MCA CONSULTANTS LTD
ENGINEERS - PROJECT MANAGEMENT

UPEI CLASSROOM VENTILATION STUDY

Project Information	
Project Classroom Ventilation Study	**MCA Project No.** 21-274
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1. Executive Summary

1.1. OVERVIEW

MCA Consultants Inc. (MCA) have completed an assessment of the classroom ventilation systems at the University of Prince Edward Island (UPEI) Charlottetown campus. The findings of this study are summarized below.

1.2. OPERATION & MAINTENANCE

Equipment maintenance was found to be very good overall with regular routine maintenance and filter replacement. Equipment interiors were generally free of excessive dirt or debris. The field reviews conducted by MCA did reveal a few operational issues with equipment that required corrective action. These corrective measures were completed prior to the issuing of this report.

Maintenance recommendations are to continue to maintain equipment in accordance with industry guidance as contained in ASHRAE documents. Automatic control system recommendations are to schedule air handling systems to operate for sufficient time before and after occupancy to ensure a minimum of three (3) air changes prior and post occupancy in accordance with ASHRAE guidance, and to discontinue CO2 demand control ventilation in the few classrooms that are equipped with this commonly used energy saving measure. We have been advised that these controls system changes were completed prior to the issuing of this report.

1.3. VENTILATION

The vast majority of classrooms on campus meet current code ventilation requirements as prescribed in ASHRAE Ventilation Standard 62.1-2019. As expected in any large campus with numerous buildings dating back many decades there were some classrooms identified that do not meet current ventilation standards. The report contains recommendations to upgrade those systems in the near term where feasible and for those spaces that may require a long term plan to correct, interim measures are recommended. Interim measures include maintaining high clean air delivery rates which may include incorporating portable HEPA air filtration units in accordance with ASHRAE COVID-19 guidance.

1.4. FILTRATION

Current filtration levels at the central air handling systems are predominantly MERV 13 or better which is in accordance with the latest ASHRAE COVID-19 guidance. This has been the standard on the UPEI campus for many years.

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Most terminal equipment filters (fan coils and heat pumps) are still predominantly MERV 8 which has been the typical standard for educational facilities and meets current construction codes. As a result of the current pandemic, the industry guidance has adjusted and the current best practice recommendation is to provide MERV 13 or better filtration or better if possible for all recirculated air. The principal filtration recommendation of this report is to upgrade existing filters on recirculating systems to MERV 13, where possible.

2. Project Overview

2.1. INTRODUCTION

MCA Consultants Inc. have been commissioned by the University of Prince Edward Island (UPEI) to provide professional Engineering services for a review of the campus classroom ventilation systems.

This review addresses the current state of classroom ventilation systems as it pertains to current best practices and accepted guidelines with respect to classroom ventilation systems during the COVID-19 pandemic.

This report provides a detailed summary of our findings and recommendations for the UPEI campus ventilation systems.

2.2. BACKGROUND

UPEI has sixty nine (69) classrooms spread throughout the Charlottetown campus in numerous buildings of varying age. With the return of the full student and staff population to the campus during the COVID -19 pandemic, concern has been raised about the possible impact the building ventilation systems may have on transmission of the virus.

At the current stage of the COVID-19 pandemic there is sufficient evidence reported that transmission of SARS-CoV-2 (the virus that causes COVID-19) through airborne means is possible. It is suggested by leading authorities that building owners and facility managers review existing ventilation systems and operations to reduce airborne exposures where possible.

3. Regulatory Requirements and Guidance

3.1. REGULATIONS

UPEI is located in the city of Charlottetown and is therefore subject to both the National Building Code of Canada (NBC) for new construction as well as Provincial Occupational Health and Safety Regulations (OH&S). The city bylaws are updated on a regular basis and as such their requirements evolve over time and adopt newer editions of building codes.

