Energy Efficient Indoor Air Quality (IAQ) Studies

Preliminary Monthly Reports Summary

for August 2020

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1.0 Introduction

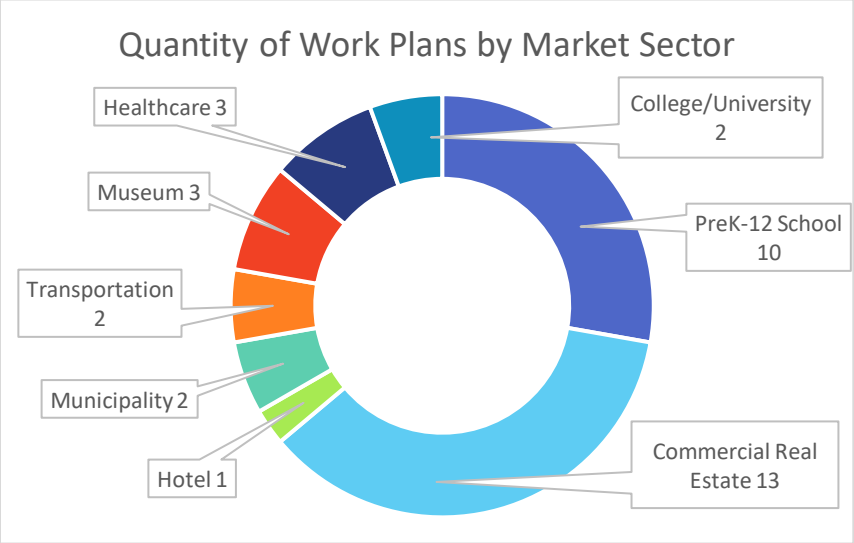
New or updated information within this month's report is presented in blue text.

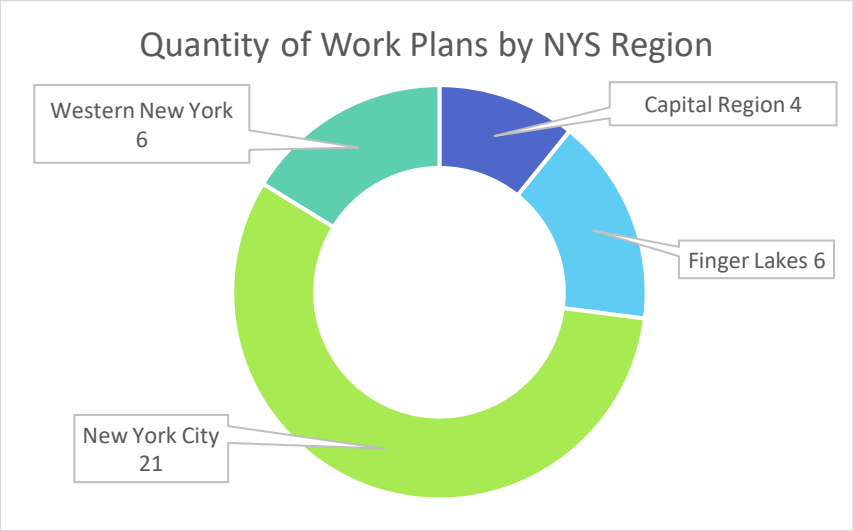
This report is intended to summarize the monthly reports submitted in August by the FlexTech consultants whom have been tasked with evaluating energy efficient COVID-safe building upgrades and operational adjustments for customers who are seeking recommendations for re-occupying their spaces safely while maintaining the pursuit of energy efficiency. The following sections will present each consultants' project progress, IAQ solutions considered in the projects, and a summary of conclusions, key findings, and commonalities found across all projects.

The consultants discussed in this report are presented in the table below, along with the enrolled customers and the regional location and market sectors of the buildings chosen to participate in the study.

