Energy Efficient Indoor Air Quality (IAQ) Analysis

LaBella Associates
Preliminary Findings Report #4
October 26, 2020

A) Summary of Progress to Date

As of October 26th, work plans for all (8) sites have been submitted and approved. The table below outlines a summary of approved sites as well as the progress with site investigations and coordination with vendors.

Work Plan #	Client Name	Facility Name	City	Sector	Work Plan Approved	Kickoff Meeting	Utility Analysis	Review Industry Guidance	Review Site Drawings & Controls Sequences	Site Visits Underway	Identify Potential Measures	Energy Calculations	Economic Analysis	Draft Report Submitted to Customer for Review	Draft Submitted to NYSERDA for Review	Estimated Report Completion Date
WP-01	NFTA	Buffalo Niagara International Airport	Buffalo	Airport	✓	✓	✓	✓	✓	✓	✓	✓	✓			Nov. 1
WP-02	City of Rochester	Blue Cross Arena	Rochester	Arena	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Oct. 21
WP-03	The Rosenblum Companies	100 Great Oaks	Albany	Office/ Medical	✓	✓	✓	✓	✓	✓	✓					Nov. 15
WP-04	NFTA	Metro Transportation Center	Buffalo	Offices/ Bus Station	✓	✓	✓	✓	✓	✓	✓	✓	✓			Nov. 1
WP-05	City of Rochester	Rundel Library	Rochester	Library	✓	✓	✓	✓	✓	✓	✓					Dec. 1
WP-06	Webster CSD	Dewitt Road E.S.	Rochester	Primary School	✓		✓	✓								Dec. 1
WP-07	OGS	299 Old Niskayuna	Albany	Office	✓	✓	✓	✓	✓	✓	✓					Nov. 15
WP-08	North Tonawanda CSD	NT Middle School	Buffalo	Middle School	✓	✓	✓	✓	✓	✓	✓					Dec. 1

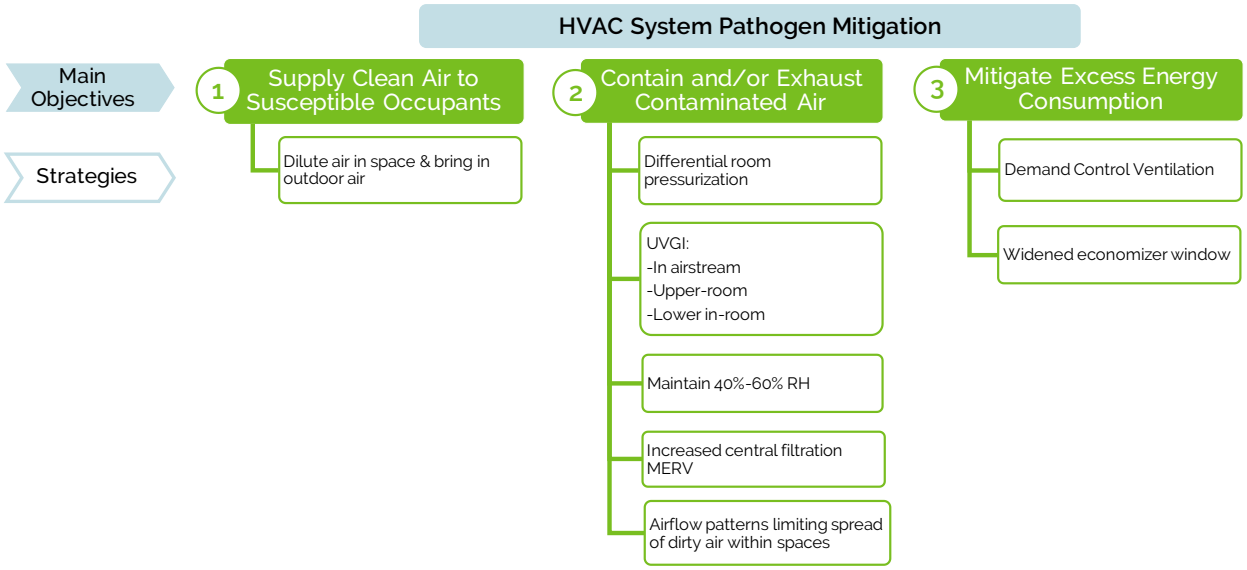
Note: cumulative report is anticipated to be submitted for review at the same time as the latest individual site report.
Boxes highlighted in green indicate progress made in past month since previous progress report.

