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Preliminary Findings Report No. 2

NYSERDA Energy Efficient Indoor Air Quality Analysis

August 28th, 2020

Executive Summary

Syska has been engaged by NYSERDA to evaluate the engineering feasibility, energy usage and operational cost impact of making indoor air quality (IAQ) improvements to existing buildings and spaces. The overall effort is split across two separate studies: a commercial office tenant in Manhattan and a commercial office building operator/occupier in Westchester. The studies focus on assessing COVID-mitigating improvements to building systems and operations that also incorporate energy efficiency without sacrificing safety or indoor air quality.

Existing Conditions

Below is a summary of the existing building characteristics and building systems for each project.

Study 1 – Manhattan Commercial Office Tenant			
Number of Floors	6	Peak Occupants (pre-COVID)	800
Project Gross Floor Area	186,000 Square Feet	Typical Operating Hours	8am through 8pm
Location	Midtown Manhattan	Current Occupancy %	2%
Heating System(s)	The tenant's floors are heated by a perimeter fin-tube radiator system outfitted with new control valves supplied by the landlord. Hot water is supplied by the landlord's boilers and routed through risers located at the perimeter columns.		
Cooling System(s)	The tenant's floors are cooled using base building supply air from two main air risers located at the buildings core. Cooling air is supplied to these floors from two variable volume AHUs. These AHUs with VFDs each provide approximately 67,000 CFM and are the main source of cooling for half the building. Chilled water is produced by 3 Chillers located in the basement totalling approximately 2,700 Tons. This chilled water is split between the AHUs that serve the lower levels and upper floor AHUs.		
Ventilation System(s)	Ventilation air is introduced via the main AHUs providing supply air to the tenant floors. The actual amount of outside air varies depending on outside conditions, but the landlord estimates the OA rate to be approximately 4,500 CFM per floor.		
Domestic Hot Water System(s)	DHW is provided by the landlord to the main core restrooms. Additional DHW for the pantries and additional tenant restrooms is provided by the tenant under-counter instantaneous water heaters and above ceiling storage type water heaters.		
Building Management System / HVAC Controls	All landlord and tenant equipment is connected to the base building BMS which is a Reliable Controls system and maintained by the landlord's automated controls contractor. Each tenant has visibility to the BMS for their HVAC terminal unit setpoints, leak detectors, CRAC/AC unit failures, etc		

Study 2 – Westchester Commercial Office Facility			
Number of Floors	3 & Parking Garage	Peak Occupants (pre-COVID)	2,828
Project Gross Floor Area	627,000 Square Feet	Typical Operating Hours	5am – 6pm Mon-Fri
Location	Westchester	Current Occupancy %	10
Heating System(s)	The site is heated by (3) 300 HP boilers which provide steam and hot water to heating and reheat coils in the central air handling units and VAV/FPBs throughout the office spaces. The perimeter is heated with supplemental constant volume fans and steam coils.		
Cooling System(s)	The site is cooled via water-cooled chiller plant, with (3) 800-ton cooling towers and a total 2,100 tons of chiller capacity. The chiller plant provides chilled water to the cooling coils of all air handing units. The perimeter is cooled as needed with supplemental constant volume fans and chilled water coils.		
Ventilation System(s)	Supply and ventilation air to the occupied areas is provided by large central air handlers, some variable volume some constant volume.		
Domestic Hot Water System(s)	DHW is generated via heat exchangers on the steam supply from the space heating boilers which is stored in a domestic hot water tank which then supply the plumbing fixtures.		
Building Management System / HVAC Controls	The ventilating and air handling units are controlled via a central BMS which monitors status of all fans and coils as well as other setpoints, including OA damper open %, fan power, supply pressure and supply and return air temperatures.		

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Progress Summary

Study 1 – Commercial Office Tenant – 186,000 GSF (Manhattan, NY)

Current Project Stage:	*Data Collection and Site Surveys*
	IAQ Measure Feasibility Analysis
	Energy and Cost Impact Analysis
	Draft IAQ and Energy Study Report
	Final IAQ and Energy Study Report
	Overarching IAQ Report and Key Findings Slides

- Pre-COVID lockdown Energy baseline established
- Research conducted on equipment and products that could be used as the basis of evaluation for feasibility and energy impact
- In process of assisting tenant with assessing IAQ-sensor for permanent installation in office spaces for monitoring of:
  - Temperature
  - Humidity
  - CO_2
  - TVOC
  - PM 2.5
- IAQ sensors also being assessed a control strategy to reduce energy usage (e.g. only turn on conference room air cleaning equipment if CO_2 is above a certain ppm threshold)
- Follow up questions sent to base building engineers regarding filtration OA and COVID measures to survey and report back, in lieu of surveying base building mechanical rooms and air handlers directly (See **Barriers Encountered** below)
- Due to base building restrictions, the team will be focusing on what the project can do in the tenant space without building owner involvement.
- See **IAQ Improvement Measures** below for refined lists of IAQ measures that are currently being considered and excluded for the space.

