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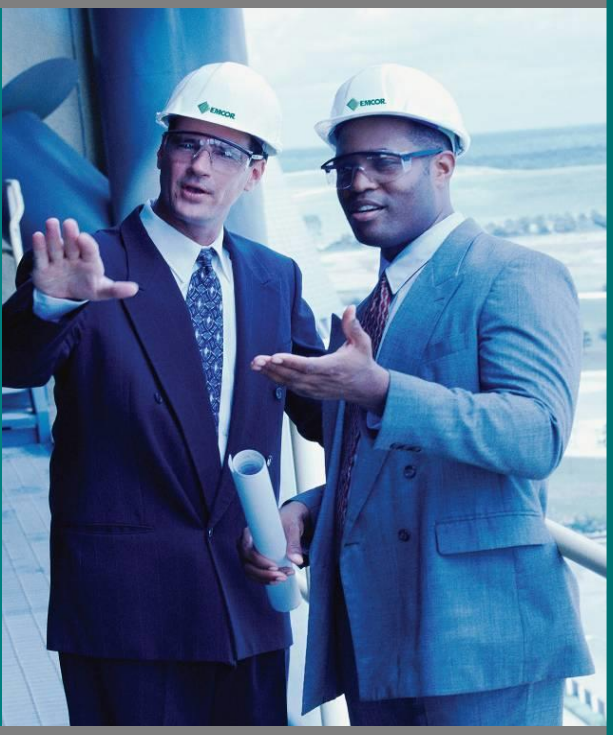

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NYSERDA Indoor Air Quality Analysis

August Preliminary Report

Prepared for

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9/3/2020

1.0 August Progress to Date

WP-01 – Rochester Museum and Science Center

During the month of August, the main focus for the Rochester Museum and Science Center was to gather available information on the systems in place and their operation. EMCOR performed a site visit for both the museum and planetarium and started to develop the ASHRAE safe operation plan with a calculated energy impact.

The next steps for the museum will be to finalize an ECM list, calculate the energy impact, finalize ASHRAE baseline calculations, and start to write the first draft report.

WP-02 – Finger Lakes Community College

In the month of August, FLCC submitted the remaining 12 months of utilities required to calculate the energy baseline for the study. A list of ASHRAE safe operation practices was developed to be included in the ASHRAE safe operation plan. The selected practices were taken from ASHRAE's guidance on re-opening for colleges and universities. Templates for the spreadsheet energy calculations for the safe operation plan are currently in progress.

During August, EMCOR compiled a list of preliminary energy conservation measures (ECMs) and began formatting energy calculations and requesting pricing for some of the ECMs as part of Tasks 4/5. At this stage, preliminary energy calculations are complete for two identified measures – installing UVGI in AHUs (system-level) and installing portable HEPA filtration units in classrooms.

2.0 Study Findings to Date

WP-01 – Rochester Museum and Science Center

RMSC – Planetarium

The Strasenburgh Planetarium is a two-story facility (with a basement) of approximately 37,000 sq. ft. of gross floor area located at 657 East Avenue, Rochester, NY 14607. The facility was built in 1968, currently serves as a Planetarium, and has a "dome" stargazing theater. The gas and electric distribution provider is Rochester Gas and Electric (RG&E), with gas and electric supply being provided by UGI Energy Services and Constellation Energy, respectively.

The Planetarium air distribution systems consist of the units summarized in the table below. Air handling units (AHUs) 4 through 7 are heat pumps that supply supplemental heating and/or cooling to the facilities. These units were not investigated at this stage of the study as they do not utilize outdoor air and will not operate as part of the ASHRAE safe operation plan. They will be analyzed as part of the next steps as they relate to potential energy conservation measures. Although it does not supply outdoor air and will not run during the safe operation plan, trend data for AHU-2 was obtained as it typically runs at the same time as AHU-1.

Designation	Make	Model	Areas Served	Notes
Return air fan	Trane	41 (Type: AF)	AHUs 1&2	5 HP fan motor with VFD
AHU-1	Trane	A02D55784 (Serial #)	Dome	10 HP fan motor with VFD
AHU-2	Trane	K01G05637C (Serial #)	Lobbies	7.5 HP fan motor with VFD
AHU-3	Trane	K02D55788 (Serial #)	Offices and meeting rooms	10 HP fan motor with VFD, VAV boxes in offices (including shop and IT areas), plate and frame heat exchanger serving reheats in offices
AHU-4	Trane	Climate Changer (Type: T6)	Front door entrance area	Just heat (no cooling coil)
AHU-5	Carrier	No nameplate	Offices/meeting areas	
AHU-6	York	HGB324-68	Rochester Engineering Society	Heat pump provides cooling only
AHU-7	York	G/HC048AA	Projector room	Heat pump provides cooling only

AHUs 1, 2, and 3 utilize variable frequency drives (VFDs) to control supply fans that are rated at 10,600, 7,500, and 10,200 CFM, respectively. Return air is supplied by a 13,000 CFM fan that serves AHUs 1 and 2

while return air for AHU-3 is supplied by a separate 8,300 CFM unit. All three AHUs utilize MERV 8 panel filters with MERV 13 bag filters. The panel filters serve as prefilters for the units.

