Energy Efficient Indoor Air Quality Analysis
Preliminary Findings Report – Month 3

520 MADISON AVENUE, NEW YORK, NY 10022

Note: Text in italics is from the previous monthly report.

Work Plan Number*: WP-VID02*
Date: 10/27/2020

Customer and/or Site Name*: 520 Madison Avenue, Tishman Speyer*

Building Square Footage:
1,000,000 square feet

Building Description:

520 Madison Avenue, New York City, is a 43-story high-rise office building located on Madison Avenue between 53rd and 54th Streets in the Plaza District of Midtown Manhattan. The property was built in 1982 with a total rentable area of approximately 1,000,000 sq. ft. intended for both corporate and retail purposes. The ground floor includes two restaurants and other retail tenants.

The building has remained open during the COVID-19 pandemic, but the tenant occupancy load is approximately 5%.

HVAC Overview:
1st Floor Lower Level houses the refrigerant plant, incoming high-pressure steam service, steam pressure reducing stations and heating equipment. The refrigerant plant consists of two (2) centrifugal electric chillers, 31 ice storage tanks with 214 tons per tank capacity, condenser water pumps and chilled water pumps. Ice is used for cooling when demand calls for it and to reduce the kw used by the main chiller during peak demand times. Ice is built after hours. Ice is ready for use at any time during the year should they need it. The heating system consists of a steam to hot water heat exchanger, circulating pumps, perimeter radiators, and hot water piping distribution.

The tenant floors are occupied by office space. The air conditioning system consists of a medium and low-pressure air distribution system, variable air volume boxes and ceiling diffusers. The conditioned air is delivered to the floor area using a medium pressure ductwork distribution system via duct risers running through the main building shafts. Variable volume boxes control the amount of conditioned air delivered to each zone. Ductwork distribution downstream of the variable air volume boxes is low pressure type. The conditioned air is returned from the office space to the main return air shafts via a ceiling return air plenum. The office spaces are typically heated by perimeter radiators fed from the main hot water supply and return risers.

Plant:
Centrifugal Chiller Plant and ice storage is located in the Basement.
Cooling Towers are on the roof.
Con Ed Steam is used for heating (via steam to hot water heat exchanger).

Airside System:
6 Large Air Handling Units (ACS-1 thru 6 : 132,000 CFM & 200 HP each) are located on the 2-story mechanical space on Floors 14 & 15, These units serve the entire building. They include steam pre-heat coils and chilled water coils. Each ACS system has a Return Fan (RS-1 through 6: 75 HP each). Return Air is pulled through return gratings.

Distribution System:
On Mechanical Floor 14/15: All Return Air mixes together before entering the 6 ACS Units.
On Mechanical Floor 14/15: All Supply Air Ducts from the 6 ACS units merge (mix) into one large Supply Duct.
On each tenant floor, there is an automatic damper at each horizontal tap on the supply and return vertical risers.
On tenant floors, return ductwork is generally not used, and the space above the ceiling is a return air plenum.
On tenant floors, supply air ductwork is installed above the hung ceiling.
VAV Boxes per floor: Approximately 25 to 30 VAV Boxes / Floor
Diffusers used: mostly square diffusers with some linear diffusers in special spaces.

Perimeter Heating:
Perimeter Heating: Finned Tube Radiation - Hot Water
No reheat coils on the tenant floors.

Supplement AC Units:
Tenants may have Supplemental AC units, as needed for small computer rooms, trading spaces, etc. Tenants may purchase condenser water from the building, as needed.

