FLEXTECH
ENERGY EFFICIENT INDOOR AIR QUALITY STUDY

FINAL CONCLUSIONS REPORT

For

Edison Energy, LLC

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Joint Statement from NYSERDA and ASHRAE on the Energy Efficient Indoor Air Quality Study Conclusion Reports

The Energy Efficient Indoor Air Quality Study Conclusion Reports summarize the findings from individual studies conducted under the FlexTech Energy Efficient Indoor Air Quality Pilot. NYSERDA presented this offering in May 2020 in response to a two-fold call from commercial market building owners and managers of New York to better understand:

1. the energy impact of the COVID-19 response guidance that was emerging in the market between March and May of 2020, and
2. how energy efficiency goals could be achieved in conjunction with reducing the risk of building occupants transmitting and contracting COVID-19 in the built environment.

When reading these reports and contemplating the conclusions drawn, it is important to consider the context of the time period in which these studies were conducted and the uniform parameters by which the consultants were bound. NYSERDA directed the consultants to use the building readiness guidance that was in the market when the studies commenced in June 2020. The ASHRAE Epidemic Task Force (ETF) guidance available to the market at the time consisted of the following document versions:

Building Readiness v.5-21-2020
Commercial v.4-20-2020
Schools & Universities v. 5-5-2020
Healthcare v. 6-17-2020
Filtration & Disinfection v. 5-27-2020
ERV Practical Guide v. 6-9-2020

While a benefit of this approach is to allow for a comparative analysis across all the studies under the initiative to explore overarching conclusions applicable to the broader market sector, a drawback emerged when ASHRAE guidance evolved significantly while the studies were underway. As a result, some of the guidance that formed the basis of the studies is no longer advocated as best practices by leading authorities in the market, including the ASHRAE ETF. Current ASHRAE ETF guidance is summarized in its Core Recommendations (1/6/2021). The concise guidance in the Core Recommendations is reflected in more recent versions of the guidance documents noted in the table above. To provide the reader a side-by-side account of the changes to the ASHRAE ETF's guidance, the table below compares guidance available to the market at the time the studies commenced to the current ASHRAE Core Recommendations and the resulting energy implications.

ASHRAE Epidemic Task Force Guidance

	THEN **Building Readiness Guidance *version 5.21.2020*** and/or **Commercial Guidance *version 4.20.2020***	**NOW** **Core Recommendations *version 1.6.2021*,** **Building Readiness *version 4.27.2021,*** and/or **Commercial Guidance *version 3.22.2021***	**Energy Impact Takeaways**
Outdoor airflow rate	• Increase system outdoor air ventilation as much as the system and or space conditions will allow to reduce the recirculation air back to the space during occupied hours • Open windows where appropriate during occupied hours. • For HVAC system that use Demand-controlled ventilation sequences we recommend disabling this feature for the duration of the crisis.	• Provide and maintain at least required minimum outdoor airflow rates for ventilation as specified by applicable codes and standards • Maintain equivalent clean air supply required for design occupancy whenever anyone is present in the space served by a system • Evaluate the use of additional outdoor air as a mitigation strategy compared to other items, such as filters or air cleaners[1]. • For HVAC system that use Demand-controlled ventilation sequences we recommend disabling this feature for the duration of the crisis[2]	It is more energy and cost efficient to operate systems with less outdoor air
Filtration	Update or replace existing HVAC air filtration to a minimum of MERV 13 (MERV 14 preferred) or the highest compatible with the filter rack	Achieve MERV 13 or better levels of performance for air recirculated by HVAC systems by using a combination of filters and air cleaners[3]	Depending on the performance of the current filtration system, higher MERV filter ratings might increase system pressure drop, leading to increased energy use and cost. Using carefully selected filters, or the appropriate combination of MERV filtration and air cleaners, could mitigate a negative energy impact.
Air Cleaners	• Where there can be a large assembly of people, consider air treatment, e.g. upper-room UVGI lamps. • Consider adding air treatment and cleaning devices such as UVGI in duct, plenums and air handling units and on the face of cooling coils[4]. • If an increase in filter MERV level cannot be accommodated using the existing air handling equipment fans and motors, consider using In Room portable HEPA filter units in high occupancy or high bioburden (such as the building entry) spaces.	• Only use air cleaners for which evidence of effectiveness and safety is clear. Per the CDC, consumers should match any specified claims against the consumer's intended use, request efficacy performance data that quantifies a protective benefit under conditions consistent with the intended application of the technology, and look for multiple sources including independent, third-party sources that conclude the same performance data. • Consider adding air treatment and cleaning devices such as UVGI in duct, plenums and air handling units and on the face of cooling coils[4]. • If the outdoor air, filter or air cleaner in the HVAC system is not achieving the desired exposure reduction, consider adding In Room portable HEPA filter units[1].	No impact in the context of these studies. Only air cleaners with a proven track record of safety and effectiveness were allowed in the NYSERDA studies. UVGI and HEPA filtration are considered safe technologies by ASHRAE if applied correctly and the appropriate safeguards are put into place.