As indicated on the graph below, 7 of the 8 approved sites have commenced with kickoff meetings, data collection, and utility analyses. Site visits have commenced with these sites with coordination with AHU vendors on available technologies and equipment selection information. Pathogen mitigation measures and energy conservation measures have been identified for 5 of the 8 sites and are in the process of collecting final selections from vendors and developing energy and cost analyses.

The estimated report completion dates are listed above and are expected to be submitted to NYSERDA in early December at the latest in order to allow for enough time for NYSERDA to make comments and LaBella to address them before the end of the calendar year. The draft report for Blue Cross Arena has been submitted to both NYSERDA and the City of Rochester for review.

B) Study Findings to Date

A thorough review of ASHRAE safe-operation measures has been conducted. The chart below indicates the main objectives of the HVAC system within its role in mitigating the spread of pathogens, as well as strategies that can be used to achieve these goals.



Based on a variety of site conditions, the strategies outlined above are narrowed down to specific recommendations that will enable the safest operation conditions. In addition to mitigating the spread of pathogens, additional energy conservation strategies are being evaluated, where feasible.

The following table outlines a summary of the recommended measures on a site-by-site basis. Factors limiting the implementation of certain ASHRAE-recommended measures are stated as well as alternate approaches to help mitigate the spread of pathogens. In general, the most common recommended measures are to maximize filtration as much as possible, bring in as much outdoor air as possible in order to increase air changes in the spaces, put UVGI on the cooling coils of air handling units as space allows, and modify controls in order to maintain humidity levels between 40% RH and 60%RH.