- ***Study findings to date***

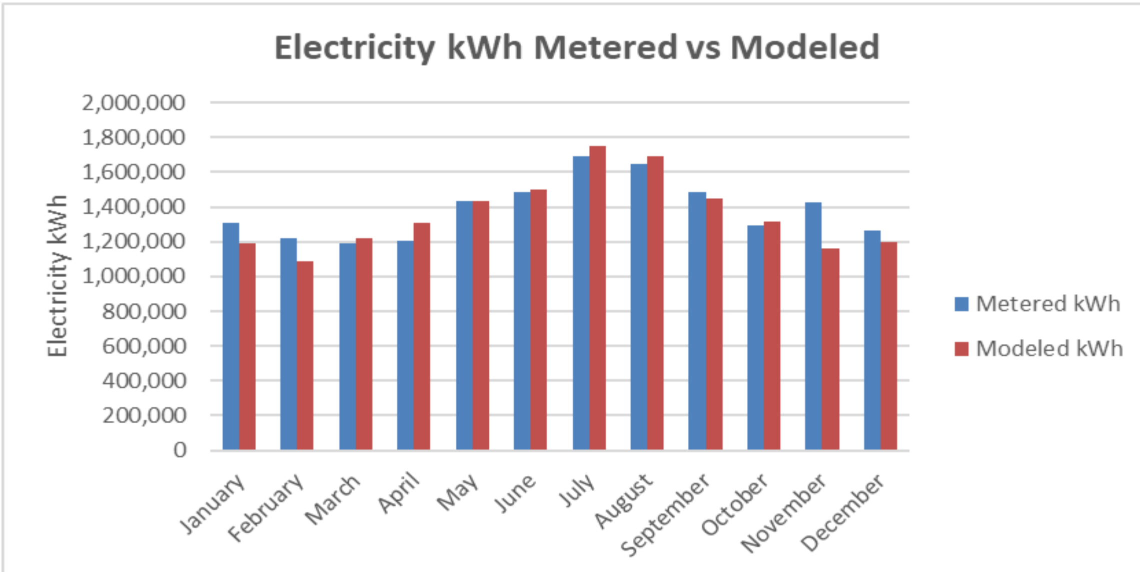
1. *Data Collection*
   - Progress to date – 100% complete.

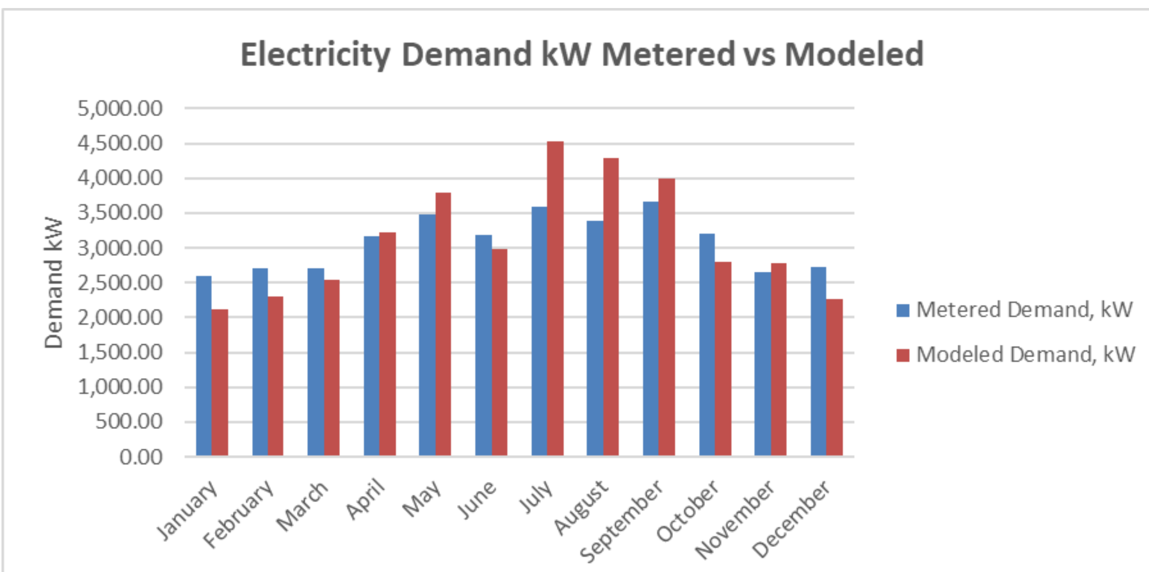
   a. *Vidaris received drawings and documents from the building manager (typical floor plans, elevations, HVAC information) for developing the baseline energy model which will be used to study the impact of various IAQ EEMs.*
   b. *Site visit by Vidaris Engineer to collect information on HVAC system (including AHU location, cfm, fan power, risers, VAV boxes, perimeter FTR heating), scope for UVGI-based and/or other filtration & disinfection strategies, and interior floor plan layouts, i.e. floor-by-floor area distribution of open office, conference, trading, dining, etc.*
   c. *Second site visit by Vidaris Engineer on 9/16/2020 to collect information about the centrifugal chillers, ice storage & pumps which were installed in 2016.*
   d. *Second meeting with Tishman Speyer to explore potential IAQ measures (HEPA & >MERV 15 filters, UVGI in front of A/C coils, portable devices using electrostatic charge in conference and pantry rooms, 100% OA flushing) and energy saving measures (OA modulation based on occupancy, air sealing of doors, tenant guidelines on lighting controls)*
   e. Received information on sequence of operation for outdoor air delivery for each air handling unit and economizer control settings.
2. *Energy Use Baseline*
   - Progress to date – 100% complete.