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Over the last twenty five (25) years, new construction in Charlottetown has typically been designed in accordance with the NBC which requires the ventilation systems adhere to good engineering practice including the ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers) Ventilation Standard 62.1-2019 – Ventilation for Acceptable Indoor Air Quality. Standard 62.1-2019 has been the most commonly used and widely accepted standard for ventilation in public educational facilities in Canada for many years.

The Provincial OH&S Regulations specify a minimum standard for ventilation in the province and is typically applied in older facilities that have not been designed to ASHRAE Standard 62.1-2019 requirements or to facilities built in areas that were not subject to the requirements of the NBC. The Provincial OH&S Regulations regarding ventilation have not changed over the past thirty (30) years.

For this study the analysis of outdoor air ventilation requirements is based on the 2019 edition of ASHRAE Standard 62.1 as it represents latest edition of the standard for outdoor ventilation. The outdoor airflow target requirements were calculated based on the current best practices, and therefore may exceed the standard by which the facility was constructed or current regulatory requirements.

Classrooms that do not meet current best practice outdoor air ventilation rates have been identified. Refer to the Findings and Recommendations Section of this study.

3.2. BASIS OF GUIDANCE

The ASHRAE organization is a global professional society of over fifty-five thousand (55,000) members committed to serve humanity by advancing the arts and sciences of heating, ventilation, air conditioning, refrigeration, and their allied fields. They are considered the leading organization in North America with respect to developing standards and guides as it pertains to ventilation systems in public occupancies.

ASHRAE has established a Task Force to help deploy technical resources to address the challenges of the COVID-19 pandemic and possible future epidemics as it relates to the effects of heating, ventilation, and air-conditioning systems on disease transmission. Guidance and building readiness information for different operational conditions has been developed for several building types including commercial, residential, schools and universities, and healthcare facilities. Their guidance documents are based on their Core Recommendations for Reducing Airborne Infectious Aerosol Exposure.

Additional information is available on the ASHRAE Coronavirus (COVID-19) resource page: *https://www.ashrae.org/technical-resources/resources*.

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Public health authorities and major health organizations such as the World Health Organization (WHO), Health Canada, and Centers for Disease Control (CDC) have identified that current evidence suggests the SARS-CoV-2 virus spreads between people in several different ways but primarily when small liquid particles are emitted from an infected person in close proximity to others, typically within one 1 metre (short-range). A person can be infected when aerosols or droplets containing the virus are inhaled or come directly into contact with the eyes, nose, or mouth. It has also been determined that the virus can spread in poorly ventilated and/or crowded indoor settings, where people tend to spend longer periods of time. This can occur because aerosols remain suspended in the air or travel farther than one 1 metre (long-range).

The position of ASHRAE is consistent with that of major public health organization and is that airborne transmission of SARS-CoV-2 is significant and should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning systems, can reduce airborne exposures.

This study focused on addressing the key ventilation system measures and recommendations contained within the ASHRAE Epidemic Task Force Guidance for Schools and Universities.

The focus of the ASHRAE guidance on which this study is based is to mitigate the potential for transmission of the SARS-CoV-2 virus through HVAC systems and to reduce concentrations of infectious aerosols present in occupied spaces to the extent possible. Adherence to ASHRAE guidance and the recommendations contained within this report does not eliminate the potential for airborne transmission of the virus and should not serve as a replacement for other measures which may include social distancing, use of masks or other face coverings, cleaning, and disinfection of surfaces, etc.

Due to the nature/methodology of transmission it is important to understand that in most public buildings, current code compliant ventilation systems have limited impact on close proximity transmission of the virus. Refer to the Provincial Chief Public Health Office for current guidance relating to specific measures required for occupancy.

3.3. SCOPE OF INVESTIGATION

The study is focused on sixty nine (69) classrooms on campus which were identified by UPEI. The term “classroom” will be used to describe any room which is occupied by students and used for educational purposes. This may include rooms such as classrooms, lecture theatres, seminar rooms, auditoriums, lecture halls, lecture theatres, design studios, amphitheatres, or meeting rooms and the Wanda Wyatt dining hall. Room maximum occupant numbers have been provided by UPEI.