Consultant Conducting Study	Customer	Regional Building Location	Market Sector
AKF Engineers, LLP	Tishman Speyer	New York City	Commercial Real Estate
	Commercial Office Building	New York City	Commercial Real Estate
Bergmann Associates	The Harley School	Finger Lakes	PreK-12 School
	St. John Fisher College	Finger Lakes	College/University
Edison Energy, LLC	Memorial Sloan Kettering Cancer Center – Breast & Imaging Center	New York City	Healthcare
	Memorial Sloan Kettering Cancer Center – Josie Robertson Surgery Center	New York City	Healthcare
EMCOR Services Betlem	Rochester Museum and Science Center	Finger Lakes	Museum
	Finger Lakes Community College	Finger Lakes	College/University
Goldman Copeland Associates, P.C.	Large Midtown Manhattan Commercial Office Building #1	New York City	Commercial Real Estate
	Large Midtown Manhattan Commercial Office Building #2	New York City	Commercial Real Estate
	Large Midtown Manhattan Commercial Office Building #3	New York City	Commercial Real Estate
Guth DeConzo Consulting Engineers, P.C.	Albany Medical Center	Capital Region	Healthcare
	North Colonie Central School District	Capital Region	PreK-12 School

Consultant Conducting Study	Customer	Regional Building Location	Market Sector
Jaros, Baum & Bolles Consulting Engineers, LLP (JB&B)	Museum of Modern Art – Main Campus	New York City	Museum
	Museum of Modern Art – Queens Campus	New York City	Museum
	Rudin Management Company – 80 Pine	New York City	Commercial Real Estate
	Rudin Management Company – 3 Times Square	New York City	Commercial Real Estate
	Rudin Management Company – 345 Park	New York City	Commercial Real Estate
	New Water Street Corporation	New York City	PreK-12 School
	Horace Mann School – Aquatics Center	New York City	PreK-12 School
	Horace Mann School - Pforzheimer Hal	New York City	PreK-12 School
	Horace Mann School – Science Center	New York City	PreK-12 School
	Horace Mann School - Tillinghast Hall	New York City	Commercial Real Estate
LaBella Associates, D.P.C.	Niagara Frontier Transportation Authority – Buffalo Niagara International Airport	Western New York	Transportation
	Niagara Frontier Transportation Authority – Metro Transportation Center	Western New York	Transportation
	City of Rochester – Blue Cross Arena	Finger Lakes	Municipality
	City of Rochester – Rundel Public Library	Finger Lakes	Municipality
	Rosenblum Companies	Capital Region	Commercial Real Estate
	Webster Central School District – Dewitt Elementary	Finger Lakes	PreK-12 School
	299 Old Niskayuna Road, LLC	Capital Region	Commercial Real Estate
	North Tonawanda School District – Intermediate School	Western New York	PreK-12 School
Syska Hennessy Group	Manhattan Commercial Office Tenant	New York City	Commercial Real Estate
	Westchester Commercial Office Facility	New York City	Commercial Real Estate
Vidaris, Inc.	Mark Hotel	New York City	Hotel
	Tishman Speyer	New York City	Commercial Real Estate
Wendel Energy Services, LLC	School District	Western New York	PreK-12 School
	Williamsville Central School District	Western New York	PreK-12 School


Quantity of Work Plans by Market Sector
Healthcare 3
College/University 2
Museum 3
PreK-12 School 10
Transportation 2
Municipality 2
Hotel 1
Commercial Real Estate 13


Quantity of Work Plans by NYS Region
Western New York 6
Capital Region 4
Finger Lakes 6
New York City 21

2.0 Consultant Progress Overview

The following table summarizes the progress made by each of the consultants on their work plans (i.e. the defined study scope). Typically, each work plan represents one building study, however in some cases there are multiple buildings represented in a work plan, which may nor may not be broken out into separate "studies" (i.e. individual study reports).

For each milestone listed below, the number of work plans that have completed a milestone are indicated.

Consultant	**# of Work Plans**	**# of Buildings Represented**	**Data Collection Completed** (# of Work Plans)	**Onsite Work Completed** (# of Work Plans)	**Analysis of Proposed Solutions Completed** (# of Work Plans)	**Study Report Completed** (# of Work Plans)	**Expected Report Completion Dates**
AKF	2	2	2	0	0	0	Mid-November
Bergmann	2	13	1	2	0	0	Mid-September – Late December
Edison Energy	2	2	2	0	0	0	Late September – Early December
EMCOR	2	3	0	1	0	0	Late October
Goldman Copeland	3	3	3	0	0	0	Mid November
Guth DeConzo	2	7	2	0	0	0	Mid November
JB&B	10	10	2	2	0	0	Late August
LaBella	8	8	4	0	0	0	Early November
Syska Hennessy	2	2	2	0	0	0	Mid-November
Vidaris	2	2	1	1	0	0	Late September
Wendel	2	8	0	0	0	0	Mid-December
Total	**37**	**60**	**19**	**6**	**0**	**0**	**Last Report: Late December**