[1] ASHRAE ETF Core Recommendations, v.1.6.21, item 2.4
[2] ASHRAE ETF Core Recommendations, v.1.6.21, item 4.2
[3] ASHRAE ETF Building Readiness Guidance v.4.27.21, Equivalent Outdoor Air section
[4] ASHRAE ETF Commercial Guidance v.4.20.20

	THEN **Building Readiness Guidance *version 5.21.2020*** and/or **Commercial Guidance *version 4.20.2020***	**NOW** **Core Recommendations *version 1.6.2021*,** **Building Readiness *version 4.27.2021,*** and/or **Commercial Guidance *version 3.22.2021***	**Energy Impact Takeaways**
Building Flush	Flushing sequence or mode may be implemented to operate the HVAC system with maximum outside airflows for two hours before and after occupied times.	When necessary to flush spaces between occupied periods, operate systems for a time required to achieve three air changes of equivalent clean air supply. Use the Equivalent Outdoor Air Calculator to determine the flush time required to achieve 3 equivalent changes of space volume based on the outdoor air levels, filtration levels, and/or efficacy of air cleaners in use OR use a 2-hour flush period.	• Depending on the system configuration, achieving three air changes of equivalent clean air supply could be less energy intensive than conducting a two-hour flush. • Performing only one flush between building occupancy will be more energy efficient than conducting a flush both pre- and post-occupancy of the building.
Air Distribution	Check that air handling systems are providing adequate airflow, there are no blockages in the duct system (for example – closed fire/smoke dampers) and air from the air handling system is reaching each occupied space.	Where directional airflow is not specifically required, or not recommended as the result of a risk assessment, promote mixing of space air without causing strong air currents that increase direct transmission from person-to-person	Both sets of guidance could have an increased impact on energy use if deficiencies in airflows levels require corrective action.
Contaminated Air Re-entry	• Well-designed and well-maintained air-to-air energy recovery systems should remain operating in residences, commercial buildings and medical facilities during the COVID-19 pandemic. • Heat wheels may continue operation if the unit serves only one space.	• Evaluate the operation of your energy recovery devices to determine that they are well-designed and well-maintained and fix them if there are issues[5]. • Limit re-entry of contaminated air that may re-enter the building from energy recovery devices, outdoor air, and other sources, such as relief air from patient rooms to acceptable levels	No substantial change in guidance
Setpoints	• Maintain dry bulb temperatures within the comfort ranges indicated in ANSI/ASHRAE Standard 55-2017 • Consider adjusting the space comfort setpoints to increase the system's ability to use more outside air. • Maintain relative humidity between 40%-60% • Prioritize increasing outside air over humidity[6]	Maintain temperature and humidity design set points	The current guidance will likely result in less energy use compared to the prior guidance.
System Performance	Verify that equipment and systems are properly functioning	Verify that HVAC systems are functioning as designed	No substantial change in guidance

[5] Practical Guidance for Epidemic Operation of Energy Recovery Ventilation Systems

[6] ASHRAE ETF Commercial Guidance v.4.20.20

It is also important to understand the basis of the package groupings in these reports.

Pre-COVID energy use establishes the typical energy use baseline prior to any impacts resulting from COVID-19

ASHRAE guidance measures include the HVAC-related guidance from the ASHRAE Epidemic Task Force documents that are feasible in the subject building(s)

Energy Efficient measures include Ultraviolet Germicidal Irradiation (UVGI), air filtration strategies, and building operation optimization solutions that perform equally on the basis of COVID-19 risk of infection to the ASHRAE guidance package of measures

ASHRAE has recommended UVGI since the inception of the Epidemic Task Force as a potential mitigation strategy. NYSERDA chose to use UVGI in the Energy Efficiency package because of its potential to reduce the energy impact of risk mitigation.

One final note is that major mechanical capital improvements were intended for exclusion from analysis under these studies.

For more information, the NYSERDA-issued mini-bid for the Energy Efficient Indoor Air Quality studies can be found here and the current ASHRAE ETF Core Recommendations can be found here.

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Energy Efficient Indoor Air Quality Study

Submitted To:
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Submitted:
October 27, 2021

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1. Executive Summary

1.1. Introduction

Considering the pandemic, most building occupancies have been greatly reduced or are nearly empty now. Government and private businesses are looking to start safely reoccupying their facilities. Various government and independent organizations are evaluating the impact on HVAC systems post Covid-19 re-entry to the buildings. There are various strategies and technologies being recommended by various government and non-government bodies for post Covid building readiness. The purpose of these strategies is to reduce the viral load in a facility and therefore reduce the risk of infections.