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The scope of investigation involved addressing the following key points (in italics) within the ASHRAE School and University guidance as follows:

.1 Inspection and Maintenance

"Consider assessing the condition of systems and making necessary repairs. All building owners and service professionals should follow ASHRAE Standard 180-2018 "Standard Practice for the Inspection and Maintenance of Commercial HVAC Systems."

Methodology Used in Study:

UPEI Facility Management, Maintenance Division was requested to review existing HVAC systems and provide verification that the systems and equipment are operational according to their intended design, equipment maintenance is up to date, and that controls components have been recently inspected and/or calibrated.

MCA Engineering staff accompanied UPEI Maintenance staff for a field review of the air handling systems to verify equipment condition, cleanliness and check key equipment components such as filters, coils, and heating operation. Any component or maintenance items discovered during the field review have either been rectified at that time or included in the action recommendations for implementation. The results of these reviews are captured in the Results Table found in Section 4.1.

.2 Ventilation

"A suitable supply of outside air, in accordance with ASHRAE Standard 62.1-2019, to dilute indoor contaminants is a first line of defense against aerosol transmission of SARS-CoV-2. Pre- and post-occupancy purge cycles are recommended to flush the building with clean air."

Note: ASHRAE Standard 62.1-2019 contains requirements for calculating ventilation requirements for both mechanical ventilation systems and natural ventilation measures (operable windows).

Methodology Used in Study:

MCA has conducted a review of the existing system design drawings and specifications with respect to the original ventilation design criteria when the facility was built to determine compliance with ASHRAE Standard 62.1-2019. Engineering calculations have been made using current maximum occupant loads to determine if systems are capable of meeting current minimum outdoor air ventilation rates.

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For systems with mechanical ventilation, field measurements of actual outdoor air quantities have been taken for all spaces under consideration using calibrated test equipment to determine if the actual airflows meet minimum recommended values.

Following initial field measurements, rooms were identified that were below recommended values. A testing, adjusting, and balancing (TAB) contractor was employed to make system balancing adjustments to increase outdoor air flows and verify AHU heating capacity in areas where outdoor air values were lower than recommended minimum values. These adjustments were made without negatively impacting other spaces served. This field adjustment exercise resulted in several spaces that were initially identified as having low outdoor air flows increased to recommended values. Any outstanding spaces that remained below ASHRAE Standard 62.1-2019 values have been identified. The results of the above reviews are captured in the Results Table found in Section 4.1.

.3 Filtration

"Use of at least MERV-13 rated filters is recommended if it does not adversely impact system operation. If MERV-13 filters cannot be used, including when there is no mechanical ventilation of a space, portable HEPA air cleaners in occupied spaces may be considered."

Prior to the pandemic, standard practice for most educational facilities, including UPEI, has been to use MERV 13 filtration or better at the central air handling units and a lower MERV rating at terminal fan coils and heat pumps, typically MERV 8.

The current ASHRAE COVID-19 guidance has increased recommended filter ratings to a minimum of MERV 13 on recirculated air if possible

Note: Minimum filtration efficiency recommendations (MERV rating) in the context of the ASHRAE COVID-19 risk reduction in schools and university classrooms are restricted to the filtration of recirculated air. For systems with a primary only recirculated air handing system, filtration at the primary air handler has been considered. For systems with primary 100% outdoor air handlers without recirculation and secondary space level recirculating air handling systems (fan coils and heat pumps), the filtration at the secondary level has been considered for the basis of this study. The rationale for this is that in the context of removal of virus particles, it is those filters that see recirculated room air which play an important role in reducing concentration levels. Filters that are treating 100% outdoor air, while necessary, are unlikely to be exposed to virus particles. It is worth noting however that most primary 100% outdoor air handling units at UPEI are fitted with minimum MERV 13 or better filters.

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Methodology Used in Study:

UPEI Facilities Management, Maintenance Division provided a summary of filter ratings in all HVAC systems on campus. MCA Consultants reviewed system configurations to determine which filters were exposed to recirculated air and recorded that data. MCA Consultants reviewed filter installations during the maintenance review as well to review potential for upgrades in areas where current filtration levels were below the current ASHRAE COVID-19 guidance. The results of these reviews are captured in the Results Table in Section 4.1.