Heating hot water for the units is provided by two Lochinvar natural gas fired hot water (HW) boilers. AHU-1 utilizes preheat and reheat coils while units 2 and 3 utilize only reheat and preheat coils, respectively. Reheat coils are used for comfort conditioning in individual spaces while the preheats are utilized to preheat makeup air when outdoor air temperature is below 55°F. A plate and frame heat exchanger is installed on the primary hot water loop to provide supplemental heating to the HW loop serving reheat coils in the (19) variable air volume (VAV) boxes. Supplemental baseboard heating serves the Rochester Engineering Society offices.

Chilled water to the cooling coils in AHUs 1-3 is provided by a 100-ton, air-cooled, R-22 Carrier chiller. Two identical Carrier air-cooled condensing units are located outside. There are also two refrigerant circuits (A and B), each circuit has its own 20 HP condenser fan with a VFD. The chiller is shut down during winter months and typically economizes when outdoor air is below 68°F.

The building is controlled via a digital/pneumatic hybrid controls system. A Johnson Controls Metasys building automation system (BAS) provides control to most the building's mechanical systems. The Metasys system controls the chiller based on outdoor air temperature and signals operation when the outdoor air temperature rises above 55°F. The boilers have reset controls which adjust the HW reheat temperature based on outdoor air temperature. The minimum HW temperature is 120°F at 60°F outdoor air temperature. Minimum outside air is set to 10% on AHUs 1 and 3.

Trended capabilities of the BMS were discussed with EMCOR technicians. A second site visit was conducted on 7/23 to establish a 14-day trending period that consisted of data logged at 15-minute intervals for AHUs 1, 2, and 3. This data includes parameters such as operating fan VFD speed as well as discharge, return, and mixed air temperatures.

As shown in the summary of the logged data in the table below, AHUs 1 and 2 have very similar runtimes. These units are either on or off while AHU-3 was shown to have unoccupied setbacks typical of office spaces. This results in "high" and "low" fan speed categories. The return air fans run nearly identical to their respective supply fans. To determine the operating demand as well as CFM, fans laws were utilized with the operating VFD speed. These in addition to the minimum and maximum operating conditions were used to determine the annual operating hours for each unit and therefore an estimated annual usage.

Existing Fan Operation							
	AHU-1 SAF	AHU-2 SAF	AHU-1&2 RAF	AHU-3 SAF "High"	AHU-3 SAF "Low"	AHU-3 RAF "High"	AHU-3 RAF "Low"
Avg. Operating (CFM)	10,272	7,497	12,937	7,642	6,349	6,218	5,165
Avg. Operating Fan Demand (kW)	8.1	6.5	4.3	3.2	2.0	1.3	0.8
Annual Operating Hours	4,064	4,057	4,064	4,934	3,826	4,931	3,829
Annual Fan Usage (kWh)	32,757	26,507	17,504	15,680	7,649	6,268	3,060

In addition to fan operational data, various conditioning parameters were logged as shown in the table below. Parameters highlighted in grey did not have trend capability and therefore were estimated based on an average of available data such as return air (RA) humidity and discharge air (DA) temperature or calculated from logged RA temperature and humidity. As shown in the table, the units have an average

operating return air humidity of 53% which is between the ASHRAE guidelines of 40-60%. However, it is unlikely that this humidity will be maintained during the winter months. In the next steps of this project, EMCOR will investigate the reactivation of the humidification units that have been abandoned in place due to their inefficacy.