Study 2 – Large Commercial Office Facility – 627,000 GSF (Westchester, NY)

Current Project Stage:	*Data Collection and Site Surveys*
	IAQ Measure Feasibility Analysis
	Energy and Cost Impact Analysis
	Draft IAQ and Energy Study Report
	Final IAQ and Energy Study Report
	Overarching IAQ Report and Key Findings Slides

- Pre-COVID lockdown Energy baseline established
- Research conducted on equipment and products that could be used as the basis of evaluation for feasibility and energy impact
- Obtained building due diligence report with equipment list
- Follow up interviews with building staff conducted
- Follow up survey and IAQ testing was performed (8/24 through 8/27). Testing included spot testing in typical occupied space types as well multi-day continuous data logging in a typical open office area. The following data points were collected in space measured:
  - Temperature
  - Humidity
  - CO_2
  - PM 2.5
  - CO
- See **IAQ Improvement Measures** below for refined lists of IAQ measures that are currently being considered and excluded for the space.

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Findings to Date

Study 1 – Manhattan Commercial Office Tenant

- Even if air cannot be treated at the supply source centrally due to cost, tenant-owner control or engineering limitations, there is technology currently available on the market which utilizes ASHRAE-recommendation based methods (MERV, HEPA, UVGI) that can improve indoor air quality at a local room/zone level with little to minor modification and installation.
    - The in-room cleaners being consisted for conference rooms consist of portable, standalone units that can be plugged into a receptable and include HEPA/MERV 14+ filters and or Carbon Filters.
- In the zone-level set of solutions, smaller portable air cleaners are not as scalable and cost-effective as more permanent in-ceiling equipment, if seeking to serve larger occupied areas beyond individual rooms. For example, a 10,000 SF office space looking to achieve 4 ACH of air purification would require 27-34 portable units depending on the ceiling height for full coverage.
    - The permanent in-ceiling equipment under consideration consists of a local recirculating fan, in series with a MERV 14+ filter or HEPA filter and an optional UV-C lamp at the filter as well.
- The following IAQ improvement measures are currently excluded from further analysis due to lack of tenant control of base building systems or necessitating envelope work to be implemented:
    - Increased outside air supply from central AHU
    - Increased outside air supply from central AHU with ERV/HRV
    - UVGI Systems at central AHU Coil
    - UVGI coils in main supply/return ductwork
    - MERV 13+ or HEPA filters in central AHU
- Currently excluded measures may be reconsidered based on the results of the base building equipment survey and questionnaire by the landlord engineer.

Study 2 – Westchester Commercial Office Facility

- The property has had sorbent-based air scrubbers installed in the return air plenum for all major air handlers for the past 2 years. These scrubbers remove almost all CO2 from a portion of the return air, thus improving the air quality of the entire air stream, but are not meant to mitigate airborne biological hazards. Current facility operation team reduces OA supply volume as an energy saving measure when scrubbers are on.
    - The existing air cleaning equipment utilizes polypropylene cartridges that contain sorbents that remove contaminants and CO2 from the air through adsorption These cartridges are then “recharged” during off-hours via an internal electric heater that forces the cartridges to release the captured contaminants, which the system then exhausts to the outdoors, readying the equipment for additional adsorption.
- Offsetting the energy usage of increased ventilation from the central air handlers was excluded from further analysis because the large size of the existing central AHUs (main supply ductwork is the 96” x 54” range, return openings are in in 252” x 36” range) would require a major renovation or completely new HVAC equipment to be installed in order to implement an energy wheel or fixed-plate heat exchanger.
- Zone-level solutions (local MERV/HEPA/UVGI-based air scrubbers) in areas with high occupancy or traffic to supplement the existing operations, which already utilize MERV 16 on the central AHUs and MERV 15 filters on the return of local fan powered boxes, may be the most cost effective IAQ improvement solution due to the scale of central air handling units.

