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HVAC SYSTEMS AND THE COVID-19 PANDEMIC

Mitigating the Risk of Spread

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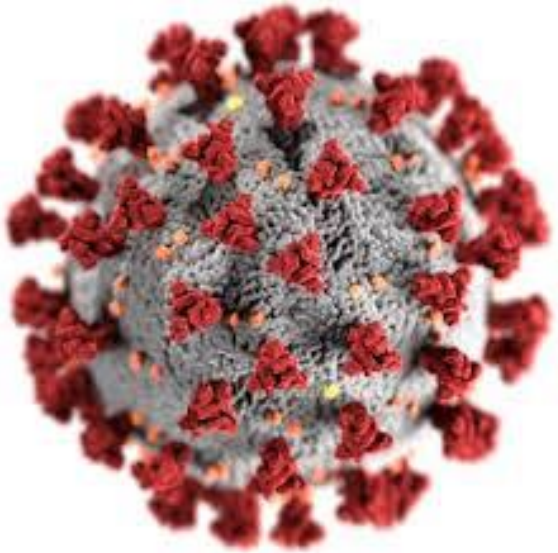
- HVAC mechanical contractor serving the Carolina Piedmont since 1977

- Engineering based HVAC solutions to the commercial and industrial marketplace, including:
  - ❑ design conception
  - ❑ engineering
  - ❑ installation
  - ❑ preventive maintenance & repair
  - ❑ system upgrades & replacement
  - ❑ automated building controls