.4 Clean Air Delivery

In addition to the key points within the ASHRAE School and University guidance listed above, the equivalent clean air delivery was reviewed for all spaces:

The ASHRAE Core Recommendations are based on the concept that within reasonable limits ventilation, filtration, and air cleaners can be deployed flexibly to achieve exposure reduction goals subject to constraints such as comfort, energy use, and cost. This is done by setting targets for equivalent clean air supply rate as measured in equivalent clean air changes per hour (ACHe) and expressing the performance of filters, air cleaners, and other removal mechanisms in these terms. The higher the ACHe value for a given space the higher the cleaning turnover and hence the greater the potential reduction of infectious aerosol droplets in the air.

ASHRAE has not indicated minimum ACHe values for schools and universities so there is a wide range of target equivalent clean air changes per hour being considered by organizations (in the range of 3-10 ACHe). The ASHRAE guidance provides a means to quantify the performance when considering upgrades to filtration and additional air cleaners. This is of particular benefit in areas that do not meet the latest recommended outdoor air requirements.

The current ACHe value has been calculated based on actual outdoor airflow measurements, actual filtration levels, and design space airflows. In some cases, filters found in recirculating terminal units (fan coils and heat pumps) could possibly be upgraded to achieve higher ACHe values. The current and upgraded, if applicable, ACHe values are included in the Results Table found in Section 4.1.

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4. Findings and Recommendations

4.1. RESULTS TABLE

The table below summarizes the criteria reviewed on an individual room basis. Overall, the findings are varied as expected in a campus with many buildings of varying ages and differing system configurations. The Recommendations column lists numbered specific recommendations on a system basis. See Specific Recommendations found in Section 4.3 for additional details of these recommendations.

Building	Room Number	Room Name	Room Ventilation Meets ASHRAE Standard 62.1-2019	Systems Inspection & Maintenance Evaluation Completed	Zone Filtration Minimum MERV 13	Clean Air Delivery ACHe (Current Filters)	Clean Air Delivery ACHe (Upgraded Filters[1])	Recommendations	
								Short Term	Long Term
Atlantic Vet College	201N	Lecture Theatre A	No	Yes	Yes	7.46	NR	4	9
Atlantic Vet College	205N	Lecture Theatre B	No	Yes	Yes	7.59	NR	4	9
Atlantic Vet College	207N	Lecture Theatre C	No	Yes	Yes	7.35	NR	4	9
Atlantic Vet College	218 S	Computer Lab	Yes	Yes	Yes	8.94	NR	NR	NR
Atlantic Vet College	278 N	Classroom	Yes	Yes	Yes	4.84	NR	5	NR
Atlantic Vet College	280 N	Classroom	Yes	Yes	Yes	4.96	NR	5	NR
Atlantic Vet College	286A N	Lecture Theatre	Yes	Yes	Yes	6.51	NR	5	NR
Atlantic Vet College	286B N	Classroom	Yes	Yes	Yes	7.26	NR	5	NR
Atlantic Vet College	286C N	Classroom	Yes	Yes	Yes	6.18	NR	5	NR
Atlantic Vet College	287 N	Classroom	Yes	Yes	Yes	7.97	NR	5	NR
Atlantic Vet College	286AN / 287N	Classroom	Yes	Yes	Yes	7.31	NR	5	NR
Cass Science Hall	101	Classroom	Yes	Yes	No	4.16	7.6	3	NR
Young Sports Centre	212	Classroom	Yes	Yes	NR	2.59	NR	NR	NR
Duffy NRC	212	Lecture Theatre	Yes	Yes	Yes	3.16	NR	NR	NR
Duffy Sci. Centre	135	Amphitheatre	Yes	Yes	Yes	5.41	NR	NR	NR
Duffy Sci. Centre	202	Classroom	Yes	Yes	No	9.20	12.1	1	NR