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Baseline Energy Usage

Utility bills and energy usage data was gathered from the 2017-2019 time periods for each project, to establish pre-COVID lockdown baselines of energy usage at typical (100%) occupancies.

For the Manhattan Commercial Office Tenant, ConEd district steam for space heating is master metered at the building-level. In order to establish a tenant-specific steam usage, the whole building steam usage was acquired from publicly available NYC LL84 energy benchmarking data and then the total building steam usage was prorated based on square footage to arrive at the tenant's portion of the overall steam consumption.

For the Westchester Commercial Office Facility, individual spaces/floors are not sub metered for gas and electricity, so in order to establish the energy usage for the portion of the building that is the project scope (some tenant spaces are excluded from the study), the whole building usages were prorated based on square footage to estimate the annual consumption of the project area. The baseline energy shown below for The Westchester Commercial Office Facility is slightly higher than actual because the site receives a portion of its electrical power from on-site solar PV panels, however this energy reduction from the PV plant was temporarily "removed" from the energy usage (by adding back in the kWh generated based on actual PV output data) in order to create a more equitable comparison with other properties and better capture seasonal trends in the utility usage for the energy analysis.

Below are the baseline energy usages for each project, based on the process described above. EPA national average site-to-source rations were used for the source EUI calculation. The calculated energy usage resulting from each IAQ improvement scenario will be compared against these scenarios to establish potential energy savings or increases.

	Study 1- Manhattan Commercial Office Tenant	Study 2- Westchester Commercial Office Facility
Annual Electricity Consumption (kwh)	771,630	12,408,793
Annual Gas Consumption (therms)	137	246,040
Annual Steam Consumption (kbtu)	4,377,210	N/A
Total Energy Consumption (kbtu)	7,485,300	66,942,754
Site EUI (for project area)	40.24	106.77
Source EUI (for project area)	75.12	230.28

IAQ Improvement Measures

Below are the specific IAQ improvement scenarios beyond existing operations that being considered for feasibility and energy impact analysis for each project. These scenarios were developed based on industry technology research, interviews with the site operations staff, and analysis of existing MEP systems and distribution based on drawings and site walkthroughs. Since additional information is still being gathered and additional site visits are planned to assess the engineering feasibility of each scenario more specifically, these lists are subject to change.

IAQ Measures part of the ASHRAE baseline COVID mitigation recommendations are in **bold**. Measures marked as *Considered* were found applicable and feasible from an engineering perspective and will be included in the energy and cost analysis. Measures marked as *Excluded* were found infeasible or requiring major renovation-level work to implement and will be excluded from further study and from the energy and cost analysis. Measures marked as *Not Applicable* were not relevant to the project scope and building systems and will be excluded from further study and from the energy and cost analysis.

Study 1 – Manhattan Commercial Office Tenant

IAQ Improvement Measure – Building-Level System Upgrades		Status	Application Notes
1	**Increase outside air supply as close to 100% as possible during occupied hours while maintaining comfortable conditions in occupied spaces.**	✗ Excluded	Cannot implement due to lack of tenant control of base building systems.
2	**Maintain relative humidity between 40-60%. Implement Humidification if needed and possible.**	✓ Considered	Portable, room-level humidifiers considered. Cannot implement at system-level.
3	**Install air filter on main AHUs with a rating of MERV 13 or greater (as high as existing systems can accommodate)**	✗ Excluded	Cannot implement due to lack of tenant control of base building systems.
4	**Shut off energy wheels in ERV systems serving 2+ spaces if they do not meet ASHRAE guidance for minimal cross-contamination between exhaust and ventilation air streams (*exhaust and OA supply fans should both e on the outdoor-side of the energy wheel so outdoor air is pushed through and exhaust air is pulled through the wheel*)**		
5	**Install UVGI systems at central AHU cooling coils**		
6	Install UVGI systems in central supply ductwork		
7	Install HEPA-rated filters on main AHUs		
8	Install heat recovery ventilation systems (fixed plate) systems for existing AHUs providing ventilation air		