World Health Organization

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION



NIH National Institute of Allergy and Infectious Diseases

SO MUCH INFORMATION- rapidly evolving and sometimes conflicting

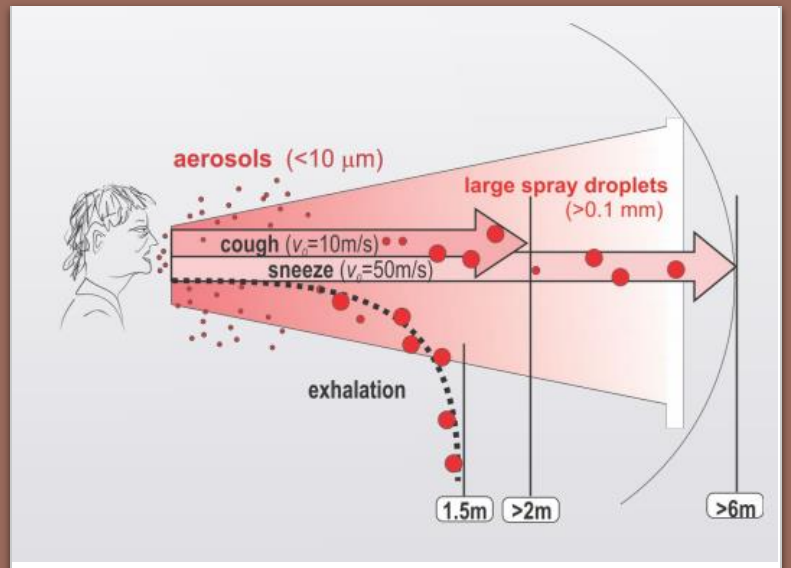
MOUNTING EVIDENCE THAT CORONAVIRUS IS AIRBORNE

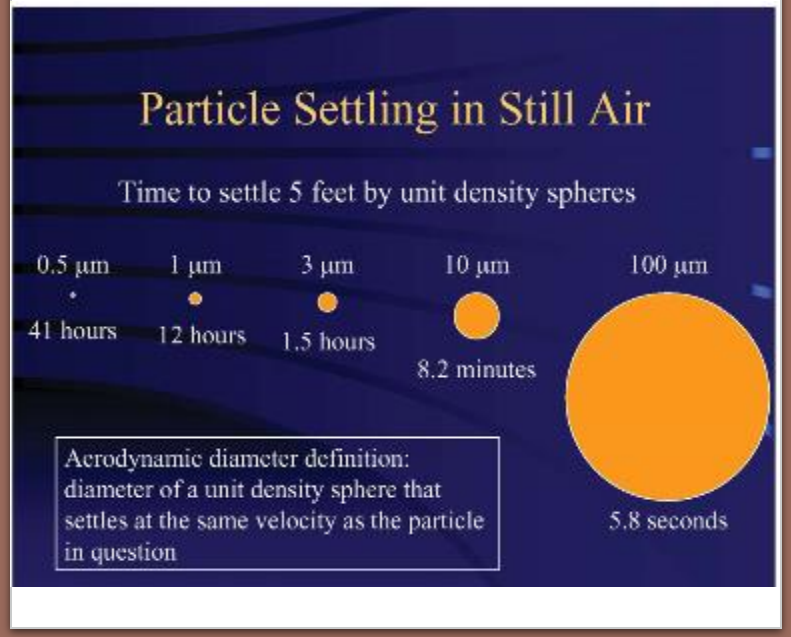
- The World Health Organization has long held that the coronavirus is spread primarily by large respiratory droplets that, once expelled by infected people in coughs and sneezes, fall quickly to the floor.

- However, many scientists have been saying for months, “the virus lingers in the air indoors—infecting those nearby.”

- A recent National Institute of Health study analyzed the virus’ stability in aerosols and on surfaces. Researchers found the virus remained variable in aerosols for hours

- Experts agree that the virus does not travel long distances or remain viable outdoors. But evidence suggests it can traverse the length of a room and, in one set of experimental conditions, remain viable for perhaps three hours.





AIRBORNE DISSEMINATION

- General dilution ventilation and pressure differentials do not significantly influence short-range transmission. Conversely, dissemination of smaller infectious aerosols, including droplet nuclei resulting from desiccation, can be affected by airflow patterns in a space in general and airflow patterns surrounding the source in particular.

- Of special interest are small aerosols (<10 μm), which can stay airborne and infectious for extended periods (several minutes, hours, or days) and thus can travel longer distances and infect secondary hosts who had no contact with the primary host.

ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers)

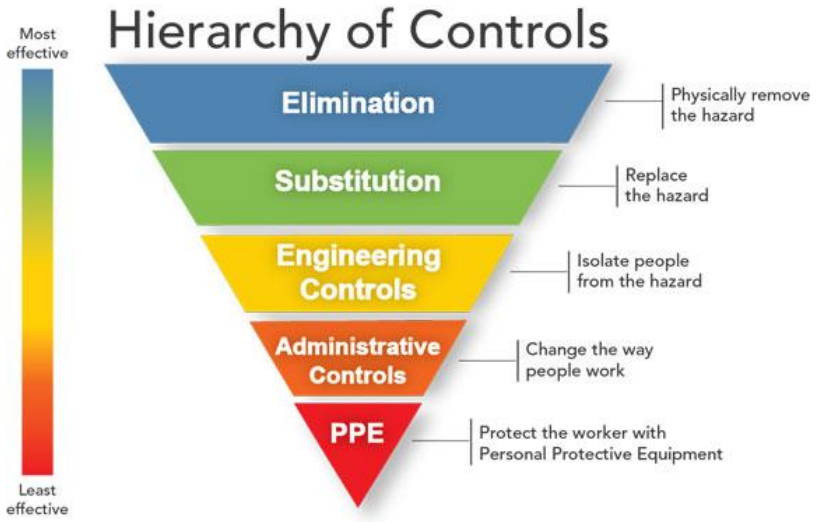
- ASHRAE, founded in 1894, is a global society advancing human well-being through sustainable technology for the built environment. The Society and its members focus on building systems, energy efficiency, indoor air quality, refrigeration and sustainability within the industry.

Their position on COVID which is not in conflict with WHO or CDC's positions.