NYSERDA proposed a study to evaluate the effects of implementing ASHRAE's Epidemic Task Force (ETF) Guidance for COVID-19 that was emerging in the market between March and May of 2020 on a building's energy consumption, and costs. Additionally, the facility systems were analyzed to identify any potential low cost / no cost Energy Conservation Measures (ECMs) to counter the expected increased energy consumption due to the increased ventilation and additional energy consumption by UVGI technology.

The ASHRAE 62.1-2013 standard permits a reduction of ventilation rates in certain situations when the alternate means are applied to remove particulates from the indoor air. Currently there are no guidelines provided by ASHRAE or any other body to reduce ventilation in response to the various products in the market to deactivate the COVID-19 virus. However, in the future, should ASHRAE or any other body recommends reducing ventilation when upper room Ultraviolet Germicidal Irradiation (UVGI) or other technologies are installed to deactivate the COVID -19 virus, these recommendations may be considered for implementation to offset increases in energy consumption. The initial ASHRAE ETF Guidelines at the time of the study were to increase ventilation in spaces as much as the system or space conditions will allow to reduce recirculation back to the space during occupied hours. At the end of the study ASHRAE Guidelines evolved and recommended that systems provide and maintain at least the required minimum outdoor airflow rates for ventilation as specified by applicable codes and standards. MERV 13 or better levels of performance may be achieved by estimating the combined performance of multiple devices, such as filters or filters & air cleaners (such as UVGI).

This report summarizes the overall results of our analysis and provides some insight into what can be expected.

2. Study Approach

A total of six (6) facilities were evaluated for this study. Annual energy consumption and cost baselines were developed for each facility based on annual utility data provided for the pre-covid 2019 calendar year. Staff interviews, review of mechanical drawings, facility walk-throughs, and BMS reviews were performed at each site. A CFR (Current Facility Requirements) document was then created for each facility. The facilities evaluated for this study are listed below.

- Memorial Sloan Kettering Cancer Center (MSKCC) – Josie Robertson Hospital
- Memorial Sloan Kettering Cancer Center (MSKCC) – Evelyn H. Lauder Breast and

Imaging Center

- Northwell - Manhattan Eye, Ear and Throat Hospital
- Performing Arts Center – Theatre Building
- Performing Arts Center – Mixed Use Building
- Empire State Building – representative sample of floors evaluated (3 total)

A break-down of energy usage by system and proposed changes in energy consumption by system was developed once ASHRAE Building Readiness Guidelines are implemented. Low-cost energy conservation measures identified in the field were also recommended if applicable.

2.1.1. Research Conducted

To determine the most effective method of combatting air born viral pathogens, research was conducted on a variety of technologies. The technologies researched were as follows:

- Enhanced Purification Systems
- Photo-Hydro-ionization
- In Duct UVGI
- Upper room UVGI
- Hydrophobic Spray

Based on our research, the technology believed to be the most effective was Upper room UVGI. This technology is also listed in the April 14, 2020 ASHRAE Position Document on Infectious Aerosols as one of three demonstrated control measures to combat the transmission of airborne viral pathogens.

2.1.2. Study Methodology

For each study, the following procedures were followed in determining the proposed facility energy consumption post measure implementation.

Utility data representing pre-Covid operation (2019 data) was collected, and an energy consumption and annual operating cost baseline was developed for each site.

Post energy consumption was then developed/calculated for each site based on recommended ETF guidelines provided by ASHRAE. These measures are as follows:

- Increase building ventilation by as much as system or space conditions will allow. For our studies, outside air ventilation rates were increased to approximately 95% due to cooling coil design limitations.
- Pre and Post Occupancy Purge operations where the air handler units operate 2 hours prior to, and after, daily occupancy with daily maximum outside air ventilation rates.

- Improve air handler unit filtration to at least MERV 13 to reduce airborne infectious aerosol exposure.

- Strategically recommended the installation of approved technologies to combat the virus. The technology chosen for our studies was the use of Upper room UVGI which would be installed in places of congregation such as conference rooms, lobbies, waiting rooms, etc. The outside air ventilation rates supplied by the air handler units serving these spaces were reduced to the minimum code required outdoor air ventilation rates/ACH. The UVGI manufacturer studies demonstrated that the air cleaning technology has an equivalent ACH ranging from 10 to 15 eACH. To be conservative, 10 eACH was chosen for our energy consumption calculations, with care taken to not reduce ventilation rates below minimum code requirements.

Proposed energy consumption was calculated utilizing in house calculation sheets developed in Excel. The calculations performed rely on weather bin hours, hours of HVAC operation, and conditioning energy (heating and cooling). Using Excel, the operation of the facilities air handler units is modeled as closely as possible to actual conditions for both the pre and during Covid conditions. The outcome of each condition is then compared to determine total changes in facility energy consumption.