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Building	Room Number	Room Name	Room Ventilation Meets ASHRAE Standard 62.1-2019	Systems Inspection & Maintenance Evaluation Completed	Zone Filtration Minimum MERV 13	Clean Air Delivery ACHe (Current Filters)	Clean Air Delivery ACHe (Upgraded Filters[1])	Recommendations	
								Short Term	Long Term
Duffy Sci. Centre	204	Classroom	Yes	Yes	No	6.40	8.3	1	NR
Duffy Sci. Centre	219	Classroom	Yes	Yes	No	6.22	NR	NR	NR
Duffy Sci. Centre	423	Classroom	Yes	Yes	No	5.16	NR	NR	NR
Engn.Building	128A	Lecture Hall	Yes	Yes	No	4.14	5.08	1	NR
Engn.Building	128B	Lecture Hall	Yes	Yes	No	4.09	5.07	1	NR
Engn.Building	202	Design Studio	Yes	Yes	No	5.33	6.65	1	NR
Engn.Building	205	Design Studio	Yes	Yes	No	8.31	10.02	1	NR
Engn.Building	301	Seminar Room	Yes	Yes	No	6.66	9.22	1	NR
Engn.Building	306	Seminar Room	Yes	Yes	No	6.63	9.23	1	NR
Health Sci. Building	103	Classroom	Yes	Yes	No	4.97	NR	NR	NR
Health Sci. Building	104	Lecture Room	Yes	Yes	No	5.18	NR	NR	NR
Health Sci. Building	105	Classroom	Yes	Yes	No	5.18	NR	NR	NR
Health Sci. Building	106	Classroom	Yes	Yes	No	5.36	NR	NR	NR
Chemistry Centre	104	Lecture Theatre	Yes	Yes	Yes	4.03	NR	NR	NR
Chemistry Centre	202	Seminar Room	Yes	Yes	Yes	8.69	NR	NR	NR
Kelley Building	210	Classroom	Yes	Yes	Yes	3.80	NR	NR	NR
Kelley Building	211	Classroom	Yes	Yes	Yes	3.15	NR	NR	NR
Kelley Building	234	Classroom	Yes	Yes	Yes	3.50	NR	NR	NR
Kelley Building	237	Classroom	Yes	Yes	Yes	2.71	NR	NR	NR
McDougall Hall	214	Classroom	Yes	Yes	Yes	3.08	NR	NR	NR
McDougall Hall	215	Classroom	Yes	Yes	Yes	2.66	NR	NR	NR
McDougall Hall	216	Classroom	Yes	Yes	Yes	2.91	NR	NR	NR

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Building	Room Number	Room Name	Room Ventilation Meets ASHRAE Standard 62.1-2019	Systems Inspection & Maintenance Evaluation Completed	Zone Filtration Minimum MERV 13	Clean Air Delivery ACHe (Current Filters)	Clean Air Delivery ACHe (Upgraded Filters[1])	Recommendations	
								Short Term	Long Term
McDougall Hall	227	Classroom	Yes	Yes	Yes	2.83	NR	NR	NR
McDougall Hall	231	Classroom	Yes	Yes	Yes	2.46	NR	NR	NR
McDougall Hall	242	Auditorium	Yes	Yes	No	7.04	9.05	1, 5	NR
McDougall Hall	243	Lecture Theatre	Yes	Yes	No	11.27	14.97	1, 5	NR
McDougall Hall	246	Lecture Theatre	Yes	Yes	No	8.98	12.03	1, 5	NR
McDougall Hall	328	Classroom	Yes	Yes	No	7.22	9.77	1, 5	NR
McDougall Hall	329	Lecture Theatre	Yes	Yes	No	7.21	9.71	1, 5	NR
Memorial Hall	104	Seminar Room	Yes	Yes	Yes	3.83	NR	NR	NR
Memorial Hall	308	Classroom	No[2]	NA	NA	NA	NA	4	10
Memorial Hall	417	Classroom	No[2]	NA	NA	NA	NA	4	10
Robertson Library	209	Classroom	No	Yes	Yes	3.52	NR	4	9
Robertson Library	210	Classroom	No	Yes	Yes	3.17	NR	4	9
Robertson Library	211	Classroom	No	Yes	Yes	2.44	NR	4	9
Robertson Library	235	Classroom	No	Yes	Yes	6.05	NR	4	9
SDU Main Building	113	Classroom	Yes	Yes	NR	4.51	NR	NR	NR
SDU Main Building	115	Classroom	Yes	Yes	NR	2.73	NR	NR	NR
SDU Main Building	211	Classroom	Yes	Yes	NR	6.31	NR	NR	NR
SDU Main Building	320	Classroom	Yes	Yes	NR	4.08	NR	NR	NR
SDU Main Building	420	Classroom	Yes	Yes	NR	2.85	NR	NR	NA
SDU Main Building	116	Classroom	Yes	Yes	NR	2.87	NR	NR	NA
SDU Main Building	117	Classroom	Yes	Yes	NR	3.08	NR	NR	NA
SDU Main Building	213	Classroom	Yes	Yes	NR	2.97	NR	NR	NR