- *"Transmission of SARS-CoV-2 (COVID-19) through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning systems, can reduce airborne exposures."*

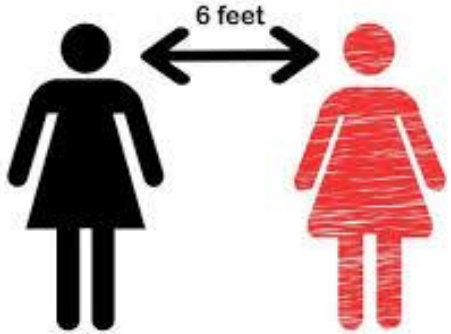
- *"Ventilation and filtration provided by heating, ventilating, and air-conditioning systems can reduce the airborne concentration of SARS-CoV-2 and thus the risk of transmission through the air."*

Holistic Approach



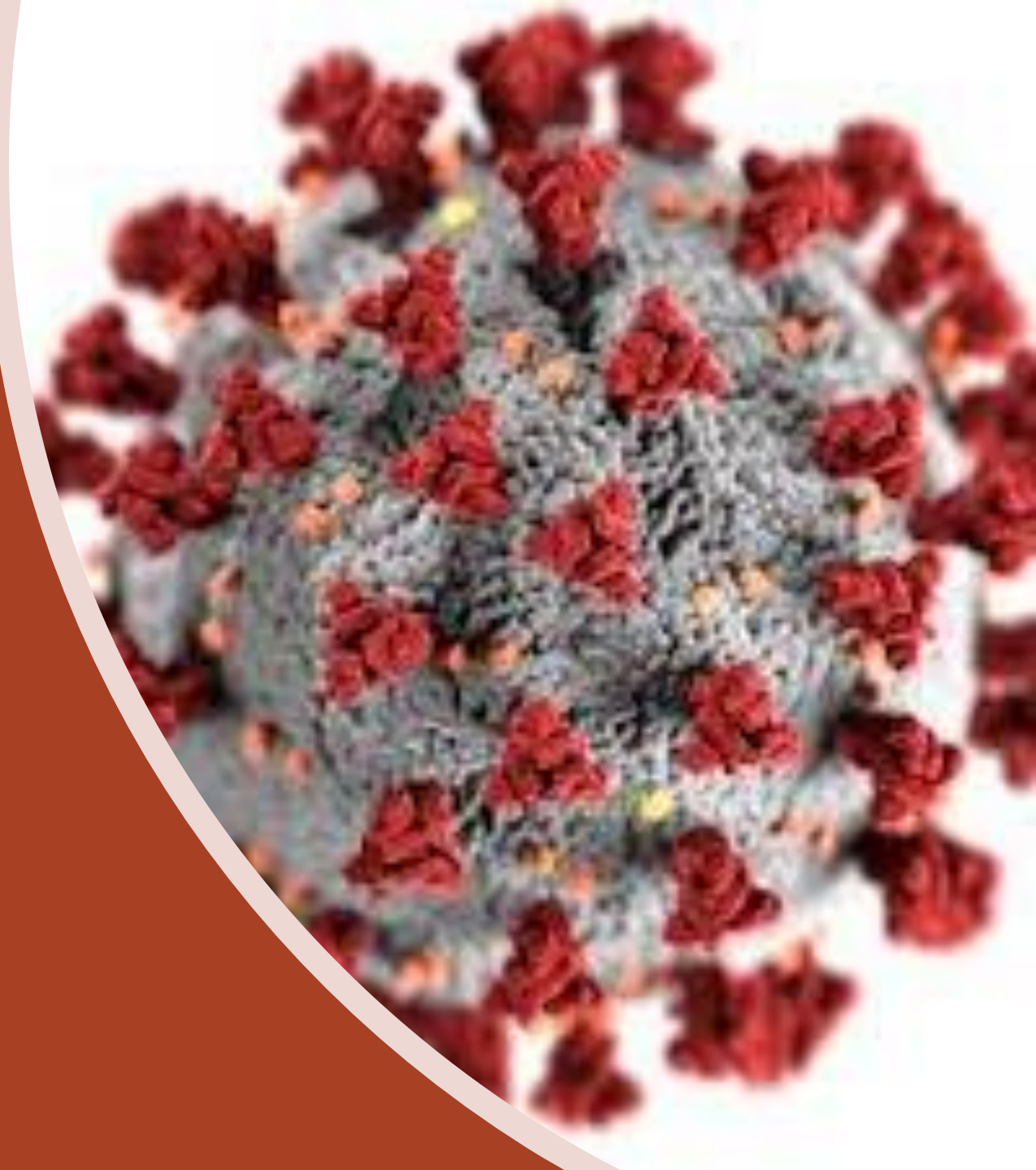
Disclaimer:

"….designers of mechanical systems should be aware that ventilation is not capable of addressing all aspects of infection control. HVAC systems do, however, impact the distribution and bio-burden of infectious aerosols."



ASHRAE RECOMMENDATIONS FOR MITIGATION AND CONTROL OF AIRBORNE EXPOSURES

- Increase ventilation rates
- Upgrade air filters
- Increase system run times
- Consider portable room air cleaners with HEPA filters
- Consider the addition of UV lighting



INCREASE VENTILATION RATES

Outside air for ventilation should be increased to as much as the HVAC system can accommodate and still maintain acceptable indoor conditions during occupied hours.

- Maintain temperature within comfort ranges
- Maintain relative humidity between 40% and 60%

Typical Ventilation Equipment

- Natural Ventilation

- Windows
- Fresh Air louvers

- Exhaust & Supply Fans

- Outdoor Air Dampers

- Economizers

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- Make Up Air Units
- Dedicated Outdoor Air Units
- Energy Recovery Ventilators

INCREASING VENTILATION RATES-- Is Not Always Possible

PERCENT OUTSIDE AIR	ENTERING AIR TEMP	PUMPING MULTIPLIER	TOTAL CAPACITY (tons)
20	77.64	73.66 GPM	37
30	78.95	1.13x	43
40	80.26	1.28x	49
50	81.56	1.41x	54
60	82.86	1.56x	60
70	84.15	1.71x	66
80	85.44	1.84x	71
90	86.72	2.03x	77

Typical Chilled Water Coil Example:

The unit was selected to be 10,000 cfm with a constant 44°F chilled water supply with a 12°F chilled water rise to make a consistent coil leaving air temperature of 52°F dry-bulb and 51.5°F wet-bulb. This assumes a return air condition of 78°F and 60% RH from the space. The coil was locked in at an 8-row coil with 126 fins per foot that is 20.45 square feet of coil face area.

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- As you increase the percentage of outside air, your capacity and chilled water pumping requirements increase. Given the design of your system, an increase in outdoor air may not be possible.
- Engineering calculations are required to determine the maximum percentage of outdoor air allowable, based on the size of the cooling coil, chiller plant, and pumping considerations.

INCREASE SYSTEM RUN TIME

- Flush building for 2 hours before and after occupied time.
- Three (3) air changes is generally sufficient to reduce the concentration of airborne particles by 95%