3.0 Solutions Considered

Each consultant is evaluating a series of solutions intended to make each building COVID-safe while limiting the impacts on building energy efficiency. These solutions are intended to be implemented so that the buildings can run efficiently without sacrificing safe IAQ. Solutions being explored by the consultants are described below:

Ventilation

Improved ventilation strategies are intended to remove contaminated air from occupant spaces and provide fresh outdoor air to occupant spaces such that safe IAQ can be achieved while optimizing energy use. Ventilation options under consideration include:

- Increased outdoor airflow
    - Greater amounts of fresh outdoor air are supplied to the space, decreasing the concentration of contaminated air
    - Thirty-three (33) studies are evaluating this solution
- Reduced outdoor airflow
    - Some spaces provide greater outdoor airflows than is necessary to maintain safe IAQ. Outdoor airflows can be reduced to maintain safe IAQ while reducing energy use. Reduced outdoor airflows in relation to the current market guidance may also be a solution if paired with an effective air disinfection technology, such as UVGI.
    - Four (4) studies are evaluating this solution
- Open Windows
    - Opening windows in spaces not served by central ventilation systems is a low/no-cost method of providing increase outdoor air to occupant spaces
    - Two (2) studies are evaluating this solution

Filtration

Improving filtration limits the size and amount of harmful particulates entering the occupant space via air handling units. Filtration options under consideration include:

- MERV 13+ filters
    - A MERV (Minimum Efficiency Reporting Value) corresponds to the minimum particulate size a filter can capture. Higher MERV values correspond to lower minimum particulate sizes. MERV filters rated at 13 and above capture smaller particulate sizes than standard commercial MERV 8 filters.
    - Thirty-three (33) studies are evaluating this solution
- HEPA filters (in-AHU)
    - HEPA (High Efficiency Particulate Air) filters capture smaller and more numerous particulates than MERV 13+ filters. In-AHU HEPA filters can be installed in air handling units in place of existing, less effective filters.
    - Seven (7) studies are evaluating this solution
- HEPA filters (portable)
    - Portable HEPA filters are installed in small, portable air circulation units and provide local, room-level air filtration
    - Eight (8) studies are evaluating this solution

HVAC Controls Improvements

Improving the operation of HVAC (Heating, Ventilation, and Air Conditioning) controls systems allow for automated, reliable responses to changes in IAQ demands while limiting the amount of building energy use. Controls improvements under consideration include:

- Time of day scheduling
  - Air handling units are operated based on occupancy schedules, so that they use the most energy to ventilate a space when it is occupied and save energy when a space is unoccupied
  - Twelve (12) studies are evaluating this solution
- Demand controlled ventilation
  - Air handling units increase or decrease ventilation rates based on sensed occupancy or air quality of a space. To ensure COVID-safe air quality, AHUs can be controlled to provide ventilation beyond the minimum recommended rate when a space is occupied or air quality exceeds ideal thresholds.
  - Twenty-six (26) studies are evaluating this solution
- Airflow setbacks
  - Variable air volume (VAV) units limit the amount of airflow provided to a space when it is unoccupied, based on either sensed occupancy or a pre-programmed schedule
  - Two (2) studies are evaluating this solution
- Airside economizer sequence
  - Outdoor airflow is increased beyond its minimum safe level when doing so would result in decreased energy use (used for cooling and typically based on outdoor air temperature)
  - Eleven (11) studies are evaluating this solution

UVGI

Ultraviolet germicidal irradiation (UVGI) technologies are intended to destroy germ particles and microbes by applying an ultraviolet light to a surface or airstream. UVGI systems being evaluated include:

- In Duct
  - UV source located within ductwork
  - Five (5) studies are evaluating this solution
- In AHU
  - UV source located within air handling unit (at filter or coil)
  - Twenty-two (22) studies are evaluating this solution
- Upper Room
  - UV source located in the upper (typically above 8 feet) part of a room
    - avoids UV contact with occupants, allowing the system to be in use during occupied hours
  - Fourteen (14) studies are evaluating this solution

