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Indoor Air Quality Study

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INTRODUCTION

Commercial buildings are preparing to reopen following building operational guidance to avoid the continuous spread of COVID-19. A number of resources, such as ASHRAE and IES, continue to develop guidance around safely re-opening for business.

Current guidelines recommend various HVAC system operational changes and potential equipment enhancements to improve commercial building Indoor Air Quality (IAQ) conditions, aligned closer to existing requirements in healthcare buildings. Operational changes include higher filtration and longer run-time for Air Handling Units, while equipment enhancements include Ultraviolet Germicidal Irradiation (UVGI) and ionizer device installations. Major mechanical capital improvements that require more invasive retrofits, such as AHU humidification equipment, have received less traction for “day 1” reopening implementation.

As part of this study, NYSERDA would like to evaluate, document, and disseminate the energy impacts of introducing Ultraviolet Germicidal Irradiation (UVGI) along with COVID safe operating procedures, as described in ASHRAE and IES guidelines. Operational changes related to filtration, ventilation, and HVAC controls improvements, as well as other system enhancements, implemented in conjunction with UVGI will be evaluated. A particular focus of this study is to determine the energy impact of possible UVGI technologies on the recommended, energy-intensive measures recommended by ASHRAE guidelines.

The following buildings owners have committed the identified buildings below for participation this study.

Owner	Address	Area (SF)	Year Built	HVAC Summary
Tishman Speyer	200 Park Avenue	2.8M	1963	<ul style="list-style-type: none"> - Centralized fan system for perimeter - Floor-by-floor AHUs for interior - Chilled water plant - ConEd Steam
Building Owner	Commercial Office	650k	1914, 1998 (Reno)	<ul style="list-style-type: none"> - Floor-by-floor AHUs - Chilled water plant - Gas-fired boiler plant
L&L Holdings	222 Broadway	756k	1961, 2011 (Reno)	<ul style="list-style-type: none"> - Centralized fan system for perimeter and interior - Chilled water plant - ConEd steam
L&L Holdings	114 5 th Avenue	350k	1910, 2014 (Reno)	<ul style="list-style-type: none"> - Floor-by-floor water cooled DX AHUs - Oil-fired boiler plant

RXR Realty	230 Park Avenue	1.4M	1929, 2004 (Reno)	<ul style="list-style-type: none"> - Centralized fan system for perimeter - Floor-by-floor AHUs for the interior - Chilled water plant - ConEd steam
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The following sections develop the preliminary findings of this study as of September 2020.

200 PARK AVENUE

Building Description

200 Park Avenue is located on the corner of Park Avenue and East 44th Street in the Midtown Manhattan. Built in 1963, this 58 story office building is approximately 2,990,000 square feet. An estimated 30 people are employed at the facility. The facility is supplied with electricity and steam. Electricity is used for day to day building HVAC operation and tenant consumption, while steam is used for space heating, steam turbine chillers, and hot water production.

Building operating hours are generally 6:00 AM to 6:00 PM, Monday to Friday, with an estimated peak occupancy of about 6,730 people. Building occupancy levels is expected to be at 50% while due to COVID-19 concerns, while building systems will maintain normal operation for lease obligations. The building is open 24/7 and services are provided after hours and on weekends by request, with limited weekend operation.

An approximate total of 138 air handling units (AHUs) serve the interior and perimeter zones of the building, ranging in size from 3,000 to 78,000 CFM. The perimeter centralized AHUs use 100% outside air, serving induction units at the perimeter, whereas the floor-by-floor interior AHUs receive ventilation air from a centralized system. A high-level summary of the AHU breakdown is provided below:

- (2) Upper zone (47th FL – 57th FL) perimeter AHUs.
- (4) Mid-zone (21st FL – 46th FL) perimeter AHUs.
- (6) Lower zone (Ground FL – 20th FL) perimeter AHUs.
- (8) Miscellaneous lower house fans.
- (116) Interior AHUs.