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Building	Room Number	Room Name	Room Ventilation Meets ASHRAE Standard 62.1-2019	Systems Inspection & Maintenance Evaluation Completed	Zone Filtration Minimum MERV 13	Clean Air Delivery ACHe (Current Filters)	Clean Air Delivery ACHe (Upgraded Filters[1])	Recommendations	
								Short Term	Long Term
SDU Main Building	310	Classroom	Yes[2]	NA	NA	NA	NA	4	10
SDU Main Building	335	Classroom	Yes[2]	NA	NA	NA	NA	4	10
SDU Main Building	409	Classroom	Yes[2]	NA	NA	NA	NA	4	10
SDU Main Building	432	Classroom	Yes[2]	NA	NA	NA	NA	4	10
SDU Main Building	508	Classroom	Yes[2]	NA	NA	NA	NA	4	10
Steel Building	218	Music Lab	Yes[3]	Yes	No	3.04	5.7	2, 6	9
Steel Building	224	Recital Hall	Yes[3]	Yes	No	2.07	3.9	2, 7	9
Steel Building	321	Music Classroom	No	Yes	No	0.80	1.5	2, 4	9
Wyatt Dining Hall	126	Cafeteria	Yes[3]	Yes	Yes	4.83	NR	8	9

NA – Not Applicable.

NR – Not Required.

[1]Applicable only to systems for which filter upgrades to MERV 13 are recommended. Refer to Recommendations column for applicability and Specific Recommendations Section for descriptions.

[2]Rooms that have only natural ventilation, requires windows to be open during all occupied periods.

[3]Rooms that require reduced maximum occupancy to meet required ventilation rates. Refer to Recommendations column for applicability and Specific Recommendations Section for descriptions.

4.2. DISCUSSION AND RECOMMENDATIONS

.1 Maintenance and Operation

The overall maintenance was found to be generally well executed. Automation systems were in most cases operating in accordance with original design criteria.

The field review did uncover some operational/maintenance issues, many of which were easily corrected however there were some more significant operational issues with a number of the older systems that prevented recommended outdoor air ventilation rates from being achieved. There are recommendations to address those systems found in Section 4.2.2.

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General Recommendations:

.1 Follow ASHRAE calibration and maintenance recommendations. Refer to guidance document: ASHRAE Epidemic Task Force - Schools and Universities.
.2 This includes maintenance staff following all recommended protocols including adequate PPE.
.3 Initiate a daily pre and post occupancy purge cycle on all air handling units to achieve at least 3 air changes of equivalent clean air.
.4 Disable demand controlled (CO2) ventilation sequence in areas so equipped. Operate ventilation at maximum occupancy level whenever the space is occupied. Refer to the Results Table Recommendations column for which systems are affected.
.5 Operate humidification systems during the heating season to maintain a minimum of 30% RH in occupied classrooms. Where humidification is not installed, consider installing if the building envelope can accommodate increased moisture loading in winter without detrimental effects. An Engineering review of the building may be required.