3. Overall Findings

The following tables list all measures identified for each facility. The tables are broken down into three (3) categories. The first table represents each facilities baseline energy consumption (i.e. – electricity, steam) prior to pandemic. The second table provides the energy consumption after ASHRAE measures (i.e. – increased ventilation and filtration) have been applied. The last table provides reduced energy consumption based on identified and recommended measures such as low cost ECMs and/or UVGI installations which allow for a reduction in overall facility ventilation based on estimated equivalent air changes resulting from the use of Upper room UVGI technology, which is discussed in the next section of this report.

3.1. Pre-Covid Baseline

Building	Pre-Covid Baseline								
	Energy Use						Energy Cost		
	kWh	kW	MMBtu	Total Suppy Air CFM	CFM Outside Air	Air Changes OA	kWh	kW	MMBtu
Evelyn H. Lauder Breast Center 300 East 66th Street, New York, NY 10065	7,716,000.0	1,927.0	24,611.9	263,000	87,000	2.8	$1,237,118	not available	$594,675
Josie Robertson Surgery Center 1133 York Ave., NY, NY 10065	5,835,482.0	1,135.0	34,155.9	185,800	70,006	2.9	$1,315,816	not available	$336,957
Performing Arts Center - Mixed Use Building, NY, NY	6,600,805.0	1,503.0	26,539.0	316,000	31,230	0.5	$984,383	not available	$696,963
Performing Arts Center - Theatre Building, NY, NY	1,622,270.0	207.0	4,377.8	109,550	53,900	4.4	$341,487	not available	$92,546
Manhattan Eye, Ear, & Throat Hospital 210 E 64th Street, NY, NY	6,455,600.0	1,414.0	34,800.3	118,706	79,300	2.3	$913,183	not available	$840,771
Empire State Building 350 5th Ave, New York, NY 10188	42,647,680.0	11,848.0	85,671.9	2,533,000	506,600	1.7	$6,102,777	not available	$2,362,604

3.2. ASHRAE Measures Baseline

Building	ASHRAE Measures Baseline									
	Energy Use				CFM Outside Air	eACH	Energy Cost			
	Measures Included	kWh	kW	MMBtu			kWh	kW	MMBtu	Implementation Cost
Evelyn H. Lauder Breast Center 300 East 66th Street, New York, NY 10065	Max OA, MERV 14	8,281,483.0	1,927.0	43,817.4	140,940	4.6	$1,327,783	$0	$1,058,720	$0
Josie Robertson Surgery Center 1133 York Ave., NY, NY 10065	Max OA	6,193,706.0	1,135.0	56,858.4	91,663	3.8	$1,396,590	$0	$560,923	$0
Performing Arts Center - Mixed Use Building, NY, NY	Max OA	8,260,251.0	1,503.0	49,629.0	282,994	4.7	$1,231,857	$0	$1,303,348	$0
Performing Arts Center - Theatre Building, NY, NY	Max OA, MERV 14	2,708,774.7	207.0	15,158.8	83,675	6.8	$570,196	$0	$320,453	$0
Manhattan Eye, Ear, & Throat Hospital 210 E 64th Street, NY, NY	Disabled Heat Wheel	6,457,661.0	1,414.0	35,090.7	79,300	2.3	$913,475	$0	$847,787	$0
Empire State Building 350 5th Ave, New York, NY 10188	2 Hr. Purge	45,245,936.0	11,848.0	87,805.6	506,600	1.7	$6,474,581	$0	$2,421,446	$0

3.3. Energy Efficiency Measures Baseline

Building	Energy Efficiency Measures Baseline									
	Energy Use				CFM Outside Air	eACH	Energy Cost			
	Measures Included	kWh	kW	MMBtu			kWh	kW	MMBtu	Implementation Cost
Evelyn H. Lauder Breast Center 300 East 66th Street, New York, NY 10065	UVGI, Reduced OA	8,549,578.0	2,428.0	42,635.3	131,836	4.3	$1,370,767	$0	$1,030,158	$461,700
Josie Robertson Surgery Center 1133 York Ave., NY, NY 10065	UVGI, Reduced OA	6,493,059.0	1,135.0	34,765.4	83,222	3.5	$1,464,090	$0	$342,970	$374,395
Performing Arts Center - Mixed Use Building, NY, NY	UVGI, Reduced OA	8,358,467.0	1,503.0	49,607.0	280,396	4.7	$1,246,504	$0	$1,302,770	$143,360
Performing Arts Center - Theatre Building, NY, NY	UVGI, Reduced OA	2,683,398.9	207	14,404.5	78,207	6.3	$564,854	$0	$304,508	$74,155
Manhattan Eye, Ear, & Throat Hospital 210 E 64th Street, NY, NY	UVGI, Reduced OA	6,710,177.0	1,414.0	34,683.9	79,300	2.3	$949,194	$0	$837,959	$461,700
Empire State Building 350 5th Ave, New York, NY 10188	UVGI	48,248,163.0	11,848.0	87,805.6	506,600	1.7	$6,904,192	$0	$2,421,446	$5,087,250

3.4. Study Comparisons

As previously stated, the facilities listed below were evaluated regarding implementing measures to improve the safety of the returning occupants post Covid-19.