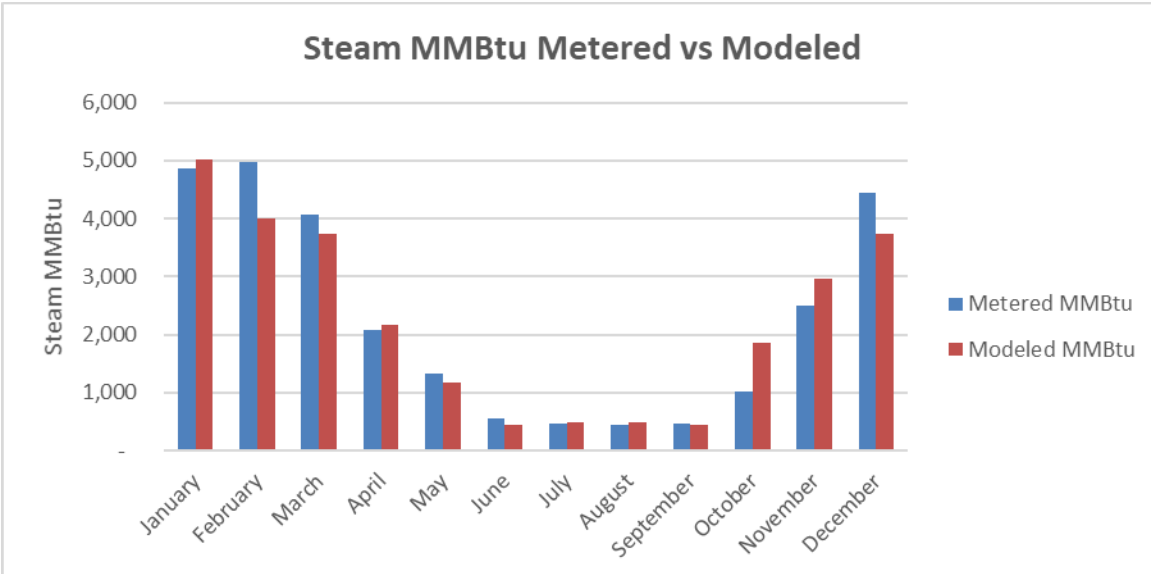
   a. Energy model has been updated to include chiller plant, ice storage and pump information collected from a site visit on 9/16/2020.
   b. The energy model has been matched with the utility bills from 2019, using the 2019 weather

file for NYC.

c. Results from Utility Matching: The actual utility bills are matched within 5% of building modeled electricity consumption, electric demand, and steam consumption. The energy model has been calibrated according to data collection, discussion with building engineer and best engineering judgement where data are unavailable. Below charts indicate actual utility bills vs modeled energy for electricity usage, electricity demand and steam usage for whole building.







3. *<u>Energy efficient IAQ model based on ASHRAE recommendations</u>*
    - Progress to date – 80% complete.
    - Ongoing discussions with Tishman Speyer to explore potential UVGI systems vendors and installers. Potential shortlist includes FSG (https://www1.fsgi.com/) for UV-C lamps downstream of the main building AHU chilled water coils; and Healthway for portable devices in high occupancy areas.
    - In the process of contacting vendors of UVGI systems and portable devices for information on energy use and sizing of the system for effective disinfection.