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Measures / Sites	Increased OA Ventilation	UVGI	Increased Filtration	Humidification Control	Energy Conservation Opportunities	Current Ventilation	Current Filtration	Current UVGI	# AHUs
BNIA Terminal	It is recommended that during pandemic mode occupied hours, the percent OA intake is increased from 17% to 40% to increase the number of outdoor air changes per hour.	1) Recommended UVGI inside large Mammoth AHUs. Smaller units do not have sufficient space for UVGI. Typical UVGI layouts in these units are spaced 18" from the cooling coil with 5 rows of 2 lamps.	All units currently have MERV-15 filters. No additional filtration is recommended based on current industry guidance.	In retrofitted unit option, Humidifiers are being recommended in order to maintain 40%-60% RH. Final selection of proposed equipment has been completed.	1) Replacement of DX cooling coils to centralized chilled water system will allow for reduced maintenance, energy cost savings, and the capacity to allow for additional OA ventilation and space for UVGI. Final vendor selection of retrofit options and air-cooled rooftop chillers is completed. Energy analyses are in 2) The supply fan in the unit is nearing the end of its useful life. Replacing the supply fan with a fan wall will present increased energy efficiency as well as increased resiliency. Fan wall and return fan retrofits have been selected.	The facility currently operates bringing in 17% outdoor air.	MERV-15 throughout	None	32
NFTA MTC	1) Increased OA ventilation is recommended. Amount of OA intake will be limited by either cooling coil capacity or ability to meet indoor air setpoints. 2) Each air handling unit has been analyzed to calculate individual unit limitations for treatment of outside air. Outside air temperature ranges to operate with 100% outside air have been defined for each unit. Total impacts on both the chilled water system and hot water system have also been calculated. The limiting factor for most AHUs is the water-side pressure drop through either the cooling or heating coils. The annual energy implications of operating the AHUs with the maximum amount of outside air possible have been calculated.	Cooling coil mounted UVGI has been selected for all (7) AHUs. Economic impacts of purchasing, installing, and operating the UVGI equipment have been calculated. Optimum layouts for each unit have been configured to maximize the UVGI efficiency in mitigating the spread of the virus.	The supply air fans for all (7) air-handling units have been analyzed on their capacity and ability to handle the additional pressure drop of installing MERV-13 filters. AHU-1 and AHU-2 have the ability to accept a 4" M13 filter, with spare BHP to accomodate the additional pressure drop. AHU-3, 4, 5, 6, and 7 are configured to accept a 2" M13 filter; these units also have available BHP to accomodate the additional pressure drop. The annual energy implications of operating each AHU at a slightly higher SP to overcome the additional static of the filters has been calculated.	1) AHU-1 and AHU-2 were originally constructed with DriSteem electric humidifiers to provide space humidification for the tower offices and spaces. The dispersion piping has since been disconnected to both of these units. A measure is currently being analyzed to re-install humidification equipment and dispersion piping to treat these areas. The intent is to provide increased humidification capabilities in the office spaces. Preliminary sizing for each humidifier has been completed, showing a separate 75-100 lb/hr humidifier required for AHU-1 and AHU-2. 2) The remaining (5) AHUs have been assessed for the feasibility of adding humidification. Due to both the nature of these spaces (high traffic, high infiltration, and materials of construction) achieving the desired humidity levels during occupied hours is not feasible. Humidifiers have been selected, as well as budgetary pricing for the materials and installation of the humidification system. Energy calculations are currently being performed to understand the increase in energy required to operate these units.	1) Replacing the existing air-cooled chiller, which is nearing the end of its useful life, will present an opportunity for increased cooling capacity- which will increase the potential for increased OA ventilation. The total increase in tonnage required for operating all (7) AHUs with maximum outside air has been calculated. It is anticipated to increase the required chilled water tonnage by 48 tons. Installing a more efficient air-cooled chiller with higher part-load efficiencies will present an opportunity for energy savings. 2) Destratification fans in the bus station terminal may present an opportunity for improved HVAC performance, which will allow more opportunity for OA ventilation. Selection of fans, layouts, and pricing is currently being evaluated. Destratification HVLS fans have been selected for the bus station terminal area. A preliminary layout has been developed, and the energy savings calculations are currently being performed. 3) Sealing ductwork in the catwalk above the bus terminals will result in increased HVAC system efficiency- which will result in energy savings as well as reduced limitations on OA intake. Aeroseal duct sealing is being assessed for economic feasibility. Ductwork sealing has been priced, and the energy savings calculations have been performed. Anticipated payback periods have been defined.	Code-minimum	MERV-8, upgrading to MERV-13	None	7
Blue Cross Arena	1) Additional OA intake is recommended for AHU-(1-4,12). Using CO_2 sensors throughout will help increase OA intake as the building occupancy increases beyond the original design for 4,500 occupants. 2) Repairing low-temperature cutoff alarms in AHU-14 and AHU-20 will reduce the amount of return air brought into the space and allow for more OA intake. 3) Repairing operating sequences of the suite fan coil units and AHUs supplying fresh air to them will allow the units to supply fresh air instead of the current 100% recirculated air	Recommended UVGI inside AHUs in cooling coil sections - all units that are not using 100% outside air.	1) Facility is currently using MERV-8 Filters and is capable of upgrading to MERV 9 or 13 Filters.	Blue Cross Arena does not incorperate humdification controls at this time. Due to both the nature of these spaces (high traffic, high infiltration, and materials of construction) achieving the desired humidity levels during occupied hours is not feasible.	1) Resolving low-temperature cutoff alarms in AHU-14 and AHU-20 will reduce the amount of return air brought into the space and allow for more OA intake. 2) Using variable speed drives to adjust return & exhaust fan speeds, will create safer airflow pathways in the arena while reducing overall energy consumption 3) Lower pressure differentials across filters will decrease the energy consumption of the supply fans.	Code-minimum. Economizer is used when OA is between 40 and 65 deg F.	MERV-8	None	26

Blue text indicated additions in past month since previous progress report.