IAQ Improvement Measure – Zone-Level System Upgrades		Status	Application Notes
9	Install portable, room-level, air filters in conference rooms, pantries and other high-traffic office spaces	✓ Considered	The portable units are only going to be operated when the spaces are occupied.
10	Install local exhaust to negatively pressurize conference rooms, pantries and other high-traffic office spaces	X Excluded	Cannot implement without major renovation level work and disruption of base-building systems
11	Install local upper-room UVGI or other air treatment systems for large public assembly spaces	Not Applicable	No public assembly spaces in scope
12	Install UVGI systems at zone-level cooling coils	✓ Considered	Measure assumes the installation of UV-C lights on secondary units located in the tenant controlled spaces.
13	Replace air filters on zone-level systems with MERV 13+ rated filters (as high as existing systems can accommodate)	✓ Considered	Install MERV 13+ filters on secondary units located within the tenant controlled spaces.
14	Install permanent, ceiling mounted, room-level air scrubbers equipped with fan, MERV/HEPA filters and/or UVGI system in high-traffic office spaces or spaces with poor air quality	✓ Considered	Calculations to be performed to determine total number of units required.
15	Install supplemental outside air ventilation units, equipped with filtration and/or heat recovery systems at a room-level in spaces with inadequate ventilation or poor air quality	X Excluded	Cannot implement without major renovation level work and envelope work
IAQ Improvement Measure – Operational Adjustments		Status	Application Notes
16	Operate HVAC systems, with outside air supply set to 100% of capacity, for at least 2 hours before and after typical occupied hours	✓ Considered	Tenant can request base-building operate AHUs serving the 6 floors occupied by the tenant in this way
17	Run toilet exhaust fans 24/7, do not open operable windows in bathrooms	X Excluded	Cannot implement due to lack of tenant control of base building systems.
18	Run garage exhaust systems 2 hours prior and after occupied times		
19	Run building exhaust systems 2 hours prior and after occupied times		
20	Divert outside air from unoccupied floors to occupied floors		

21	Perform system flush-out; operating all air handlers supplying occupied spaces at maximum CFM of outside air for at least two hours before and two hours after occupied times	✓ Considered	Tenant can request base-building operate AHUs serving the 6 floors occupied by the tenant in this way
22	Disable DCV systems where existing to supply the maximum amount of design OA to high occupancy spaces.	X Excluded	Cannot implement due to lack of tenant control of base building systems.
23	Open windows where possible during occupied hours while maintaining comfortable conditions in occupied spaces.	X Excluded	The space does not have operable windows.
24	Maintain DHW storage temperatures at 140F minimum and DHW supply temperatures at 120F.	X Excluded	Cannot implement due to lack of tenant control of base building systems.
25	Install permanent IAQ sensors (CO2, PM2.5, Temp, RH, TVOC) and operate ventilation systems to provide additional ventilation (above minimums) to spaces only if IAQ metric thresholds are exceeded	✓ Considered	Tenant planning to install permanent IAQ sensors throughout occupied spaces, though operating ventilation systems based on data is outside of tenant control
26	Limit maximum building occupancy to 50% of typical peak occupancy (adjust ventilation airflows per reduced occupancy)	✓ Considered	Reduced occupancy possible but modifying operation of ventilation systems based on data is outside of tenant control

Study 2 – Westchester Commercial Office Facility

IAQ Improvement Measure – Building-Level System Upgrades		Status	Application Notes
1	Increase outside air supply as close to 100% as possible during occupied hours while maintaining comfortable conditions in occupied spaces.	✓ Considered	Achieving 100% OA for the supply air is not possible due to current sizes of outside air dampers on central AHUs but holding them at a full-open position will be assessed.
2	Maintain relative humidity between 40-60%. Implement Humidification if needed and possible.	✓ Considered	Current systems only capable of dehumidification, not humidification. In-duct humidifiers may be necessary to maintain min. 40% RH in wintertime.
3	Install air filter on main AHUs with a rating of MERV 13 or greater (as high as existing systems can accommodate)	✓ Considered	MERV 16 filters are currently installed on all main central AHUs. Will compare the relative increase in energy versus typical commercial building filters (MERV 14, MERV 8 respectively)
4	Shut off energy wheels in ERV systems serving 2+ spaces if they do not meet ASHRAE guidance for minimal cross-contamination between exhaust and ventilation air streams (*exhaust and OA supply fans should both e on the outdoor-side of the energy wheel so outdoor air is pushed through and exhaust air is pulled through the wheel*)	Not Applicable	No ERV systems present in the building.