The following items are identified as building-specific opportunities for COVID-safe energy efficient IAQ package of improvements:

a. *UV-C lamps adjacent to AHU cooling coils: 6 Large Air Handling Units are located on the double-height mechanical floor 14 and serve the entire building. There appears to be adequate space (but tight) for the UV-C lamps on the leaving side of the chilled water coil in the air handling unit. At that location the air velocity is relatively low (approx. 500 feet per minute to prevent condensation drop carry-over) and almost linear flow. The electrical box would likely need to be relocated a couple feet to the side.*
Addressed Tishman Speyer's concerns about installing UV-C lamps in this space. Building engineer had concerns about UV-C lamps getting wet or getting in the way of workers during cleaning and maintenance of cooling coils. Space needed is at least 3 feet between the UV-C lamps and cooling coils. It appears from the photos that this space is available. Engineer also had concerns about safety of workers around the UV-C lamps. Vidaris recommended automated controls attached to access door that will turn off UV-C lamps when the door is opened. Tishman Speyer requested a recommendation for a UVGI vendor with experience in this field. Vidaris has researched and provided this recommendation.
There is a large supply duct (approx. 15 feet AFF) on mechanical floor 14/15 where air from all 6 supply ACS units combine briefly. However, the duct velocity is likely higher (1600 to 1800 fpm). And additionally, special ladders, supports and platforms would be required for safe UV-C system/lamp install & maintenance. Installing UV-C lamps here is not recommended.
b. *UV-C Lamps at Lobby AHU: Access to lobby AHU is via tenant space and is difficult.* This option is

impractical and no longer under consideration.

c. *Portable UVGI devices in large meeting rooms, dining area and trading floors (this option to be used if UV-C lamps cannot be installed at the central AHU location due to space limitations; or if treatment at the central AHU location is inadequate to handle the disinfection needs of particular high-occupancy spaces). Client is open to using portable UVGI devices to disinfect high-occupancy areas before and after occupancy. Client is interested in portable devices (manufactured by Healthway) which use MERV13 and electrostatic charge. This turns MERV13 into MERV20. Places like conference rooms and pantries may be candidates. With 5 ACH supplied by the HVAC system there may still be some viral load between air changes. That is where portable devices may help.*
d. *Reduce infiltration by better air sealing at doors so untreated air doesn't go to other spaces. Client is open to reduce infiltration by better air sealing at doors so untreated air doesn't go to other spaces. Vestibules around the elevators to minimize the stack effect is one option.*
e. *IAQ sensors to monitor particulates in addition to CO_2; sensors need to measure CO_2, concentration of other contaminants besides CO_2, and particle sizes to evaluate air quality before determining whether 100% OA should be used at any point in time. Client is open to IAQ sensors to monitor particulates in addition to CO_2; client believes sensors need to measure CO_2, concentration of other contaminants besides CO_2, and particle sizes to evaluate air quality before determining whether 100% OA should be used at any point in time.*
f. *Air flushing before and after occupancy. Building is capable of providing 100% OA and air flushing before and after occupancy is done when the weather allows it. HVAC (heating and cooling coils) is not designed to condition 100% OA on a design day.*
g. *Heat recovery for OA. Limited scope for adding heat recovery for OA due to space limitations.*
h. *Building has MERV 15 filters already in place*
i. *Static pressure monitoring to make sure filters are replaced at the right time. Static pressure at filters is monitored regularly as 75% of the building is DDC, to make sure filters are replaced at the right time.*
j. *Rotation of filters. Rotation of filters is impractical as there are too many filters (444+ filters) and the labor would be too time consuming.*
k. *Oversize fan motors for better part-load operation. This is not possible because fan motors are already too big to make it bigger*

4. <u>*Economic Analysis*</u>
   Not started yet. Will be done after completion of previous tasks.
5. <u>*Draft Report*</u>
   Not started yet. Will be done after completion of previous tasks. Expected delivery: Fourth week of November *2020.*
6. <u>*Final Report*</u>
   Not started yet. Will be done after completion of previous tasks. Expected delivery: Third week of December *2020*