- Whole Room
  - UV source located within occupant's level
    - UV light contacts occupant spaces, restricting operation to unoccupied hours
  - Two (2) studies are evaluating this solution
- Portable
  - Portable UV source located within occupant's level
    - Various portable systems are available, such as those where UV light contacts occupant spaces, restricting operation to unoccupied hours, and others where the UV light is not visible to occupants and can be operated during occupied hours
  - Two (2) studies are evaluating this solution
- Elevator
  - UV source located in elevator car
    - activated when elevator car is not occupied
  - Two (2) studies are evaluating this solution

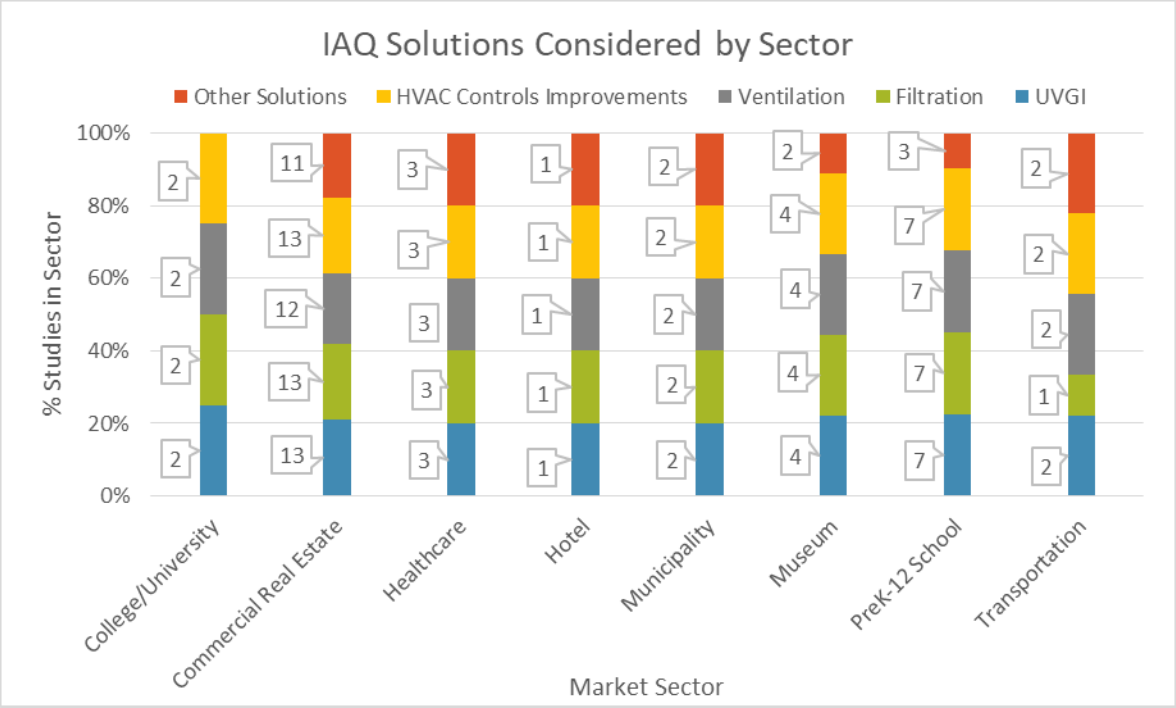
<u>Other Solutions</u>

Other solutions considered include the following:

- Humidification
  - Maintaining relatively humidity levels of 40-60% has been found to be the optimal humidity range to limit the transmission of most disease-causing particles, reduce the survival rate of pathogens, and increase healthy immune system function
  - Nineteen (19) studies are evaluating this solution
- Energy or heat recovery
  - Heat taken from exhaust air is transferred to incoming outdoor air in order to limit the additional heat energy needed to condition greater amounts of outdoor air
  - Four (4) studies are evaluating this solution
- Retro-commissioning
  - Existing systems are tested, inspected, and repaired or replaced to ensure they are operating optimally
  - Three (3) studies are evaluating this solution
- Bi-polar ionization (not included as part of the NYSERDA-funded study)
  - Reactive ions are introduced into the airstream in order to neutralize bacteria, viruses, and other particles.
  - Effectiveness of this technology is not widely verified and has therefore been excluded from the NYSERDA-funded scope of these studies until independent, unbiased, 3rd party evidence of the technology's ability to inactivate the SARS-CoV-2 virus and operate safely becomes available
  - Ten (10) studies are evaluating this solution independently

3.1 Prevalence of Solutions Considered by Sector

The number of studies for which each solution is being considered within each market sector is presented in the graphs below. Note that solutions covered under the "Other Solutions" category may be broken out into their own categories in future reports if there is an apparent widespread evaluation of any of these specific solutions across multiple work plans.