Heating and Cooling Operation				
	AC-1 SAF	AC-2 SAF	AC-3 SAF "High"	AC-3 SAF "Low"
Avg. Operating RAT (°F)	72.5		73.9	75.2
Avg. RA Humid.	52%	50%	54%	55%
Est. RA Enthalpy	27.2	25.8	28.5	29.5
Avg. DA Humid.	42%			
Avg. DAT (°F)	64.3	60.1	58.0	58.0
Discharge Enthalpy (lbs./°F)	21.4	31.4	18.7	18.7
Min. Cooling Temp (°F)	55.0			
Est. Heating RAT (°F)	68.0			
Est. Heating DAT (°F)	72.0			

An ASHRAE safe operation plan is being developed using the ASHRAE commercial recommendations resource. This safe operation plan consists of two main ASHRAE recommendations: a two-hour flush cycle to be implemented before and after occupied hours and increasing outdoor air to the highest allowable amount during occupied hours. For this baseline, AHUs 1 and 3 are being analyzed as they supply outdoor air to the facility. The energy impact for these measures will be calculated using a TMY3 bin analysis. EMCOR anticipates that results of this analysis will be provided in the September Preliminary Findings Report.

Next Steps

- Complete ASHRAE Safe Operation Baseline
- Complete energy impact calculations for the identified ECMs.
    - Investigation of the filtration for AHUs 4-7
    - Revitalization of humidity units during the winter months
- Obtain pricing, equipment submittals from equipment manufacturers.

RMSC – Museum

After the first site visit, EMCOR started to analyze the current operations of the HVAC systems. After reviewing the space and the controls, it was determined that most of the information gathered will have to be through design documentation and conversations with the facilities staff. The museum's primary HVAC system is four supply air fans (SAF) serving dozens of water-source heat pumps throughout the building. Based on the design documentation, SAF-1, SAF-2, and SAF-3 supplies the building with outdoor air. Below is the single line diagram for SAF-1 and is the same layout for SAF-2 and SAF-3. Outdoor air dampers are currently locked in at 30%. Design outdoor air is 5,000 CFM for SAF-1 and is about half of the full flow for each supply air fan. The return air is pretreated by a heat pump before mixing with outdoor air going into the filter box. Each supply fan has a filter box with before the fan with MERV 10 pleated panels and MERV 13 bag filters. There is another heat pump after the supply air fan that heats/cools the discharge air to 70-75 °F during heating and 50-55 °F during the cooling season.

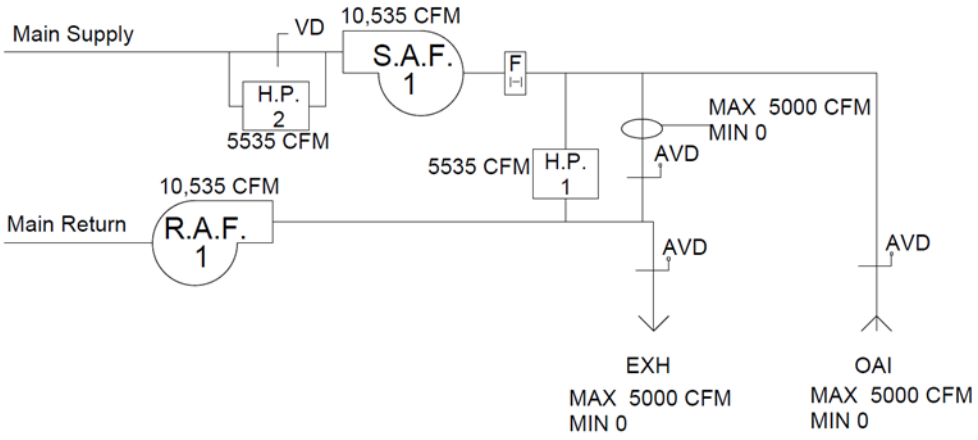

Figure 1 - SAF-1 Airflow Line Diagram

An ASHRAE safe operation plan was developed using the ASHRAE commercial recommendations resource. It was determined that the supply air fans operate as a dedicated outdoor air system with return air. There is a heat pump dedicated to each fan to temper the supply air the is supplied to the heat pumps throughout the building. ASHRAE suggests that a two-hour flush cycle to be implemented before and after occupied hours. In addition, ASHRAE suggests that the outdoor air be increased to the highest allowable outdoor airflow during occupied hours. The energy impact for the flush cycle and increase in outdoor air during occupied hours will be calculated using a TMY3 bin analysis.

Next Steps

- Develop ASHRAE baseline energy impact calculations.
- Develop energy impact calculations for the identified ECMs.

Proposed Work Plan Adjustments

None at this time.

Lessons Learned

None at this time.

WP-02 – Finger Lakes Community College

There is a total of 18 AHUs and makeup air units (MAUs) at FLCC which provide space heating and cooling and introduce outdoor air to occupied spaces. Two of these AHUs are original equipment from when the facility was built (AC-01 & AC-03 ~50 years of age) and are scheduled to be replaced within the next year, and a third (AC-05) is slated to be replaced with a redesigned unit in the near future. As such, these units are not being evaluated for UVGI. EMCOR intends to make recommendations regarding UVGI systems for the future replacements of these units. The table below shows all the AHUs and MAUs in service at FLCC.