.2 Ventilation

The majority of classrooms on campus meet ASHRAE Standard 62.1-2019 outdoor air ventilation requirements. Newer systems, and systems with 100% outdoor air central air handlers serving secondary fan coils or heat pumps (primary/secondary systems) appeared better at maintaining the design outdoor air requirements versus the older central VAV systems.

Some classrooms in older buildings do not meet current ASHRAE Standard 62.1-2019 recommended outdoor air flow rates. The systems are mostly mixed air systems where due to system degradation and/or limitations, the systems are not able to operate at a sufficient percentage of outdoor air to meet the current standard. Most of these systems still have significant outdoor air so upgrading filtration levels and increasing ACHe values in these spaces can have a significant positive impact on the space. The spaces which do not meet ASHRAE Standard 62.1-2019 recommendations and require significant system upgrades or equipment replacements are as follows:

.1 Atlantic Vet College AHU-2
.2 Robertson Library AHU-1
.3 Steel Building AHU-1
.4 Wanda Wyatt Dining Hall AHU-1

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There are seven (7) several classrooms that do not have mechanical ventilation, relying entirely on natural ventilation (operable windows). Five (5) of which do meet ASHRAE Standard 62.1-2019 requirements for ventilation, while the remaining two (2) do not meet ASHRAE requirements. There is concern with use of natural ventilation because in order to ensure compliance these windows must be kept open during all occupied periods. This becomes a challenge in cold weather.

General Recommendations:

.1 Provide mechanical ventilation systems in areas where there is only natural ventilation at present. Refer to the Results Table Recommendations column for which systems are affected.
.2 Upgrade or replace ventilation equipment that does not meet ASHRAE Standard 62.1-2019. In the interim period, until such time that a system upgrade/replacement can be executed, use operable windows where available and weather permitting to supplement mechanical ventilation. Additional measures such as installing portable HEPA air filtration units or reducing maximum occupants where possible should also be considered. Refer to the Results Table Recommendations column for which systems are affected. Refer to Section 4.2.4 for further discussion of portable HEPA air filtration units.

.3 Filtration

Filtration levels at the central air handling systems are predominantly MERV 13 or better as this has been standard practice in most post secondary buildings many years.

Most terminal equipment filters (fan coils and heat pumps) are still predominantly MERV 8 which also was typical construction practice prior to the current pandemic.

General Recommendations:

.1 Ensure filters are all tightly fitting within filter frames without air gaps that would permit air to bypass filters.
.2 Upgrade recirculated air filtration levels to MERV 13 or better where possible. This recommendation applies predominantly to terminal fan coil and heat pump units currently fitted with 2" MERV 8 filters where upgrade is not expected to negatively impact system airflow. Prior to campus wide implementation it is also recommended that the airflow on a single representative terminal unit be tested before and after filter replacement to confirm the system can accommodate the change. Refer to the Results Table Recommendations column for which systems are affected.

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.3 It is not recommended that filter change frequency be increased significantly unless there is a marked reduction in room airflow.
.4 For future new construction projects upgrade to MERV 13 filters as a base specification for all recirculated air.

.4 Clean Air Delivery

The current equivalent clean air delivery rates in mechanically ventilated spaces varies significantly, with a range of 1-12 ACHe.

If the recommendation to increase recirculated air filtration to MERV 13 is adopted, it should significantly improve clean air delivery rates in those areas not currently equipped with MERV 13 filters. Refer to the Results Table Clean Air Delivery ACHe (Upgraded Filters) column for the potential positive impact.

It was noted that the spaces with 100% outdoor air have the lower clean air delivery rates as expected. Upgrading systems that fall in this category to increase clean air delivery has not been identified as an ASHRAE recommendation so is not included in the General Recommendations Section below but is something that could be considered if UPEI wish to set a minimum clean air delivery rate.