Operational Changes

As part of their re-opening effort, the facility has adopted the following ASHRAE COVID operational strategies:

ASHRAE Recommendations ¹	Energy Impact	Adoption	Insights/Comments
Increase air filtration to MERV 13 or greater	Medium	Included	Floor AHUs had MERV-14 filters. All being upgraded to MERV-15.
Eliminate or reduce air recirculation, increase outside air fraction up to 100%	High	Included	Certain AHUs have been operating at 100% OA for 4-5 hours/day.
Maintain relative humidity levels between 40-60%	Medium	Included	Already performed as part of regular operation
Deactivate or bypass heat recovery wheels	High	Excluded	No heat recovery systems at the facility

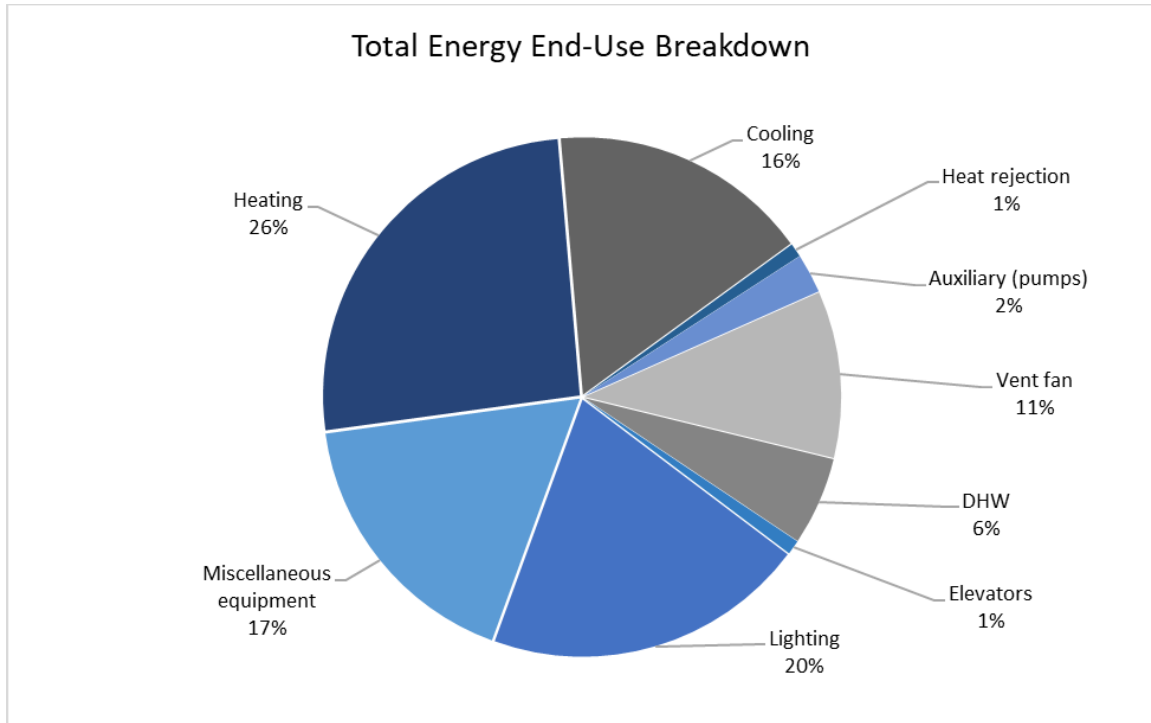
¹<https://www.ashrae.org/technical-resources/healthcare#suggested>

Other operational changes at the facility include:

- Building experiencing limit occupancy. Approximately 300-400 people visit 200 Park Avenue daily. Occupancy anticipated to increase to 500-600.
- AHU operation has been modified to 6AM-8PM, slightly extended from 6PM shutdown prior to COVID more operation. Restaurant and associated HVAC equipment are operating at reduced modified hours.
- There are a few tenant overtime HVAC requests for weekend operation related to tenant IT staff needs to keep move-in schedules on track.

Energy End-Use Breakdown

AKF developed an eQUEST energy model for 200 Park Avenue to simulate energy consumption at the facility. The model was calibrated using actual meteorological year for 2019 weather data, compared against the actual 2019 energy consumption for the building, to reflect energy consumption pre-COVID operational changes. The following chart present a preliminary energy end-use breakdown as generated by the energy model.



Proposed UVGI and Other Technologies

As part of this investigation, 200 Park Avenue is considering both UVGI and non-UVGI technologies to incorporate into their systems, with the goal of possibly rolling back the ASHRAE recommendations and their energy impact. The following measures are being considered at the facility.