5	**Install UVGI systems at central AHU cooling coils**	✓ Considered	Measure assumes UV-C lamps be installed directly prior to the cooling coil in each main central AHU.
6	Install UVGI systems in central supply ductwork	✓ Considered	Measure assumes UV-C lamps be installed in main supply trunk of each central air handler.
7	Install HEPA-rated filters on main AHUs	✓ Considered	Will involved replacing all MERV 16 filters will HEPA-rated filters of equivalent sizes on all main AHUs and will compare additional pressure drop and costs of regular replacements vs measure #3.
8	Install heat recovery ventilation systems (fixed plate) systems for existing AHUs providing ventilation air	*X* Excluded	The large size of the existing central AHUs (main supply ductwork is the 96" x 54" range, return openings are in in 252" x 36" range) and their distance from a exhaust air streams of similar CFM range would require a major renovation or completely new HVAC equipment to be installed in order to implement an energy wheel or fixed-plate heat exchanger
IAQ Improvement Measure – Zone-Level System Upgrades		Status	Application Notes
9	**Install portable, room-level, air filters in conference rooms, pantries and other high-traffic office spaces**	✓ Considered	Portable, plug-in air filters would be installed in all conference rooms and pantries but only operated when the space was occupied in the case of conference rooms or the floor was occupied in the case of pantries.
10	**Install local exhaust to negatively pressurize conference rooms, pantries and other high-traffic office spaces**	*X* Excluded	Current exhaust fans and ductwork layout will not allow for pressurization without a major renovation of exhaust systems.
11	**Install local upper-room UVGI or other air treatment systems for large public assembly spaces**	Not Applicable	There is a large assembly space in the building, but it is not solely operated by the client as part of its occupied space and is excluded from the project scope.
12	**Install UVGI systems at zone-level cooling coils**	✓ Considered	Implementation will involve providing UV-C lamps at all single-zone AHUs or supplemental AC coils serving occupied areas (not CRAC units).

13	Replace air filters on zone-level systems with MERV 13+ rated filters (as high as existing systems can accommodate)	✓ Considered	MERV 15 filters are currently installed on returns of FPBs and MERV 16 filters installed on zone-level AHUs. Will compare the relative increase in energy versus typical commercial building filters (MERV 8)
14	Install permanent, ceiling mounted, room-level air scrubbers equipped with fan, MERV/HEPA filters and/or UVGI system in high-traffic office spaces or spaces with poor air quality	✓ Considered	If implemented would be in lieu of measure #9 in same areas and be operated based on IAQ sensors or space occupancy (manual or via occ.sensor)
15	Install supplemental outside air ventilation units, equipped with filtration and/or heat recovery systems at a room-level in spaces with inadequate ventilation or poor air quality	✓ Considered	Implementation assumes using existing, underutilized, openings in the envelope for supply/exhaust, only considered if IAQ testing shows high concentrations of CO2 in specific space types.
IAQ Improvement Measure – Operational Adjustments		Status	Application Notes
16	Operate HVAC systems, with outside air supply set to 100% of capacity, for at least 2 hours before and after typical occupied hours	✓ Considered	Building is currently doing something similar but with a night-time flush out and the pre-cooling the space. Will compare operating 2hrs before/after vs current flush out operation.
17	Run toilet exhaust fans 24/7, do not open operable windows in bathrooms	✓ Considered	Current operation to garage exhaust to be verified, measure N/A if they already run at max CFM 24/7. No operable windows exist in restrooms.
18	Run garage exhaust systems 2 hours prior and after occupied times	✓ Considered	Current operation to garage exhaust to be verified, measure N/A if they already run at max CFM 24/7.
19	Run building exhaust systems 2 hours prior and after occupied times	✓ Considered	Building exhaust systems currently being run at full during night flush out. Will compare operating 2hrs before/after vs current flush out operation.
20	Divert outside air supply from unoccupied floors to occupied floors	✗ Excluded	There is no DOAS system and all OA is mixed with return air before being sent out to the VAV/FPBs, so there is no means of achieving this without major renovation.

21	Disable DCV systems where existing to supply the maximum amount of design OA to high occupancy spaces.	✓ Considered	Several smaller zone-level AHUs serving lounge/game room areas do have DCVs controls tied to CO2 sensors in the space.
22	Open windows where possible during occupied hours while maintaining comfortable conditions in occupied spaces.	Not Applicable	There are no operable windows in any of the occupied areas
23	Maintain DHW storage temperatures at 140F minimum and DHW supply temperatures at 120F.	✓ Considered	Will verify existing DHW setpoints via BMS
24	Install permanent IAQ sensors (CO2, PM2.5, Temp, RH, TVOC) and operate ventilation systems to provide additional ventilation (above minimums) to spaces only if IAQ metric thresholds are exceeded	✓ Considered	Sensors to be installed in representative sample of occupied spaces. Need to verify if existing BMS can interface with new sensors for OA damper control purposes.
25	Limit maximum building occupancy to 50% of typical peak occupancy (adjust ventilation airflows per reduced occupancy)	✓ Considered	Building currently implementing max 50% occupancy schedule (one week in-office, one week remote). Adjusting over ventilation based on actual occupancy to be evaluated for feasibility.