- ***Proposed work plan adjustments***

1. <u>*EEMs to be kept*</u>
   a. *OA modulation*
   b. *Air sealing doors*
2. <u>*EEMs that are considered potentially impractical, but still under consideration:*</u>
   a. *Heat recovery*
3. <u>*EEMs that are considered potentially impractical, and removed from consideration:*</u>
   a. *Replacing certain fan motors with larger ones to operate at lower part load (Fans are very big already.)*
   b. *Static pressure reduction for advanced filtering (Building already has DDC controls and MERV 15 advanced filters.)*

    c. *Rotation of filters on a scheduled basis (Over 400 filters – impractical in terms of labor.)*

- ***Next steps***

1. *<u>Energy Model</u>*
    a. Code IAQ Measures to investigate energy use impact (this step is ongoing)
    b. Code Energy Efficiency measures to study how energy use can be reduced (this step is ongoing)

2. <u>Economic Analysis</u>
    a. Obtain cost information for IAQ measures and EEMs
    b. Perform simple payback analysis for EEMs.

Energy Efficient Indoor Air Quality Analysis
Preliminary Findings Report Month 3

THE MARK HOTEL, NEW YORK, NY 10075

Note: Text in italics is from the previous monthly report.

Work Plan Number: WP-VID01
Date: 10/26/2020

Customer and/or Site Name: Mark Hotel LLC

Building Square Footage:
185,000 square feet

Building Description:

Built in 1927 and upgraded during 2006 -2009 with new restaurants and penthouse, the 118-room boutique hotel is approximately 185,000 SF and has short- and long-term guest rooms and suites, guest amenities such as meeting rooms, salon, restaurant, full-service kitchen and fitness areas. Laundering process is outsourced except in house emergency guest services.

The building is heated and cooled by two absorption chiller heaters. AHUs with heating and cooling coils provide comfort cooling and ventilation in lower level common areas. Two natural gas fired DX roof top units provide conditioned ventilation air in corridors. Dedicated kitchen make-up air units, toilet and other exhaust fans provide the air pressurization balance. A Building Management System controls schedules and setpoints and setbacks for the HVAC System. Domestic HW heaters are dedicated for Guestrooms, Low Zone/Salon, and Kitchen/Restaurant.

The hotel was closed due to COVID-19 from March 28, 2020 through June 15, 2020. After reopening, the occupancy is currently at around 20%. The hotel restaurant opened on July 6, 2020.

- **Study findings to date**
  1. Data Collection
     - Progress to date – 90% complete.

       a. *Vidaris received architectural and mechanical drawings from Mark Hotel for creating baseline energy model and usage.*
       b. *A comprehensive list of all air handling units and AC units has been assembled based on field measurements. The data includes make, model, serial number flow rate, and outdoor air CFM.*
       c. *The following table lists all AHUs serving the facility and their flow rates, as well as the % outdoor air operation in the current COVID-pandemic phase. Some units are operating at 100% outdoor air (i.e. AHU C-5 Lobby) and are 24/7 to keep any potential contaminants from reentering the supply air.*
       d. *The table also shows existing MERV filter ratings on these units that can be upgraded to MERV 13/14 ratings for better filtration as recommended by ASHRAE.*