UVGI and Other Strategies Considered	Adoption	Insights/Comments
UV Lights installed in the AHU / duct mounted	Pending	Pending site walkthrough and additional discussions with facility staff
UV Lights installed in the upper room	Pending	Pending site walkthrough and additional discussions with facility staff
UV Lights in the elevator cab	Included	N/A
UV Lights installed in the loading dock	Included	N/A
Photocatalytic oxidation (PCO) duct-mounted unit	Pending	Pending technology review by NYSERDA

AKF is still in the process of evaluating other non-UVGI technologies as part of our analysis. Technologies that are deemed suitable for evaluation will be shared with NYSERDA for further evaluation and inclusion in this study.

Next Steps

- Conduct preliminary site walkthrough.
- Energy model:
 - o Develop a post-COVID energy model baseline, to reflect ASHRAE recommended measures.
 - o Evaluate the energy impact of UVGI and other strategies.
- Develop a simple payback for the measures evaluated.
- Present estimated impacts on energy consumption and carbon emissions, ease of implementation, and order of magnitude cost impact.
- AKF to provide a draft report by 11/13/20.

COMMERCIAL OFFICE BUILDING

Building Description

The commercial office building is approximately 650,000 square feet, has 11 stories, and was built in 1913. An estimated 10 people are employed at the facility. The facility is supplied with electricity and natural gas. Electricity is used for day to day building HVAC operation and tenant consumption, while natural gas is used for space heating and tenant consumption.

Building operating hours are generally 6:00 AM to 6:00 PM, Monday to Friday, with an estimated peak occupancy of about 1,200 people. Building occupancy levels is expected to be at 50% while due to COVID-19 concerns, while building systems will maintain normal operation for lease obligations. The building is open 24/7 and services are provided after hours and on weekends by request, with limited weekend operation. There are 3 major tenants that occupy floors 2 to 11, and three of the four available ground floor retail spaces are currently occupied. The following equipment serves the building:

- (6) base building boilers and associated pumps.
- (4) cooling towers and 3 associated pumps.
- Approximately 6 exhausts fans.
- (4) large electric chillers and 6 associated pumps.
- (3) small AC units.
- Approximately 4 miscellaneous pumps.
- (1) make-up air unit that provides fresh air to the floors.
- (29) floor by floor AHUs, controlled by the tenants.
- (45) computer room air handling unit, controlled by the tenants.
- 22MW of available emergency power generators.

Operational Changes

As part of their re-opening effort, the facility has adopted the following ASHRAE COVID operational strategies:

ASHRAE Recommendations ¹	Energy Impact	Adoption	Insights/Comments
Increase air filtration to MERV 13 or greater	Medium	Excluded	Built-up AHUs cannot accommodate filters larger than MERV-8
Eliminate or reduce air recirculation, increase outside air fraction up to 100%	High	Included	Makeup-air unit running at constant speed, 100% outside air

ASHRAE Recommendations ¹	Energy Impact	Adoption	Insights/Comments
Maintain relative humidity levels between 40-60%	Medium	Included	Already performed as part of regular operation
Deactivate or bypass heat recovery wheels	High	Excluded	No heat recovery systems at the facility