4.0 Issues Encountered and Common Observations

A summary of relevant issues encountered and observations that have been identified are presented below, categorized by market sector.

College and University – Two (2) studies

- The AHUs in one (1) study are old and due for replacement. This makes UVGI application in these units unfeasible as a long-term solution.

Commercial Real Estate – Thirteen (13) studies

- Twelve (12) studies are considering increasing ventilation rates
  - One (1) study previously considered increasing ventilation rates, but excluded it due to lack of tenant control over solutions implemented at central AHUs
- Four (4) studies are considering increasing run hours of HVAC systems
- Ventilation controls in one (1) study are being overridden in order to correct a humidity control issue
- All thirteen (13) studies are considering MERV 13+ filters
  - Two (2) of these studies are additionally considering in-AHU HEPA filters
  - Five (5) of these studies are additionally considering portable HEPA filters
- The fan power of the AHUs in one (1) study may be too low for feasible implementation of filter upgrades
- Eleven (11) studies are considering demand control ventilation
- Two (2) studies are considering changes to airside economizer sequences
- No studies in this sector are considering airflow setbacks to date
- Although AHUs are reported to exist in all thirteen (13) of the studies, only eight (8) of the studies are considering in-AHU UVGI and only four (4) are considering in-duct UVGI
  - The AHUs in three (3) studies are too large or too small of a size for practical application of in-unit UVGI
  - The site conditions in two (2) studies limit adequate access for installation of in-duct UVGI
  - One (1) study previously considered in-AHU UVGI, but excluded it due to lack of tenant control over solutions implemented at central AHUs
- Six (6) studies are considering upper room UVGI
  - One (1) study previously considered upper room UVGI, but excluded it as there were no spaces large enough for practical application of the solution
- Two (2) studies are considering elevator UVGI
- Two (2) studies are considering energy recovery

- Two (2) studies are considering bi-polar ionization and other solutions that are outside the NYSERDA-funded portion of this study
- The AHUs in one (1) study are too large for practical implementation of energy recovery
- Excessive envelope renovation would be required to implement negative pressurization in two (2) studies
- The tenant under consideration in one (1) study does not have control over solutions implemented at central AHUs (i.e. ventilation rates, in-AHU UVGI, central AHU filter upgrade), therefore solutions considered are only applicable at zone level

Healthcare – Three (3) studies

- All three (3) studies are considering increased ventilation rates
- Two (2) studies are considering reduced ventilation rates
- Two (2) studies are considering increasing run hours of HVAC systems
- Two (2) studies are considering demand control ventilation
- All three (3) studies are considering MERV 13+ filtration
- Although AHUs are reported to exist in all three (3) studies, no studies are considering in-duct UVGI at this time and only one (1) study is considering in-AHU UVGI
    - One (1) AHU in one (1) study is due for replacement in the near future, making any long-term IAQ solutions impractical
- Two (2) studies are considering upper room UVGI
- One (1) study is considering whole room UVGI
- Two (2) studies are considering airflow setbacks
- One (1) study is considering humidification measures
- Two (2) studies are considering energy recovery
- One (1) study is considering bi-polar ionization, which is outside the NYSERDA-funded portion of this study

Hotel – One (1) study

- The one (1) study in this sector is considering in-duct, in-AHU, and portable UVGI, MERV 13+ filtration, increased ventilation rates, demand control ventilation, and humidification measures
    - The site conditions in this study cause difficult access for installation of in-duct and in-AHU UVGI
- Energy recovery was previously considered in this study, but was excluded due to limited space in AHUs for energy recovery installation

Municipality – Two (2) studies

- The two (2) studies in this sector are considering in-AHU UVGI, MERV 13+ filtration, in-AHU HEPA filtration, increased ventilation rates, demand control ventilation, changes to the airside economizer sequence, and humidification measures
- One (1) study is considering increasing run hours of HVAC systems
- The control sequence for the fan coil units (FCUs) and AHUs in one (1) study need to be repaired to allow for greater ventilation rates
- The design characteristics of some of the AHUs in one (1) study cannot accommodate the installation of improved filters nor in-unit UVGI

Museum – Four (4) studies

- All four (4) studies are considering increased ventilation rates
- All four (4) studies are considering MERV 13+ filtration
- Two (2) studies are considering portable HEPA filters
- Two (2) studies are considering demand control ventilation
- Two (2) studies are considering increased run hours of HVAC systems and changes to airside economizer sequences
- Two (2) studies are considering in-AHU and upper room UVGI
- Two (2) studies are considering humidification measures and bi-polar ionization.