				Design (M Dwgs, Submittals, Catalog Data)			
Unit	Service	Location	Make	Supply Fan Flowrate cfm	Outdoor Air Flowrate cfm	% OA	Air Filter
AHU-C-1	Cellar Switch Gear Rm	Cellar Switch Gear Rm	United CoolAir Corporation	2,160	0	0%	Pleated, Throw-away, 30% efficiency, MERV 7
AHU-C-2	Cellar Telecom	Cellar Telecom	United CoolAir Corporation	800	0	0%	Pleated, Throw-away, 30% efficiency, MERV 7
AHU-C-4	Cellar Office, Locker Rooms, Employee Lounge/Dining	Cellar Women's Locker Rm	United CoolAir Corporation	2,200	2,200	100%	Pleated, Throw-away, 30% efficiency, MERV 7
AHU-C-5	FL 1 Lobby	Cellar Men's Locker Rm	York/JCI	8,000	8,000	100%	Prefilter-Merv 7 Post Filter-Merv 8
AHU-C-6	Cellar Laundry	Cellar Laundry	United CoolAir Corporation	800	200	25%	Pleated, Throw-away, 30% efficiency, MERV 7
AHU-C-7	Cellar Compactor Rm	Cellar Compactor Rm	United CoolAir Corporation	400	0	0%	Pleated, Throw-away, 30% efficiency, MERV 7
AHU-C-8	Cellar Kitchen	Cellar Kitchen	United CoolAir Corporation	4,500	4,500	100%	Pleated, Throw-away, 30% efficiency, MERV 7
AHU-1-1	FL 1 Casual Dining/Lounge	FL 1 Glass Wash Rm	United CoolAir Corporation	1,750	0	0%	Pleated, Throw-away, 30% efficiency, MERV 7
AHU-1-2	FL 1 Casual Dining	FL 1 Casual Dining	United CoolAir Corporation	1,300	600	46%	Pleated, Throw-away, 30% efficiency, MERV 7
AHU-2-1	FL 1 Formal dining	FL 2 MER	United CoolAir Corporation	4,000	2,000	50%	Pleated, Throw-away, 30% efficiency, MERV 7
AHU-2-2	FL 2 Fitness	FL 2 MER	United CoolAir Corporation	3,000	1,000	33%	Pleated, Throw-away, 30% efficiency, MERV 7
AC-16-1	FL 2-16 East Corridor	Roof	York	3,000	3,000	100%	
AC-16-2	FL 2-16 West Corridor	Roof	York	3,000	3,000	100%	

e. *In addition, measurements were also performed for air temperatures, CHW flow rates, and temperatures.*
f. *The AHU and FCU MERV filter upgrade measurement plan has been finalized. AHU-C-5/Lobby and two different model/size Guest Rm FCUs will be tested for pressure drop.*
g. *The Hotel's HVAC service provider has ordered the MERV 13/14 filters. They are expected to arrive in two weeks of time however the vendor has notified that they are backordered. The Hotel's engineering department has also ordered filters for the FCU units which have arrived.*
h. *JCI/York has been asked to provide a material and labor proposal for air disinfection UVC lamps for AHU-C-5 Lobby. Note, the original United CoolAir Corporation AHU was replaced with a JCI/York unit in 2012-2013. JCI/York offers factory UVC lamp options (by UVDI).*
i. *The cost quotation for material and labor from JCI/York has been obtained for the UVDI V-MAX Grid*.
j. Vidaris measured pre and post energy data including fan power, CFM, current, voltage, and power factor for the fan coil units with the MERV13 filters. A sample of two different size FCUs is shown in the image below.
k. Since the MERV 13 filters installed are brand new there wasn't much pressure drop noted between the existing and MERV filters that would adversely affect the energy use.
l. To verify the actual energy use another quick round of power measurements is planned in two weeks' time after the MERV filters are used for a month and expected to be loaded/dirty which may increase the fan power slightly.

Fan Coil Unit: Rm 310			
	Existing Air Filter	New Air Filter	New Air Filter
	MERV-	MERV-8	MERV-13
Quantity & Dimensions	(1) 7x48.5x1		(1) 7x48.5x1
FPM/CFM Filter	392/664		307/
FPM/CFM Discharge Grille	558/664		501/596
Static Pressure Drop-Across Filter (inwc)	0.175		0.253
Fan Motor Volts (nameplate)	115-127		115-127
Fan Motor Amps (nameplate)	(2)1.5		(2)1.5
Service Factor (nameplate)			
Fan Motor Volts (actual) Med Speed	125		124
Fan Motor Amps (actual) Med Speed	.7/.6		.6/.6

Fan Coil Unit: Rm 301			
	Existing Air Filter	New Air Filter	New Air Filter
	MERV-	MERV-8	MERV-13
Quantity & Dimensions	(1)7x34x1		(1)7x34x1
FPM/CFM Filter	346/410		276/
FPM/CFM Discharge Grille	482/410		435/370
Static Pressure Drop-Across Filter (inwc)	0.103		0.201
Fan Motor Volts (nameplate)	115-127		115-127
Fan Motor Amps (nameplate)	(1)1.5		(1)1.5
Service Factor (nameplate)			
Fan Motor Volts (actual) Med Speed	125		125
Fan Motor Amps (actual) Med Speed	0.6		0.6

2. <u>Energy Use Baseline</u>
   - Progress to date – 100% complete.