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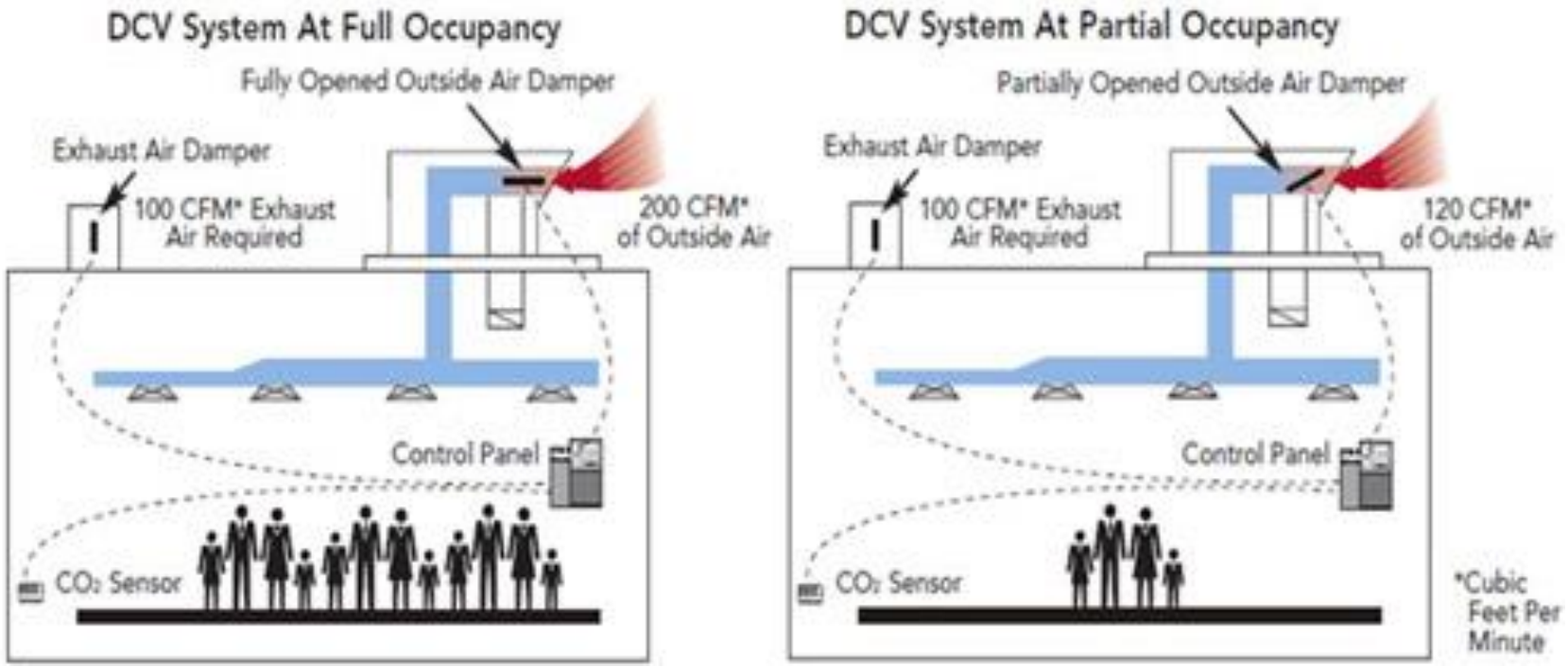
Disable Demand Control Ventilation



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UPGRADE AIR FILTERS

- Improve central air filtration to the MERV-13 or the highest compatible with the filter rack
- Seal the edges of the filter to limit bypass
- Make sure the air handling systems and fans can overcome the additional pressure drop of the new filters and still maintain air flow at acceptable levels.

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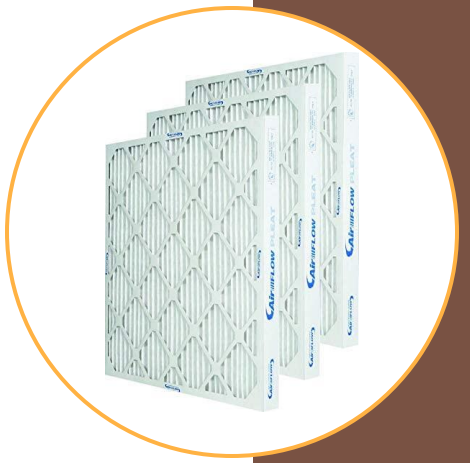
**MERV ratings measure how effectively the filter stops contaminants from passing through the filter and into the air stream. Higher MERV = higher efficiency.*