General Recommendations:

.1 For those spaces equipped with mechanical ventilation that are not meeting ASHRAE Standard 62.1-2019 ventilation levels consider installing portable HEPA air filtration units to improve clean air delivery in those spaces. This could be a temporary measure until existing mechanical ventilation is upgraded to meet ASHRAE ventilation levels. This recommendation affects sixteen (16) classrooms. Refer to the Results Table Recommendations column for which systems are affected.
.2 For planned upgrades and new systems consider standardizing on a minimum clean air delivery rate in the range of 4-6 ACHe for all recirculated systems.

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4.3. SPECIFIC RECOMMENDATIONS

Numbers below correspond to specific system recommendation in the Results Table Recommendations column.

No. Description

Short Term Recommendations:

1 Replace terminal unit filter with 2" MERV 13 and rebalance. Test on a single representative terminal unit prior to implementing throughout campus.
2 Replace primary unit filter with MERV 13 and rebalance.
3 Install MERV 13 filter rack in recirculation ductwork and rebalance.
4 Install portable HEPA air filtration units.
5 Disable demand controlled (CO2) ventilation sequence. Operate ventilation at maximum occupancy level whenever the space is occupied.
6 Reduce maximum occupancy from 23 to 12 people until Recommendation 9 is implemented.
7 Reduce maximum occupancy from 152 to 130 people until Recommendation 9 is implemented.
8 Reduce maximum occupancy from 400 to 150 people until Recommendation 9 is implemented.

Long Term Recommendations:

9 Upgrade or replace existing ventilation system to meet ASHRAE Standard 62.1-2019.
10 Provide new mechanical ventilation system per ASHRAE Standard 62.1-2019.

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5. Appendix A – Calculations

5.1. ASHRAE STANDARD 62.1-2019 OUTDOOR AIR REQUIREMENTS

Explanation:
Quantity of outdoor air (CFM, L/s) in the breathing zone and ventilation zone of the occupied space required by ASHRAE Standard 62.1-2019.

Equations:
Ventilation rate: $V_{oz} = V_{bz} / E_z = ((R_p \times P_z) + (R_a \times A_z)) / E_z$

Variables:
V_{oz} = outdoor airflow required in the ventilation zone of the occupied space.
V_{bz} = outdoor airflow required in the breathing zone of the occupied space.
R_p = outdoor airflow rate required per person (ASHRAE Std 62.1-2019, Table 6-1).
P_z = number of people in the ventilation zone during use.
R_a = outdoor airflow rate required per unit area (ASHRAE Std 62.1-2019, Table 6-1).
A_z = net occupiable floor area of the ventilation zone.
E_z = zone air distribution effectiveness (ASHRAE Std 62.1-2019, Table 6-4).

5.2. ASHRAE EQUIVALENT AIR CHANGES PER HOUR

Explanation:
Equivalent outdoor air changes per hour delivered to the space calculated using the principle of filters in series and the effectiveness at reducing particles.

Equations:
100% OA System: $ACH_e = ACH_{SA}$
Recirculating Air Systems: $ACH_e = ACH_{OA} + (ACH_{RS} - ACH_{OA}) \times Eta$
Supply air system plus HEPA filter units: $ACH_{e,HEPA} = (ACH_e \times E_z) + (ACH_{HEPA} \times Eta_{HEPA} \times N)$

Variables:
ACH_e = equivalent air changes per hour.
ACH_{SA} = supply air changes per hour.
ACH_{OA} = outdoor air changes per hour.
ACH_{RS} = mixed AHU or recirculating terminal unit supply air changes per hour.
Eta = AHU or recirculating terminal unit filter efficiency.
$ACH_{e,HEPA}$ = equivalent air changes per hour aided by portable HEPA filter unit(s).
E_z = zone air distribution effectiveness (ASHRAE Std 62.1-2019, Table 6-4).
ACH_{HEPA} = portable HEPA filter unit(s) supply air changes per hour.
Eta_{HEPA} = portable HEPA filter unit efficiency.
N = Number of portable HEPA filter units in space.

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