PreK-12 Schools – Ten (10) studies

- Seven (7) studies are considering increased ventilation rates
- Two (2) studies are considering opening windows for ventilation
- Seven (7) studies are considering MERV 13+ filtration
- Two (2) studies are considering in-AHU HEPA filtration
- One (1) study is considering portable HEPA filtration
- Six (6) studies are considering demand control ventilation
- Two (2) studies are considering changes to economizer sequences
- For buildings that are reported to contain air handlers (6 studies), in-AHU UVGI is being considered for four (4) studies and no studies are considering in-duct UVGI
- One (1) study in this sector is considering upper room UVGI
- One (1) study is considering whole room and portable UVGI
- Three (3) studies are considering humidification measures
- One (1) study is considering bi-polar ionization and other solutions that are outside the NYSERDA-funded portion of this study.
- The filter maintenance schedule in one (1) study lists inconsistent filter names and types
- The design characteristics of the AHUs in two (2) studies cannot accommodate the installation of improved filters nor in-unit UVGI
- Thermal comfort issues were reported in one (1) study

Transportation – Two (2) studies

- Both studies are considering increased ventilation rates
- One (1) study is considering MERV 13+ and in-AHU HEPA filtration
- One (1) study is considering increased run hours of HVAC systems
- Both studies are considering demand control ventilation and changes to airside economize sequences
- Both studies in this sector are considering in-AHU UVGI and upper room UVGI
- The design characteristics of the smaller AHUs in one (1) study cannot accommodate the installation of in-AHU UVGI. The AHUs in the same study are already equipped with MERV 15 filters and cannot accommodate higher efficiency filters.
- Both studies are considering humidification measures

Overarching

- One (1) study in the College/University sector, one (1) study in the Commercial Real Estate sector, and one (1) study in the Healthcare sector have existing UVGI systems installed
- One (1) study in the College/University sector, two (2) studies in the Commercial Real Estate sector, and one (1) study in the Transportation sector have existing MERV 13+ filters installed

5.0 Consultant Study Sources

The sources used by the consultants as part of these studies are cited below:

1. ASHRAE Epidemic Task Force
   https://www.ashrae.org/technical-resources/resources

2. ASHRAE Standard 62.1-2013, Ventilation for Acceptable Indoor Air Quality
   https://ashrae.iwrapper.com/ASHRAE_PREVIEW_ONLY_STANDARDS/STD_62.1_2019

3. ASHRAE Standard 211-2018, Standard for Commercial Building Energy Audits https://ashrae.iwrapper.com/ASHRAE PREVIEW ONLY STANDARDS/STD 211 2018

4. Renat Manassypov, *Evaluating Virus Containment Efficiency of Air-Handling Systems,* ASHRAE Journal, July 2020

5. Zhen-Dong Guo et. al. *Aerosol and Surface Distribution of Severe Acute Respiratory Syndrome Coronavirus 2 in Hospital Wards, Wuhan, China, 2020*, CDC EID Journal Volume 26, Number – July 2020

6. Mahesh Jayaweera et. al. *Transmission of COVID-19 virus by droplets and aerosols: A critical review on the unresolved dichotomy,* NIH's Elsevier Public Health Emergency Collection, June 13, 2020

7. Emanuel Goldman, *Exaggerated risk of transmission of COVID-19 by fomites,* The Lancet, July 30, 2020

8. Steven Taylor, Taylor Engineering, *Covid Transmission White Paper*, https://taylorengineers.com/wp-content/uploads/2020/05/TE-COVID19-White-Paper.pdf

9. Mosto Technologies, Humidification White Paper

10. Steril Aire, Equipment Information and Specifications

11. RESET IAQ Sensor Accreditation Standard
    https://www.reset.build/download/RESET_Standard_v2_2_6_Monitor%20Standard%20180921.pdf

12. RESET Standard-compliant sensors: indoor, room-level sensors
    https://www.reset.build/monitors/type/indoor

13. RESET Standard-compliant sensors: in-duct, system-level sensors:
    https://www.reset.build/monitors/type/induct