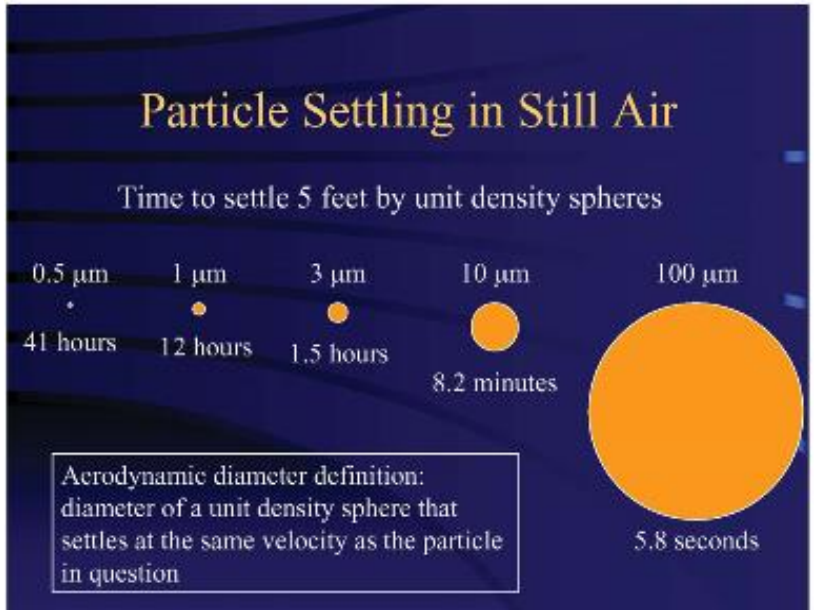
MERV AIR FILTER RATINGS

Minimum Efficiency Reporting Value (MERV)	Average Dust Spot Efficiency	Arrestance	Typical Controlled Containment	Typical Applications
20	n/a	n/a	<.30 pm particle size	Cleanrooms
19	n/a	n/a	Virus (unattached)	Radioactive Materials
18	n/a	n/a	Carbon Dust	Pharmaceutical Manufacturing
17	n/a	n/a	All Combustion smoke	Carcinogenetic Materials
16	n/a	n/a	.30-1.0 particle size	General Surgery
14	90-95%	>98%	Most Tobacco Smoke	Smoking Lounges
13	89-90%	>98%	0.3- 1.0 µm Propelet Nuceli (Sneeze)	Superior Commercial Buildings
11	60-65%	>95%	1.0-3.0 µm particle size Humidifier Dust Lead Dust	Better Commercial Buildings
8	30-35%	>90%	3.0- 10. µm particle size Mold Spores	Commercial Buildings



MERV 13 FILTER EFFICENCY

- The average dust spot efficiency is based on the filters overall ability to filter out 3 ranges of particles sizes:
  - 3.0- 10 µm: 99.0%
  - 1.0- 3.0 µm: 90.4%
  - 0.3- 1.0 µm: 63.1%



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Test Report-ASHRAE Test Standard 52.2-2007