     Vidaris has developed an energy use baseline consisting of several years of building utility use prior to any recent building shutdowns or adjustments due to COVID-19. This energy use will be used as a baseline to determine the energy impact from COVID-safe energy efficient IAQ package of improvements in a manner that aligns with published guidance from reputable sources and code minimums.
3. *<u>Economic Analysis</u>*

   Not started yet. Will be done after completion of previous tasks.
4. *<u>Draft Report</u>*

Not started yet. Will be done after completion of all field tasks. Expected delivery: Second week of November 2020.

5. *Final Report*
   Not started yet. Will be done after completion of previous tasks. Expected delivery: Fourth week of November 2020

- **Proposed work plan adjustments**
  - Progress to date – 90% complete.

    a. *After field investigation it was determined heat recovery to the lobby system may not be feasible due to the lack of the room in the ceiling ductwork and return air plenum for installation of the heat recovery wheel. Following new measures are being considered in-lieu of this measure:*
    b. *Absorption chiller 1 Qty @ 330T may be replaced by an array of modular chillers 11x30T Multistack modules – Sizing calculation is ongoing and rigging paths, and electrical infrastructure are being investigated.*
    c. *2 Qty CHW pumps are also being reviewed and whether a higher delta T design (44-56) could be pursued instead of (44-54) on some AHUs based on AHU cut sheets and existing piping and balancing valves. These pumps are already on VFD.*
    d. *The Gym AHU 2-2 is a standalone unit rated 3,000 cfm. This unit operates continuously and cycles at night to maintain setpoint. We will review the possibility of adding portable devices during unoccupied times and cycling the AHU during those times.*
    e. *Analysis underway for ECM to reduce fan runtime in common area AHUs as a result of upgrading the chiller plant and installing new boilers.*
    f. Analysis and QC underway for ECM to reduce 100% outdoor air from the lobby, dinning, and fitness room units to ASHRAE 62.1 recommended levels.
    g. Analysis and QC underway for EC motors in guestrooms fan coil units.
    h. Analysis and QC complete for Intellihood kitchen controls on the kitchen hood that reduce exhaust air rate.

- **ECMs considered but not selected**

    a. *The Lobby AHU is a 100% OA system with no heat recovery or demand-controlled ventilation currently. Typically, the system operates at 50% OA spring, fall and summer; However currently due to the COVID-19 it is operating at 100% OA. This will affect the energy use negatively but is a necessity, for now, to maintain safe indoor environment. Installing heat recovery was considered as an EEM but due to space limitations and access issues this measure was not deemed suitable.*
    b. *UV feasibility in AHUs and Ductwork for guestrooms – cost of installation of any UVGI devices would be much higher since the access to majority of the AHUs is from guest rooms. Some systems may not have a direct access at all and would need to have to cut a hole in the ceiling to gain access to the AHUs.*
    c. *UVGI Portable Room Decontamination as Maintenance Protocol.*

- **Next Steps**
    1. Finalize data collection
        a. Complete measurement of in-room FCUs and two AHUs.

2. Energy report
    a. Draft energy report including energy conservation measures and IAQ improvements.

Additional Resources:

https://www.orf.od.nih.gov/TechnicalResources/Bioenvironmental/Pages/default.aspx

https://www.orf.od.nih.gov/TechnicalResources/Bioenvironmental/Documents/ASHRAE_Final_Operating_Room_508.pdf

https://www.orf.od.nih.gov/TechnicalResources/Bioenvironmental/Documents/Applicationsofultravioletgermicidalirradiationdisinfectioninhealthcarefacilities_508.pdf