Barriers Encountered

Study 1 – Manhattan Commercial Office Tenant

- Building owner does not allow 3rd party groups to inspect building equipment as a standard policy.
  - Why is this a barrier?

    Cannot directly obtain information about equipment filtration, fans & ventilation to assess IAQ measure feasibility and energy impacts.
  - Resolution/workaround

    Project team sent a list of questions to base building engineers to survey in our stead and answer

- Tenant-occupier has limited control of ventilation air or ventilation system controls.
  - Why is this a barrier?

    Providing 100% OA, additional outside air or running 2 hours before/after occupancy per ASHRAE recommendations cannot be attempted through direct action of the occupants.
  - Resolution/workaround

    Tenant requested list of COVID mitigation measures being performed by base-building and will required these additional practices be performed for the AHUs serving their spaces if the base building isn't planning to implement them already.

Study 2 – Westchester Commercial Office Facility

- Manufacturer unable to provide cutsheets for existing equipment due to age and initial installation date (30+ years for some HVAC)
  - Why is this a barrier?

    Cannot directly obtain information about equipment fans & capacities and electrical data to assess energy impacts of IAQ measures.
  - Resolution/workaround

    Will rely on past building equipment lists and reports as well as system setpoints provided by BMS sensors to estimate missing information for energy calculations.

- Architectural and MEP plans are not available for all areas and equipment due to age of the facility
  - Why is this a barrier?

    Makes planning for a site survey and assess the scale of IAQ measure implementation (i.e. how many VAV boxes, how many AHUs, ductwork sizes etc) more difficult.
  - Resolution/workaround

    Utilize the snippets of existing floorplans from recent mechanical renovation projects and building equipment reports to pull together mechanical schedules and ventilation ductwork distribution, use photos from site survey and reasonable estimates based on known typical layouts to fill in the knowledge gaps.

Lessons Learned

Study 1 – Manhattan Commercial Office Tenant	Study 2 – Westchester Commercial Office Facility

- It is important to maintain a clear line of communication and educational outreach between tenants, building owners and building operators whenever a newer technology or equipment is installed in a building that affects their systems or space conditions, IAQ-based or otherwise. When the decision makers that research, approve and oversee retrofits are separate from the building operational staff, the technical information and design intent of the new equipment is not always passed on in a comprehensive manner to those involved in day-to-day tasks. This can lead to inefficient or improper operation of upgraded building systems.

Proposed Work Plan Adjustments

Study 1 – Manhattan Commercial Office Tenant	Study 2 – Westchester Commercial Office Facility

- No new adjustments to work plan

Next Steps

Study 1 – Manhattan Commercial Office Tenant	Study 2 – Westchester Commercial Office Facility
• Schedule follow up site visit to assess feasibility and scope of air scrubber installation • Assess feasibility of base-building centric modifications based on answers from landlord engineers. • Perform energy calculations for ASHRAE baseline scenarios • Develop scheduling-based and additional IAQ improvement strategies for assessment, beyond the ASHRAE-recommendations • Anticipated final IAQ report submission date: 11/27/20	• Analyze follow up survey and IAQ testing results • Perform energy calculations for ASHRAE baseline and proposed IAQ measure scenarios • Collect sample previous IAQ reports • Develop scheduling-based and additional IAQ improvement strategies for assessment, beyond the ASHRAE-recommendations • Anticipated final IAQ report submission date: 11/27/20