- MSKCC Evelyn H. Lauder Breast and Imaging Center
- MSKCC Josie Robertson Hospital
- Northwell - Manhattan Eye and Ear Hospital
- Performing Arts Center – Theatre Building
- Performing Arts Center – Mixed Use Building
- Empire State Building

As the above facilities all differ, consisting of office buildings, hospitals and a music hall, so did our results and recommendations for each. Following the ASHRAE Building Readiness Guidelines, the main Covid-19 countermeasures recommended by Edison Energy are as follows:

1. **Increased Ventilation** - increase outdoor air volume permitted by the site's AHU coils and reduce the recirculation of return air to reduce the bioburden in the spaces. For this measure, two options were provided. For all facilities, Option 1 was recommended which entails the following strategy:

a. “If the cooling coil control valve is less than 90% AND the discharge air temperature (or space temperatures) are satisfied, OPEN the OAD [CLOSE the RAD] 3% every 15 minutes. If the cooling coil control valve is greater than 90% OR the discharge air temperature (or space temperatures) is exceeded by 1 0F, CLOSE the OAD [OPEN the RAD] 6% every 5 minutes.”

Recommendations for this measure varied across all sites depending on facility type and systems in place. For example, the Empire State Building’s air handler units are minimum outside air units with fixed outside air quantities of 20% and cannot be increased based on their design. For the Manhattan Eye, Ear and Throat Hospital, the majority of the air handler units serving the hospital’s critical spaces (i.e. – operating rooms, labs, etc.) are already operating at 100% outside air. For the minority of units, this increase in ventilation rate was not recommended due to cooling coil capacity issues reported by MEETH staff due to the age and condition of the coils, as well as limitations on their building management system (BMS).

Implementation of this measure also requires that any existing Demand Control Ventilation sequences and/or energy recovery wheel units be de-activated to allow for increased ventilation and to avoid potential contamination of incoming outside air due to the inherent cross stream infiltration of exhaust air into the outside air stream that is known to occur with heat / energy recovery wheels. Note – it has been recommended that AC-9’s energy recovery wheel serving the 7th floor of MEETH be disabled as a result.

In addition to increasing ventilation rates, both pre and post occupancy purge rates were recommended for facilities that do not operate 24/7. For a well-mixed space, it requires 3 ACH to reduce the bioburden in the spaces served by 95%. Edison Energy has proposed operating Josie Robertson, and the Performing Arts building’s air handling units for 2 hours pre- and 2 hours post-occupancy resulting in a total of 4 hours of additional operation for the AHUs. This will allow a reduction of the bioburden in the space. The overall strategy for the operation of the AHUs in the unoccupied and occupied is as follows:

a. Occupied Mode: bring in the maximum possible outside air as per option 1 described above.

b. Un-Occupied Mode: Operation of AHUs in Occupied Mode for 2 hours prior to, and 2 hours after, daily occupancy.

2. **Increased Filtration** - ASHRAE recommends that mechanical filter efficiency be at least MERV 13 and preferably MERV 14 or better to reduce the spread of virus’. ASHRAE recommends installing MERV 13 and greater filters which are better at removing particles in the 0.3 micron to 1-micron diameter size (the size of many virus particles). Please note however that the higher efficiency of filter recommended may result in an energy penalty due to greater pressure differentials. More efficient filtration should be carefully selected to prohibit or avoid significant increases in pressure differential such that there will be little to no energy penalty.

   Recommendations for this measure varied across sites as well, as the majority of sites studied already utilized MERV 13 filters or better. This was the case for the Performing Arts Center Mixed Use Building, Josie Robertson Hospital, and Empire State Building. The Performing Arts Center Theatre Building also utilized MERV 15 filters in 3 out of their 4 air handler units. The majority of air handler units at MEETH were also MERV 15 with only a select few serving non-critical spaces that were operating with filters lower

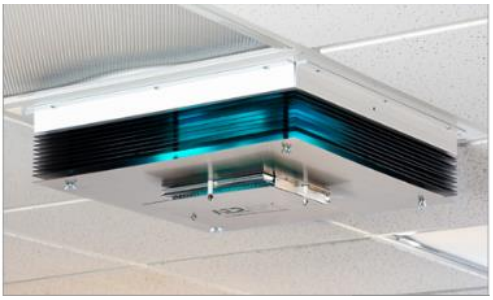
than MERV 13.