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Measures / Sites	Increased OA Ventilation	UVGI	Increased Filtration	Humidification Control	Energy Conservation Opportunities	Current Ventilation	Current Filtration	Current UVGI	# AHUs
Webster CSD - Dewitt Road Elementary	More information required before site-specific recommendations are made.	More information required before site-specific recommendations are made.	More information required before site-specific recommendations are made.	More information required before site-specific recommendations are made.	More information required before site-specific recommendations are made.	More information required.	More information required.	More information required.	More information required.
299 Niskayuna	Current OA intake is being overridden in order to satisfy the humidity control issue in the building. Upgraded controls sequencing and CO2 sensors in spaces is being investigated in order to better control OA ventilation as well as maintain humidity in space below required threshhold. In most areas, OA ventilation appears to be excessive, resulting in energy waste and uncontrolled humidity levels.	1) Coil-mounted UVGI is not possible in some areas due to limited space and accessibility to units for maintenance. Office areas have been identified as candidates for UVGI in return ducts. Cost estimates are being developed with vendor 2) In-duct UVGI and upper-room UVGI for the warehouse space is not recommended due to limited space occupancy and space size.	Owner is currently in process of upgrading to MERV-13 filters. Higher-rated filters are not recommended due to pressure drop issues in the units. Calculations are being prepared showing the increased costs associated with the higher performing filters.	Strict humidity requirements were already in-place in this facility to accommodate paper storage requirements. OA Ventilation recommendations will take into account relative humidity in the space.	Incorporating an economizer function into the air handling units will allow for significant savings as well as increased outdoor air ventilation. Issues have been identified with economizer controls and unintended economizer leakage. Recommendations are being developed to mitigate these issues which will result in energy savings. Additional zones for incorporating demand control ventilation have been identified and are being evaluated.	Units are controlled by combination of CO2 sensors and standard economizer controls. Some units do not currently bring in OA into the space, exceot as a result of leakage, which appears to be very high. CO2 levels in all spaces with sensors remain very low at all times.	MERV-8, upgrade to MERV-13 is completes	None	28
100 Great Oaks	The existing units ventilate outdoor air based on CO2 levels in the building. Thew unit's ability to incorporate additional ventilation has yet to be determined and will depend on either the cooling coil capacity or unit's ability to meet space setpoints. There may be issues with lack of sufficient CO2 sensors to maintain levels in all areas served by common RTUs.	There is very limited space in AHUs for UVGI. Installing UVGI in return ducts is a possible solution that will be investigated further in upcoming site visits. Our site visit to investigate this was postponedand a new site visit has been rescheduled for next week. The cloent requires 14 days notice for the tenants to	There is currently a 2" filter rack in the AHUs. The feasibility of upgrading to higher-rated MERV filters has yet to be determined based on the fan'a ability to overcome the pressure drop. Calculations are in progress to determine maximum-rated MERV filters.	More information required before site-specific recommendations are made.	More information is required in upcoming site visits before site-specific recommendations are made.	Unit ventilation is controlled by CO2 sensors within space.	MERV-8	None	10
NT Intermediate School	More information required before site-specific recommendations are made.	More information required before site-specific recommendations are made.	More information required before site-specific recommendations are made.	More information required before site-specific recommendations are made.	More information required before site-specific recommendations are made.	More information required.	More information required.	More information required.	More information required.
COR Library	1) Outside air to the public spaces is primarily supplied by the main penthouse air handler (AHU-1). Office and storage areas (closed to the public) are supported through natural ventilation and various zone air handlers. Potential improvements are still being evaluated.	1) UVGI is currently being evaluated for the main penthouse air handler's cooling coil section as this provides the majority of fresh air to the building. Other units are being reviewed for potential installations.	1) Most air handlers are being considered for upgrades to MERV-13 and will likely be capable of the increased static pressure. Fan Coils that provide localized cooling likely don't have capacity to support a MERV-13 filter.	More information required before site-specific recommendations are made.	More information required before site-specific recommendations are made.	The building has been designed for a combination of natural and mechaical ventilation. This is currently being compared to 2020 code to evaluate potential improvements.	Air Handlers currently use MERV-8 filters. Fan Coils used for local cooling support MERV 4 (estimated)	None	10

Blue text indicated additions in past month since previous progress report.