Appendix

Resources

- For spaces or buildings looking to install IAQ sensors, the directories of RESET-accredited IAQ monitors can serve as a useful starting point for commercial-grade sensors that are more robust than consumer-grade technology but not as costly as industrial-grade IAQ monitoring equipment. Manufacturers must submit their IAQ sensors for 3rd party testing and achieve certain thresholds for performance, accuracy, and data loss in order to be accredited and listed on RESET's website. See the links below for the IAQ sensor directories and RESET sensor standard:
    - Indoor, room-level sensors: https://www.reset.build/monitors/type/indoor
    - In-duct, system-level sensors: https://www.reset.build/monitors/type/induct
    - RESET IAQ Sensor Accreditation Standard: https://www.reset.build/download/RESET_Standard_v2_2_6_Monitor%20Standard%20180921.pdf
    - About RESET: *The RESET Standard is the world's first sensor-based and performance-driven data standard and certification program for the built environment. The RESET Standard creates a structure for data quality, continuous monitoring, and benchmarking. The standard harnesses the power of technology in order to assess the performance of buildings and interior spaces during their operational phase.*

Industry Research

- After a review of in-room portable air filters and HEPA or Carbon Filter-based purifiers, the majority were found to operate in the 100-300 CFM range. Based on the airflow, room height, and targeted air changes per hour (i.e. amount of times the equivalent of the entire of volume of air in the surrounding space passes through the filtration unit), the square feet of covered area can be established. Below is a sample coverage table for a typical in-room purifier.

		Ceiling Height (ft)		
		8	9	10
Air Changes per Hour (ACH)	2	750	665	600
	3	500	440	400
	4	375	330	300
	5	300	265	240
	6	250	220	200
	7	210	190	170
	8	185	165	150
	10	150	130	120
	12	125	110	100

Fig. 1 –
Manufacturer's Serviceable Area in SF vs ACH & Room Height table
for a typical 200 CFM in-room air purifier

- Below is a list of the additional technologies on the market that are being requested by commercial properties and installed by others to improve indoor air quality and potentially mitigate biohazards. These technologies are not included as part of this IAQ study as there is not currently sufficient third-party research and direct support by ASHRAE regarding their effectiveness at mitigating COVID risk specifically, as such they are listed only for general reference:
    - Bipolar Ionization / Needlepoint Bipolar Ionization
    - Disinfecting Filtration System (DFS)/ Electronically Enhanced Filtration (EEF)
    - Photocatalytic Oxidation (PCO)
    - Dry Hydrogen Peroxide

Preliminary IAQ Testing Results

As part of Study #2 for the Westchester Commercial Office Facility, IAQ testing was performed to spot check the temperature, relative humidity, CO2, CO and particular matter levels (PM2.5 = particulate matter that is 2.5 microns in diameter or smaller) in each type of occupied space, as well as perform continuous monitoring over the course of a few days to better map the effects of building operations. A full results summary will be featured in subsequent reports. However, below are some preliminary results from the 3-day continuous monitoring portion of the testing.

It is important to note that the building is currently under a nightly "flush-out" mode, where all outside air dampers are set to full open, the supply CFM on the main air handlers set to maximum and the exhaust fans are run at maximum airflow. Additionally the current building occupancy is low and the office area in which the sensors were places experienced minimal occupancy during the testing period (0-20%) The sensors that gathered the data were set up in the middle of a typical open office space on the 3rd floor and left to continuously sample the surrounding air quality in 1-minute intervals, for 3 days.

The initial results demonstrate that a small amount of additional particulate matter is being introduced to the space during the nightly flush outs with additional ventilation, however once the additional OA is reduced and more recirculation occurs, the existing MERV 16/15 filters successfully reduce the concentration of PM2.5 in the air during occupied hours, in some cases to down to zero (Fig. 2). The CO2 levels in the space stayed constant at relatively low levels (<1000 ppm, which is industry benchmark beyond which CO2 begins to has negative cognitive effects), despite additional outside air provided during non-occupied times (Fig 3.). This may be due to a lack of a significant number of occupants to introduce additional CO2 into the space and/or because the ambient level of CO2 in the outdoor air is close to the existing indoor levels of CO2, thus no dilution of CO2 occurs.