3. **UVGI equipment** - Different UVGI products were researched and evaluated, based on discussion with NYSERDA. Upper room UVGI products were shortlisted based on the effectiveness of this technology. The upper room UVGI product that has been recommended consists of an enclosed UV lamp in the device. Air is drawn into the unit by a fractional HP fan. The fan sends air across the UV lamps and discharges the air out into the space. The effectiveness of these units is estimated to be equivalent to 10-15 equivalent ACHs, according to numbers provided by the device the manufacturers. There are two types of upper UVGI products that Edison Energy has recommended and are provided below in detail:

    a. Upper Room UVGI - This product has a size of 2'x2' and can be easily placed in a 2'x2' dropped ceiling or hung by cables on a hard ceiling. The unit consists of a fan that draws air from the room and recirculates the air in all four directions. This product can be used to serve spaces ranging from 1,000SF to 1,500SF. It should be noted that a generous amount of airflow is suggested for upper room UVGI to be effective.

    b. Wall Mounted UVGI - This product is a self-contained unit consisting of UV lamps and a recirculating a fan. The unit draws air from one side and distributes the air in three directions. This unit is mounted on a wall. The product is installed in small spaces, under 500SF.

Pictures of each product are located below:

Ceiling Mounted Unit (Zone 360)	Wall Mounted Unit (PSF-M06)
	

Recommendations for this measure entailed the installation of UVGI units in spaces where people are known to congregate. The following typical space types were recommended for each facility type.

a. Lobbies/Vestibules

b. Lounges

c. Reception Areas

d. Locker Rooms

e. Open/Shared Office Spaces

f. Staff Lounges

g. Conference Rooms

h. Cafeteria/Dining, Kitchen Areas

i. Restrooms

j. Corridors

k. Choral Rooms (specifically for Performing Arts Theatre Building)

l. Dance Studios (specifically for the Performing Arts Mixed Use Building

For hospitals, the additional spaces listed below were also recommended to have UVGI units installed.

a. Nurses Stations

b. Exam Rooms

c. Waiting Rooms

4. **Equivalent Air Changes (eACH)** - This measure allows for facilities utilizing anti-virus technologies to operate at lower ventilation air rates which will result in lower impacts to operating costs. The anti-virus technologies chosen as seen above are Upper Room and Wall Mounted UVGI equipment. Based on UVGI manufacturer's studies, UVGI eACH was determined to range from 10 to 20 eACH. As such, Edison Energy developed a methodology to reduce outdoor air ventilation to spaces that are to have upper room UVGI installed per our recommendations. For the upper room UVGI spaces, Edison Energy chose 10 eACH as a conservative number for the upper room UVGI product.

   The outside air ventilation rates supplied by the air handler units serving these spaces were then totalized and the required building design outside air ventilation rates were determined using ASHRAE 62.1 guidelines. The total outside air ventilation rate for spaces served by UVGI, were then reduced by 10 eACH for each facility. Care was taken to not reduce ventilation rates below minimum code requirements.

   Upper room and Wall mounted UVGI have been mostly recommended for common areas for practical and cost reasons. Based on our calculated results, utilization of these technologies has revealed that buildings with a higher percentage of common space areas yield greater savings, while buildings with smaller common space area percentages result in smaller savings as buildings with larger common space areas have greater outdoor air requirements as compared to buildings with smaller common space areas.

5. **Low-Cost Energy Conservation Measures** – In addition to the standard measures

listed above, Edison Energy was tasked with identifying low-cost energy conservation measures to curtail the increased operating costs that may come with increased ventilation, filtration and UVGI. However, only a few low-cost measures were identified as the majority of the facilities evaluated are already operating efficiently as they have recently undergone Energy Audits and Retro-Commissioning surveys and have implemented recommended conservation measures. The low-cost measures identified are as follows:

Recommended Measures

Manhattan Eye, Ear and Throat Hospital (MEETH)

a. **Install Programmable Thermostats** – Two air handler units were identified to operate 24/7. These units are AC-9 and AC-10 and serve spaces that are occupied 12 hours a day, Monday through Saturday. AC-9 is a condenser water sourced heat pump unit with local steam reheats. The unit is a fixed outside air heat unit with the heat pump load being a minor component of the energy consumption. AC-10 is a "cooling only" unit with heat provided by steam radiators. Both units serve office spaces and are not deemed critical.

   This ECM assumes reducing unit run-time by approximately 38% through the use of installed timers and/or programmable thermostats to shut down the units during unoccupied periods. The post implementation run-times for these units are estimated to be 16 hours a day, Monday through Saturday, to account for 4 hours of ventilation purge as recommended above (2-hours pre-occupancy and 2-hours post occupancy).