C) Lessons Learned/ Barriers Encountered

A study performed by Bianco et al. (2020) at the Italian National Institute for Astrophysics quantifies the susceptibility of the COVID-19 virus to UV lighting. Key findings indicate that a surface UV-C dose of 3.7 mJ/cm^2 is sufficient to achieve a 3-log inactivation (99.9% effectiveness) and complete inhibition of all viral concentrations was observed at 16.9 mJ/cm^2. This information supports UVGI selections from vendors and verifies ASHRAE guidance on UV air and surface treatment.

Industry guidance provided in the 2019 ASHRAE Handbook in chapter 62 indicates that the required irradiance for a typical in-duct system is on the order of 1,000 to 10,000 μW/cm^2 and coil surface irradiance levels are on the order of 1 to 100 μW/cm^2. Since irradiance (μW/cm^2) is a direct function of UV dosage (mJ/cm^2) and time of exposure, it is reasonable to conclude that the claims from the Bianco et al study fall in-line with ASHRAE's guidance.

One of the sites with multiple tenants has been unable to produce drawings for many of its tenant spaces. Many of the tenant spaces have been modified by the tenants to serve their individual needs. The revised approach to this building is to gather information from a sample number of tenant spaces and make assumptions regarding conditions in the remainder of the spaces. Accessibility to some of the tenant spaces is limited and requires 14 days' notice before site visits are permitted.

D) Proposed Work Plan Adjustments

N/A

E) Next Steps

- Complete remainder of site visits
- Finalize measures to be evaluated at each facility with vendor input and pricing
- Perform energy calculations & feasibility analyses
- Submit draft reports for review

F) Study Findings

The following indicates preliminary findings from the Blue Cross Arena study. It should be noted that this report is currently under review and may be subject to change. None of the recommendations listed below are required by code.

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Blue Cross Arena

259,000 sf sports arena located in Rochester, NY

Site-Specific Proposed Measures	Description	Annual Electric Savings (kWh)	Annual Steam Savings (MMBtu)	Net Annual Cost Savings	Estimated Cost of Installation
UVGI on Cooling Coils	Install UVGI lights on downstream side of cooling coils in (16) AHUs and (36) fan coil units. Installation costs equate to $2,646 per units.	-11,793	0	$ (2,818)	$ 137,600
Filter Upgrades	Upgrade from existing MERV 8 filters to high-efficiency MERV-9 filters with increased filtration and reduced pressure drop as well as rebalancing of airside systems. Installation costs equate to $530 per unit.	12,985	0	$ 1,066	$ 13,800
Outdoor Air Ventilation Improvements	Incorporate demand control ventilation to ensure that sufficient OA is supplied during high-occupancy events. This will also limit exorbitant energy consumption. A re-balancing of the air handling units is also recommended in order to refine airflow measurements.	0	-5	$ (100)	$ 9,400
Purge Fan Exhaust	Equip large fans with variable speed drives and allow the fans to operate as exhaust in leiu of current return air located in the stands. Doing so will improve airflow patterns in the arena bowl when occupied as well as reduce the number of return fans operating during events.	12,948	0	$ 1,096	$ 25,600
AHU Low Temperature Cutoff Repair	It is recommended that (2) AHUs are repaired in order to resolve low temperature cutoff alarms. Doing so will enable the units to bring in increased outdoor air.	-280	-146	$ (2,849)	$ 16,300
Suite AHU Controls Modifications	Change operating sequence of fan coil units in suites to economize when the outdoor air temperature is between 45° and 65°. Doing so will allow (2) AHUs to shut down and conserve energy as well as increase outdoor air ventilation.	-1,679	0	$ (280)	$ 3,700