. However, there was a relatively new ventilation unit in the boiler room that appears to be serving a nearby science room. Further review of the design of this system to ascertain its purpose and capabilities would be recommended.

CCM #3 – Improved Filtration

Improve filtration to up to MERV-13 on air handling systems, especially those which recirculate air. In addition, if possible, as filters are replaced provide sealant or gasketing between and/or around filters to reduced air bypass around filter sections.

The old ventilation shaft system which does not appear to be operational. As such, this system is not currently capable of implementing this measure. However, there was a relatively new ventilation unit in the boiler room that appears to be serving a nearby science room. Further review of the design of this system to ascertain its purpose and capabilities would be recommended.

B. ENHANCED HVAC COVID-19 CONTROL MEASURES

In addition to the suggested above measures below are some Enhanced HVAC COVID-19 Control Measures (ECCM) which could be considered for implementation. Refer to the Ventilation System Summary Table under the respective schools for applicable recommendations.

ECCM #1: Portable Room Purifiers

Portable room air purifiers could be used in select areas to help clean the air within that room. These could be applied in areas such as those where the population is in a higher risk group of developing COVID-19 complications or anywhere where real time space cleaning is required such as the nurse's office. Products which include HEPA filters and fans with air exchange rate appropriate for the size room should be selected.

ECCM #2: UV-C Light Sterilization

UV-C lights can be inserted in equipment and ductwork to help neutralize viruses as it is exposed to the light. UV technology has been studied and used extensively, primarily in hospital settings for virus and bacteria control and in the general HVAC primarily to prevent build-up on coils. To properly mitigate the virus an extended run of return air duct would need to be identified to allow for adequate exposure to UV-C light since a light bar just at the unit coil or filter will primarily just prevent build-up of mold, bacteria, and viruses on those surfaces.

ECCM #3: Bipolar Ionization

Air ionizers are meant to be installed in the supply air duct or plenum downstream of fans and filters. They are also offered as portable units for room application. In University Park Campus Schools case they could be installed in the UV system as well as portable units could be used. WPS has already begun to incorporate Bipolar Ionization extensively throughout the University Park Campus School to address the current pandemic condition.

Air ionizers appear to be showing quite a bit of promise for low system impact in retrofit applications. For years, these products have been used to primarily clean air of dust and particles by forcing the particles to bind together and either drop out of the breathing zone and/or better be able to be captured by HVAC system air filters by making particles larger. Recently, there are studies which claim to show that ionizers work on neutralizing viruses in the space prior to needing to draw these pollutants back to the units where filters and/or other cleaning technology such as UV-C could occur.

ASHRAE has not taken a definitive stance on Bipolar Ionization with regards to virus mitigation as of yet and has deferred to CDC's comment that it is still considered an emerging technology in this regard. Bipolar Ionization has been used for decades primarily for the removal of particles within the air. During that period, its use was focused more on facilities such as convention centers, airports, casinos, and the like as there are large amounts of occupant and activity generated pollutants. Only recently has Bipolar Ionization been looked at for virus mitigation which is why ASHRAE and CDC still view it as an emerging technology being that there are not extensive 3rd party studies and reviews of its capability in this regard.

That said, even ignoring its potential virus neutralizing capabilities, the ability of the product to bind smaller particles into larger particles results in an overall desirable indoor air quality benefit in that it increases the capabilities of air filters to filter the air as well as promotes particles to drop out of the breathing zone. We do, however, recommend the technology be provided on systems that meet code required outdoor air ventilation levels as this technology is not a replacement for outdoor air.

Inevitably, during an epidemic, the best approach is a multi-faceted one and should include the above HVAC strategies as well as proper housekeeping (cleaning of spaces and surfaces), occupant actions (hand cleaning, wearing masks, social distancing, following recommended CDC guidelines) and other mitigation strategies.

2) Natural Ventilation Summary

University Park Campus School (Fremont School)

Room Name / Number	Space Use	Net Floor Area (SF)	4% of Net Area	A 5.38 (AWNING)	C 5.22 (AWNING)	D 1.88 (DBL HUNG)	E 3.83 (DBL HUNG)	Total open Area (SF)	Difference between actual and required SF	PASS?	Additional Notes
Basement											
Men's Room	toile	604	24.16					0.00	24.16	NO	
Men's Room - Storage A	storage	59	2.36					0.00	2.36	NO	
Men's Room - Storage B	storage	116	4.64					0.00	4.64	NO	
Men's Room - Storage C	storage	61	2.44					0.00	2.44	NO	
Ladies' Room	toile	386	15.44					0.00	15.44	NO	
Teacher's Lounge	support	401	16.04					0.00	16.04	NO	
Teacher's Lounge - Storage	storage	47	1.88					0.00	1.88	NO	
Cust Room	support	124	4.96					0.00	4.96	NO	
Cafeteria - A	café	549	21.96					0.00	21.96	NO	
Cafeteria - B	classroom	836	33.44			2		3.75	29.69	NO	
Tv Studio / Computer Room	classroom	857	34.28			2		3.75	30.53	NO	
Center Lobby	common	548	21.92					0.00	21.92	NO	
Storage Room	storage	124	4.96					0.00	4.96	NO	
First Floor											
Room 1	classroom	913	36.52	6				32.29	4.23	NO	
Room 2	classroom	915	36.6	6				32.29	4.31	NO	
Spec Edu - Office	office	120	4.8		2			10.44	-5.64	YES	Formally Nurses Office
Room 3	classroom	908	36.32	6				32.29	4.03	NO	
Room 4	classroom	906	36.24	6				32.29	3.95	NO	
Principal's Office	office	122	4.88		3			15.67	-10.79	YES	
Secretary Office	office	77	3.08					0.00	3.08	NO	
Lobby	entry	945	37.8					0.00	37.80	NO	
Second Floor											
Room 5	classroom	910	36.4	6				32.29	4.11	NO	
Room 6	classroom	910	36.4	6				32.29	4.11	NO	
Guidance Office	office	123	4.92		2			10.44	-5.52	YES	
Room 7	classroom	902	36.08	6				32.29	3.79	NO	
Room 8	classroom	902	36.08	6				32.29	3.79	NO	
Curriculum Office	office	123	4.92		3			15.67	-10.75	YES	
Assessment Office	office	77	3.08					0.00	3.08	NO	
Lobby	entry	936	37.44					0.00	37.44	NO	
Third Floor											
Room 9	classroom	786	31.44				6	23.00	8.44	NO	
Room 10	classroom	783	31.32				6	23.00	8.32	NO	
Future Office	office	80	3.2					0.00	3.20	NO	
Toilet	toilet	31	1.24					0.00	1.24	NO	
Room 11	classroom	848	33.92				6	23.00	10.92	NO	
Room 12	classroom	854	34.16				6	23.00	11.16	NO	
Storage	storage	164	6.56					0.00	6.56	NO	
Conference Room	conference	128	5.12					0.00	5.12	NO	
Lobby	entry	885	35.4					0.00	35.40	NO	

Window Type	Width	Height	Projection	Venting
A - Awning	41	21	12.5	5.38
C - Awning	26	21	16	5.22
D - Double Hung	18	15	0	1.88
E - Double Hung	23	24	0	3.83

Room Color Key	
Green	Rooms that meet or exceed the minimum code required ventilation
Yellow	Rooms that do not meet the code required ventilation, but have operable windows.
Red	Rooms that do not have operable windows (either fixed or none present)