Measures Not Recommended

Josie Robertson Surgery Center

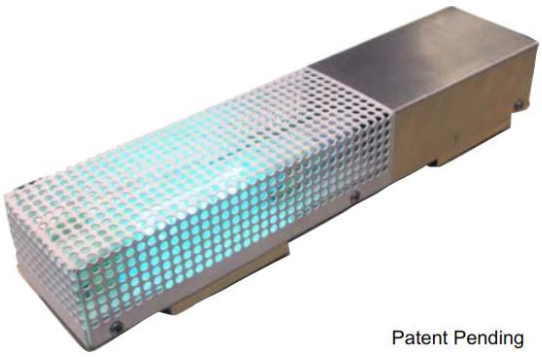
b. **Single Zone VAV** - AHU 2-5 and AHU 15-3 both serve lobby spaces. These units are equipped with variable frequency drives but operate as constant volume units at 100% speed. The units discharge their supply air at the end of a very short supply duct with no time or space for the unit to build up static pressure. As a result, the low static pressure seen by the controls commands the associated drive to run at 100% speed to meet the programmed set point. Based on the areas served by these units, energy savings could be achieved by programming the units to operate as single zone variable volume units via the BMS.

   The benefit would be to save fan energy at part loads, like a VAV system, without the expense and disruption of installing VAV boxes throughout the spaces. Fan speeds would modulate based on return air temperature with minimum required airflow used for heating and maximum design airflow during full cooling demand. Furthermore, this can be integrated with the economizer sequence to modulate outside air intake minimizing demand on the unit's heating and cooling systems (steam and chilled water). This measure was not recommended as the sequence of operation calls for varying airflow with respect to return temperatures. Although this measure will reduce energy consumption, it can potentially result in safety concerns with regards to Covid-19 as outside air ventilation will also turndown as the unit's supply fan VFDs slows down.

4. Technology Reviewed - Not Recommended:

4.1. PHI Technology (Photo-hydro-ionization):

The PHI Unit by RGF® is designed to reduce odors, air pollutants, Volatile Organic Compounds (chemical odors), smoke, mold bacteria and viruses. Units are easily mounted into air conditioning and heating system air ducts where most sick building and IAQ problems occur. When the HVAC system is in operation, an enhanced UV light operates to create disinfectants (i.e. – hydrogen peroxide) in the air stream which can reduce micro-organisms and odors (i.e. – VOCs, gases, etc.) by over 95%. Use of this technology is stated to leave the air in the spaces served fresh and odor free. The system is fully assembled for easy installation.



TYPICAL INSTALLATION

This technology is not being recommended because ongoing research has indicated that its effectiveness to deactivate the virus in an airstream is not significant.

4.2. Enhanced Air Purification Systems:

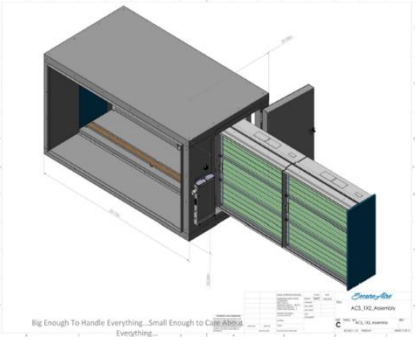
SecureAire manufactures both portable air handler units which recirculate air in a space and filter box sections that are then installed in larger air handler units replacing existing filter banks. Portable units are sized up to 1,000 cfm, while filter box sections are each sized for up to 2,000 cfm.

Each of these models utilize an electronically enhanced air purification system which consists of 3 basic components. These components are known to be the Particle Collider, the Collector and the Internal Particle Collider.

The Particle Collider emits both positive and negative charges at a high voltage and low current to avoid ozone generation. As particles pass through this section, they will pick up these charges, increasing their forces of attraction, resulting in the formation of larger particles.

Larger particles then head into the Collector, which is an electrically polarized, high efficiency (MERV 15) filter which captures the enlarged charged particles. In addition, a high voltage electrostatic field is used in this section to inactivate any viable airborne pathogens.

Lastly, air flows through the Internal Particle Collider which uses a pulsed electrodynamic field to condition and capture any particles that escaped from the Collector.

SecureAire APS-1000X (Portable Unit)	SecureAire APS-1000X (Filter Box Installations)
	Filter Box Installation For Installation in supply ductwork downstream* *Max Face Velocity of 650 FPM 

This technology was evaluated by Edison Energy but not recommended as the product is only tested for UL867, which has a lower ozone test threshold as compared to the recently recommended UL2998 Zero Ozone standard CDC has accepted to be used for IAQ. There are other products available in the market with a UL2998 rating. The impact of such products on occupant health needs further investigation and Edison Energy at this stage is not recommending any of these products.