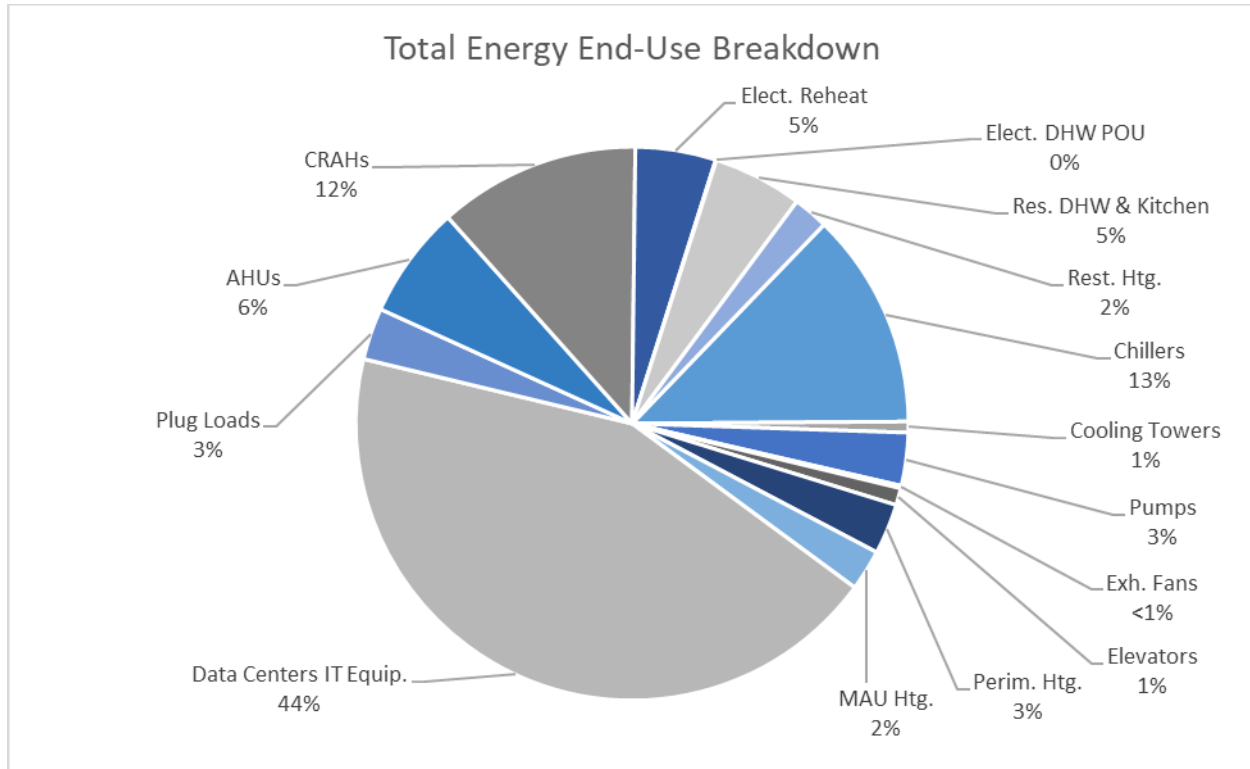
¹<https://www.ashrae.org/technical-resources/healthcare#suggested>

Other operational changes at the facility include:

- Building still experiencing limit occupancy, only floors 8 through 10 are occupied. No expected to change in the near future.
- A total occupancy of approximately 120 people, less than 5% of the typical occupancy.
- All AHUs are tenant controlled and are following normal operating schedules.
- There are a number of floors with AHUs running in curtailment mode of operation.
- Building has prepared a day-1 re-entry plan.
- An IAQ and mold assessment in the common areas was conducted in May.
- Facility has been approached by HVAC contractors regarding UV technologies.

Energy End-Use Breakdown

AKF developed an eQUEST energy model for the building to simulate energy consumption at the facility. The model was calibrated using actual meteorological year for 2019 weather data, compared against the actual 2019 energy consumption for the building, to reflect energy consumption pre-COVID operational changes. The following chart present a preliminary energy end-use breakdown as generated by the energy model.



Proposed UVGI and Other Technologies

As part of this investigation, the facility is considering both UVGI and non-UVGI technologies to incorporate into their systems, with the goal of possibly rolling back the ASHRAE recommendations and their energy impact. The following measures are being considered at the facility.

UVGI and Other Strategies Considered	Adoption	Insights/Comments
UV Lights installed in the AHU / duct mounted	Pending	Pending site walkthrough and additional discussions with facility staff
UV Lights installed in the upper room	Pending	Pending site walkthrough and additional discussions with facility staff
UV Lights in the elevator cab	Included	N/A
UV Lights installed in the loading dock	Included	N/A
Photocatalytic oxidation (PCO) duct-mounted unit	Pending	Pending technology review by NYSERDA

AKF is still in the process of evaluating other non-UVGI technologies as part of our analysis. Technologies that are deemed suitable for evaluation will be shared with NYSERDA for further evaluation and inclusion in this study.

Next Steps

- Conduct preliminary site walkthrough.
- Energy model:
 - o Develop a post-COVID energy model baseline, to reflect ASHRAE recommended measures.
 - o Evaluate the energy impact of UVGI and other strategies.
- Develop a simple payback for the measures evaluated.
- Present estimated impacts on energy consumption and carbon emissions, ease of implementation, and order of magnitude cost impact.
- AKF to provide a draft report by 11/13/20.

222 BROADWAY

Building Description

222 Broadway is located on the corner of Broadway Avenue and Fulton Street in Manhattan. Built in 1961, and renovated in 2011, this 31 story office building is approximately 756,000 square feet. An estimated 15 people are employed at the facility. The facility is supplied with electricity and ConEd steam. Electricity is used for day to day building HVAC operation and tenant consumption, while steam is used for space heating and cooling through steam driven chillers.