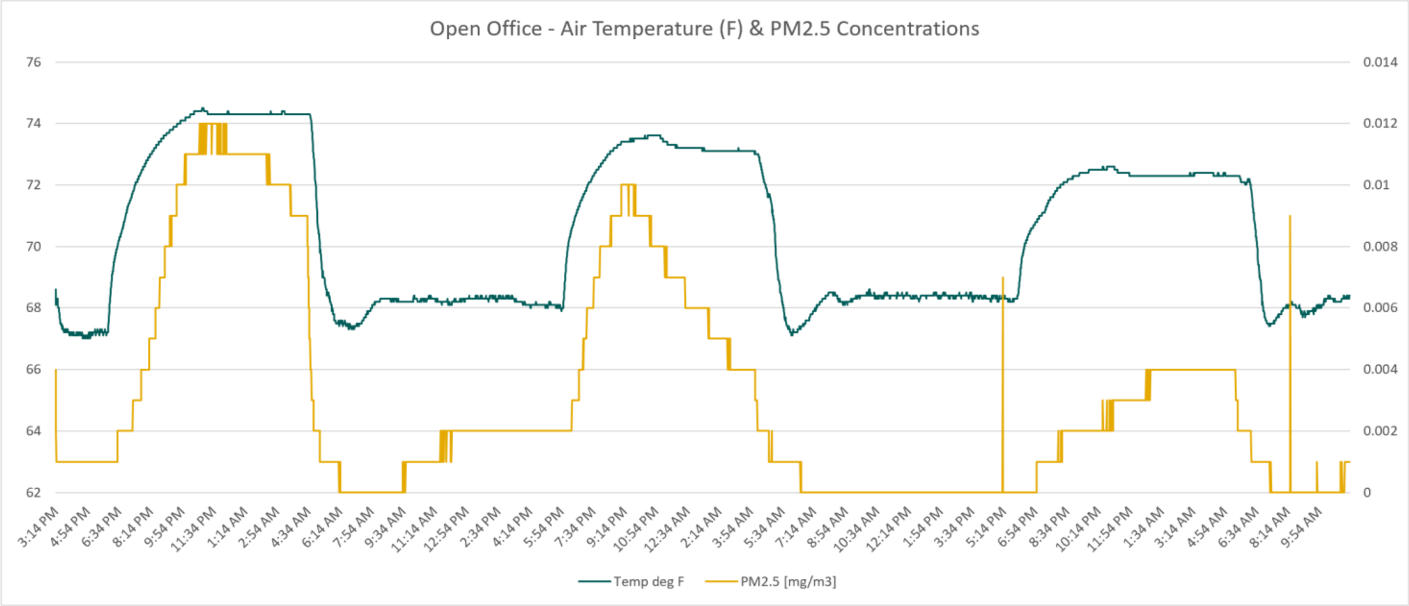

Fig. 2 – Air Temperate & PM2.5 over 3-day period in typical open office area.

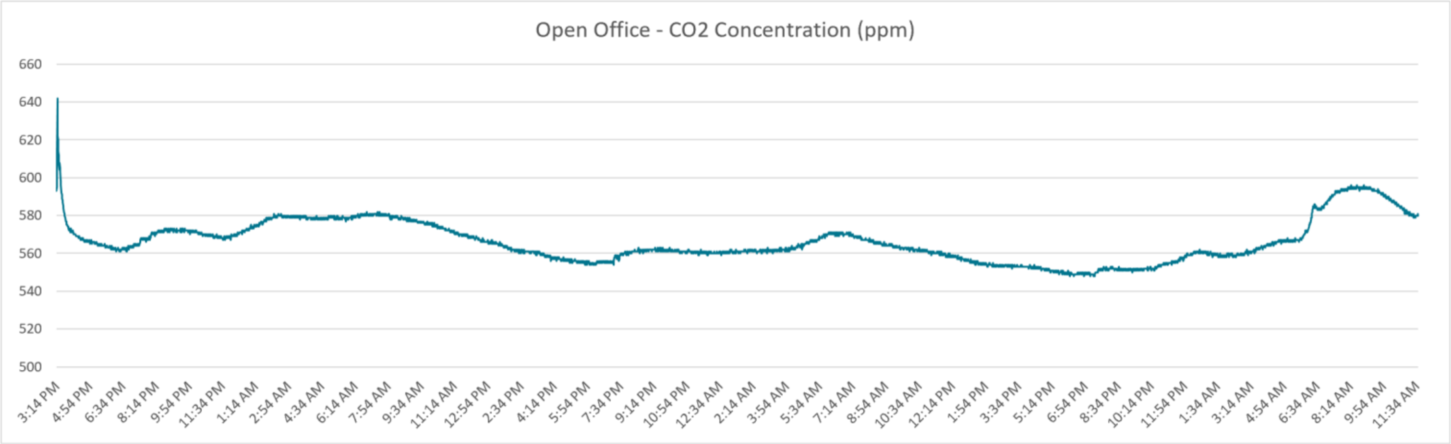

Fig. 3 – CO2 over 3-day period in typical open office area