4.3. In Duct UVGI

This technology involves the installation of UVGI lamps within air distribution ductwork. Edison Energy reviewed several in-duct UVGI technology products in the market. The manufactures claim is that by installing their product in the ductwork, bioburden of the virus can be reduced by 99.99%. However, the majority of the “In Duct UVGI” systems reviewed by Edison Energy would not specify or provide information regarding the sizing and engineering of the UVGI in-duct systems.

A list of the manufacturers contacted / reviewed is as follows:

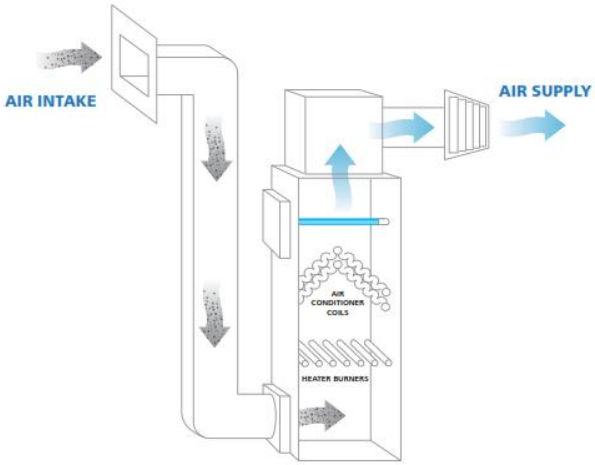
1. Ductmaster in-duct UVGI technology
2. Magneto in-duct technology
3. FreshAire-Airborne Duct System (TUV-C-ADS)
4. Aerapy – in-duct UVGI technology (PAH & PPR Series)

Three out of the four manufactures listed above claim that the virus can be deactivated up to 99.99%, however, the dosing required is excessive as it can take up to 6 hours to achieve this level of sterilization. One manufacturer, however (Aerapy) claims that their In-Duct UVGI product, when properly engineered, coupled with their proprietary sizing technology can achieve

the desired results (deactivation of the virus by 99.998%) in a single pass, greatly reducing the time required to achieve sterilization, providing the necessary dosing to the virus at the air speed in the ductwork (500 fpm and greater).

PPR SERIES

PAH SERIES



This technology if in fact effective as stated by the manufacturer would be the most energy and cost-effective solution as compared to other technologies. However, when Edison Energy requested supporting calculations to size and specify the lamp configurations, 3 out of 4 manufacturers listed above would not specify or provide information regarding the sizing of the UVGI in-duct systems. One manufacturer (Aerapy) claimed that they would provide us with the sizing and specification guidelines, but that this information is proprietary. In order for Edison Energy to obtain this information, Edison Energy would need to sign an NDA (Non-Disclosure Agreement). At this time, Edison Energy is not willing to sign an NDA, so as to not take on potential liability issues as this information will ultimately be shared with multiple organizations/clienteles.

4.4. Hydrophobic Spray

This technology involves utilization of a hydrophobic spray which is applied to AHU filters. This spray has been developed by Curran Biotech. The hydrophobic solution upon drying, adheres to the Covid 19 virus, water is repelled away from the filter. The cell wall of the virus is damaged, and the virus is inactivated. The spray does not block the pours of the filter implying that there will be no increase in static pressure across the filters. Curran Biotech claims there will be no energy increase post implementation.

This technology is not recommended at this time as the technology is still being evaluated and has yet to be listed as a demonstrated control measure by ASHRAE.

5. Overarching Takeaways

With this pandemic, various governmental and non-governmental bodies worked diligently to determine ways to best combat the virus to create safer living and working conditions. Different approaches and methods were observed to change as expected over the last year based on newer research results, information, etc., for which to make more educated decisions on effective strategies.

Edison Energy reviewed the ASHRAE Building Readiness Guidelines presented in Q2 of 2020, as well as various studies related to HVAC system operation to improve indoor air quality (IAQ), greatly reducing the Covid virus to allow for safer working conditions upon post Covid building re-entry. Updated ASHRAE EPIDEMIC TASK FORCE guidelines for Building Readiness have been posted to the website. These new guidelines were released on 2-1-2021 and provide new strategies for improving indoor air quality for post Covid building re-entry. As per the new guidelines, outdoor air ventilation should be maintained at minimum code requirements. ASHRAE now has a calculator to determine the equivalent air changes required for the purposes of determining flushing times between occupancies. With regards to filtration, the guidelines remain the same as filters are to be increased to MERV 13 or higher.

These new guidelines are less disruptive to building HVAC operations than the previous guidelines as increasing outdoor air ventilation to maximum levels to reduce bioburden is no longer recommended. As such, the significant energy consumption impact that results in maximizing outside air ventilation due to increased heating and cooling conditioning costs is no longer a concern.

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