Building operating hours are generally 6:00 AM to 6:00 PM, Monday to Friday, with an estimated peak occupancy of approximately 3,000 people. Building occupancy levels is expected to be at 50% while due to COVID-19 concerns, while building systems will maintain normal operation for lease obligations. The building is open 24/7 and services are provided after hours and on weekends by request, with limited weekend operation. There are a variety of major tenants that currently occupy the floors.

The following equipment serves the building:

- (2) steam and electric driven chillers, and 3 associated pumps.
- (4) cooling towers and 3 associated pumps
- (3) glycol towers and 3 associated pumps.
- (16) AHUs serving building and tenant spaces.
- (6) exhaust fans and 1 supply fan.

Operational Changes

As part of their re-opening effort, the facility has adopted the following ASHRAE COVID operational strategies:

ASHRAE Recommendations ¹	Energy Impact	Adoption	Insights/Comments
Increase air filtration to MERV 13 or greater	Medium	Included	AHUs had MERV-14, increased to MERV-15 in April 2020.
Eliminate or reduce air recirculation, increase outside air fraction up to 100%	High	Included	Outdoor air fraction increased above 33% normal.
Maintain relative humidity levels between 40-60%	Medium	Included	Already performed as part of regular operation
Deactivate or bypass heat recovery wheels	High	Excluded	No heat recovery systems at the facility

¹<https://www.ashrae.org/technical-resources/healthcare#suggested>

Other operational changes at the facility include:

- Building purged with fresh OA at the end of the day.
- CO2 readings are being taken throughout the day.
- Approximately 80-100 people/day, about 2% of maximum occupancy.
- The facility expects an increase in occupancy to at most 25% by mid-October, and possibly 50% by January 2021.
- No major changes in operating equipment schedules.
- Running airside economizer whenever possible.
- The facility is considering UV technologies for back of house and elevator spaces.

Next Steps

- Gather additional building information, review and confirm CFR.
- Review utility data, interval utility data, and BMS trend data when available.
- Conduct preliminary site walkthrough.
- Energy model:
 - o Recalibrate existing energy model to pre-COVID operation.
 - o Develop a post-COVID energy model baseline, to reflect ASHRAE recommended measures.
 - o Evaluate the energy impact of UGVI and other strategies.
- Develop a simple payback for the measures evaluated.
- Present estimated impacts on energy consumption and carbon emissions, ease of implementation, and order of magnitude cost impact.
- AKF to provide a draft report by 12/4/20.

114 FIFTH AVENUE

Building Description

114 5th Avenue is located on the corner of 5th Avenue and East 17th Street in Manhattan. Built in 1910, this 19 story retail and office building is approximately 350,000 square feet. An estimated 10 people are employed at the facility. The facility is supplied with electricity and fuel oil. Electricity is used for day to day building HVAC operation and tenant consumption, while fuel oil is used boiler consumption for steam and hot water production.

Building operating hours are generally 6:00 AM to 6:00 PM, Monday to Friday, with an estimated peak occupancy of about 1,500 people. Building occupancy levels is expected to be at 50% while due to COVID-19 concerns, while building systems will maintain normal operation for lease obligations. The building is open 24/7 and services are provided after hours and on weekends by request, with limited weekend operation. There are a variety of major tenants that currently occupy the floors. The following equipment serves the building:

- Two oil fired steam boilers that produce steam.
- Steam is used for heating and for heating hot water production via steam to hot water heat exchangers.
- Perimeter heating via fin tube radiators, zone heating via VAV hot water reheat.
- Floor by floor DX air handling units, each with electric preheat for incoming outside air, and a waterside economizer coil for free cooling.
- Miscellaneous exhaust fans.