Tag	Service	Location	System	Year	Make	Design CFM	Heat Coil (MBH)	Cool Coil (tons)
AC-01	D-Wing 3rd Floor Health Offices	3837 Mech	3-Pipe	1971	York	5,400	163	16
AC-02	D-Wing 2nd Floor Classrooms	3869 Mech	4-Pipe	2013	Air Enterprise	12,000	525	62
AC-03	D-Wing 3rd Floor Offices	3869 Mech	3-Pipe	1971	York	5,300	160	16
AC-04	2nd Floor Lecture Halls	3837 Mech	4-Pipe	2013	Air Enterprise	5,000	171	26
AC-05	B-Wing General	Clock Tower	3-Pipe	2002	York	7,720	380	16
AC-06	B-Wing 2nd, 3rd, 4th	Roof (B-Wing)	4-Pipe	2013	Air Enterprise	30,000	991	156
AC-07	C-Wing 2nd, 3rd, 4th	Roof (B-Wing)	4-Pipe	2013	Air Enterprise	50,000	4,013	263
AC-09	2nd Floor Offices, Practice Rooms	2628 Mech	4-Pipe, DX	2013	Air Enterprise	16,000	625	87
AC-10	Library	4510 Mech	3-Pipe	1995	Rochester Cust.	43,000	1,156	143
AC-11	Music	Gym Mech	3-Pipe	1991	Buffalo Forge	11,000	423	38
AC-12	Computer	4260 Mech	3-Pipe	1991	Buffalo Forge	27,000	1,058	93
AC-13	Art Classrooms	Roof (C-Wing)	4-Pipe	2016	Temtrol	6,900	648	391
AC-14	General SSC	3030 Mech	SSC 4-Pipe	2010	Temtrol	60,000	3,189	193
AC-15	Kitchen Makeup	3030 Mech	SSC 4-Pipe	2010	Temtrol	10,500	1,020	-
AC-16	SSC Auditorium	3030 Mech	SSC 4-Pipe	2010	Temtrol	15,000	719	52
HVU-01	Gym	Gym Roof	Gas-Fired	1991	Rapid	18,000	1,650	-
HVU-02	Gym	Gym Roof	Gas-Fired	1991	Rapid	18,000	1,650	-
HVU-03	Locker Rooms	3837 Mech	3-Pipe	1971	York	4,000	238	-

Preliminary energy impact calculations were completed for two of the identified ECMs: system-level UVGI and portable HEPA filtration units for classrooms. These calculations are still considered preliminary as submittals have not yet been received from manufacturers of either product, so power-draw is being calculated based on available data online. The manufacturer evaluated for system-level UVGI is Steril-Aire, and the portable HEPA unit under investigation is manufactured by Carrier. Additional manufacturers may be contacted through this process to broaden the base of evaluated products. Below are the preliminary energy impact metrics for these two measures. The energy use presented for the UVGI ECM at this state is for lamp usage only. The annual energy use of these systems is listed as a percentage of a year's typical energy use at the facility for context.

Description	Electricity Savings (kWh)	Peak Demand Savings (kW)	Natural Gas Savings (therms)	Annual Dollars Saved	% Electric Use	% Gas Use
Install system-level UVGI.	*(178,114)*	-	-	$ *(16,248.41)*	-3.2%	
Install portable HEPA filtration units in classrooms.	*(149,206)*	*(62)*	-	$ *(13,611.22)*	-2.7%	

A resource that has been particularly helpful in this past month has been IES' Committee Report: "Germicidal Ultraviolet (GUV) – Frequently Asked Questions." This document has been invaluable in

better understanding the operation and design of UVGI systems and how they may be best applied and evaluated in this study.

Lessons Learned

None at this time.

Proposed Work Plan Adjustments

None at this time.

Next Steps

- Continue work on ECM energy impact calculations.
- Complete calculations for ASHRAE safe operation plan.
- Obtain pricing, equipment submittals from equipment manufacturers.

3.0 Resources and Guidance

[1] *Germicidal Ultraviolet (GUV) – Frequently Asked Questions* – IES Committee Report

https://www.ies.org/standards/committee-reports/ies-committee-report-cr-2-20-faqs/

[2] *Reopening of Schools and Universities* – ASHRAE

https://www.ashrae.org/technical-resources/reopening-of-schools-and-universities

[3] *Commercial* – ASHRAE

https://www.ashrae.org/technical-resources/commercial