Operational Changes

As part of their re-opening effort, the facility has adopted the following ASHRAE COVID operational strategies:

ASHRAE Recommendations ¹	Energy Impact	Adoption	Insights/Comments
Increase air filtration to MERV 13 or greater	Medium	Included	AHUs already equipped with MERV-13
Eliminate or reduce air recirculation, increase outside air fraction up to 100%	High	Included	Outdoor air fraction increased to 100%
Maintain relative humidity levels between 40-60%	Medium	Included	Already performed as part of regular operation

ASHRAE Recommendations ¹	Energy Impact	Adoption	Insights/Comments
Deactivate or bypass heat recovery wheels	High	Excluded	No heat recovery systems at the facility

¹<https://www.ashrae.org/technical-resources/healthcare#suggested>

Other operational changes at the facility include:

- Filters being switched quarterly, units direct vented to the building façade.
- Normal occupancy about 1,400-1,500 people, currently at 10-30 people/day, very low occupancy
- Typically about 50-80 employees/floor

Next Steps

- Gather additional building information, review and determine CFR.
- Review utility data, interval utility data, and BMS trend data when available.
- Conduct preliminary site walkthrough.
- Energy model:
 - o Develop spreadsheet energy model.
 - o Develop a post-COVID energy model baseline, to reflect ASHRAE recommended measures.
 - o Evaluate the energy impact of UGVI and other strategies.
- Develop a simple payback for the measures evaluated.
- Present estimated impacts on energy consumption and carbon emissions, ease of implementation, and order of magnitude cost impact.
- AKF to provide a draft report by 12/4/20.

230 PARK AVENUE

Building Description

230 Park Avenue is located on the corner of Vanderbilt Avenue and East 46th Street in Manhattan. Built in 1929 and renovated in 2004, this 34 story office building is approximately 1.4 million square feet. An estimated 20 people are employed at the facility. The facility is supplied with electricity and ConEd steam. Electricity is used for day to day building HVAC operation and tenant consumption, while steam is used for space heating and cooling with steam absorbers and steam driven chillers.

Building operating hours are generally 6:00 AM to 6:00 PM, Monday to Friday, with an estimated peak occupancy of about 4,500 people. Building occupancy levels is expected to be at 50% while due to COVID-19 concerns, while building systems will maintain normal operation for lease obligations. The building is open 24/7 and services are provided after hours and on weekends by request, with limited weekend operation. There are a variety of major tenants that currently occupy the floors. The following equipment serves the building:

- AHUs serving the perimeter induction units.
- Central AHUs that provide air to tenants, with supply and return fans.
- Centralized chilled water plant, with both steam absorbers and steam turbine driven chillers.
- Supplemental water cooled AHUs for tenants.
- High pressure steam for steam absorber chillers, ground floor heating, and base building AHU steam coils.
- One large exhaust fan for the building restrooms.

Operational Changes

As part of their re-opening effort, the facility has adopted the following ASHRAE COVID operational strategies:

ASHRAE Recommendations ¹	Energy Impact	Adoption	Insights/Comments
Increase air filtration to MERV 13 or greater	Medium	Included	AHUs already equipped with MERV-13.
Eliminate or reduce air recirculation, increase outside air fraction up to 100%	High	Included	Outdoor air fraction increased to 100% for certain units
Maintain relative humidity levels between 40-60%	Medium	Included	Already performed as part of regular operation

ASHRAE Recommendations ¹	Energy Impact	Adoption	Insights/Comments
Deactivate or bypass heat recovery wheels	High	Excluded	No heat recovery systems at the facility

¹<https://www.ashrae.org/technical-resources/healthcare#suggested>

Other operational changes at the facility include:

- Staff is performing a morning and after hours air flush, with high air changes per hour.
- Systems currently under normal operation
- Card entry systems allows for monitoring activity into the building. People counters coming online.
- FCU under maintenance for some large tenants, a majority of supplemental ACs not maintained by the base building.
- Facility equipped with iES/MACH WellSTAT, over the 100 sensors, will investigate as part of the study.
- Main approach – improve dilution in the space.
- Technologies being considered:
 - o UVGI.
 - o Would like to tackle elevators and restrooms – possibly UVGI, oxidizers (non-ionizer), maybe even conference rooms.
 - o Concern about refraction for upper room applications
 - o Dedicated exhaust fans for elevator cabs, or maybe purifiers
- Would like to prioritize elevator cab UVGI technology

Next Steps

- Gather additional building information, review and determine CFR.
- Review utility data, interval utility data, and BMS trend data when available.
- Conduct preliminary site walkthrough.
- Energy model:
 - o Develop spreadsheet energy model.
 - o Develop a post-COVID energy model baseline, to reflect ASHRAE recommended measures.
 - o Evaluate the energy impact of UGVI and other strategies.
- Develop a simple payback for the measures evaluated.
- Present estimated impacts on energy consumption and carbon emissions, ease of implementation, and order of magnitude cost impact.
- AKF to provide a draft report by 12/4/20.