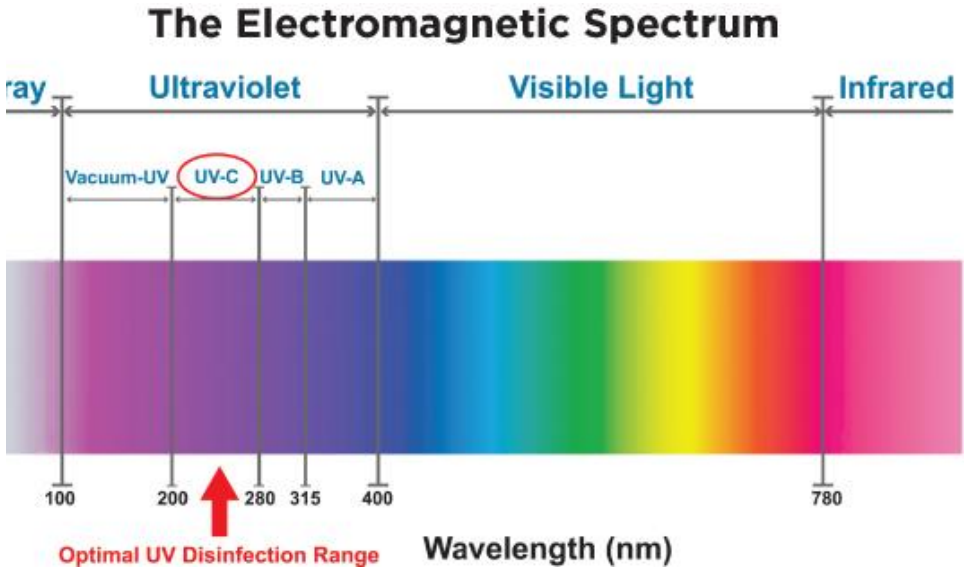
Report #: 2773
Test Date: 10/16/2012

Test Requested By:	Airflow Products Company
Manufacturer:	Airflow Products Company
Filter ID:	AFP30 Airflow Pleat M13
Model Number:	N/A
Dimensions:	24" x 24" x 2"
Number of Pleats:	31-Plts
Filter Description:	White synthetic Filter
How Filter Obtained:	Provided by Airflow Products Company

Test Results

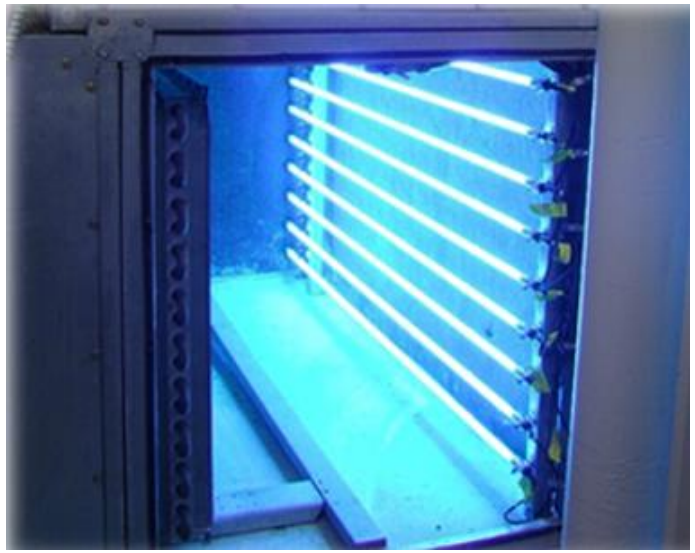
Test Air Flow Rate(CFM)/Velocity (FPM)	1968 cfm / 492 fpm
Initial Resistance (in. WG)	0.390"
Final Resistance (in. WG)	1.500"
Minimum Efficiency Rating Value (MERV)	MERV 13 @ 1968 cfm
Minimum Average Efficiency 0.3 to 1.0 Microns (E1)	63.1
Minimum Average Efficiency 1.0 to 3.0 Microns (E2)	90.4
Minimum Average Efficiency 3.0 to 10 Microns (E3)	99.0
Dust Fed to Final Resistance (grams)	11.3 grams
Dust Holding Capacity (grams)	10.9 grams
Arrestance:	96.4%

UVGI (UV) LIGHTING



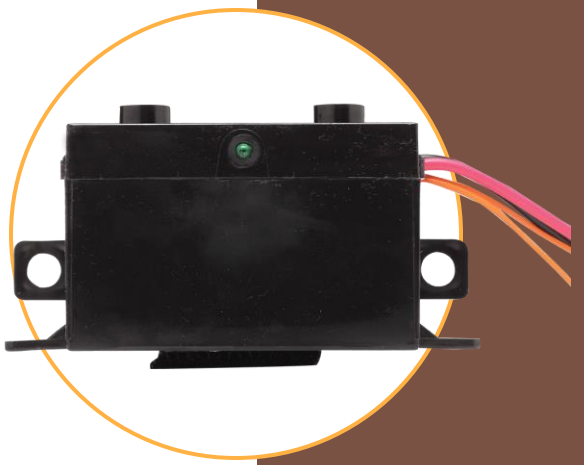
- Ultraviolet energy inactivates viral, bacterial, and fungal organisms so they are unable to replicate and potentially cause disease.

- The entire UV spectrum is capable of inactivating microorganisms, but UV-C energy (wavelengths of 100 – 280 nm) provides the most germicidal effect, with 265 nm being the optimum wavelength.



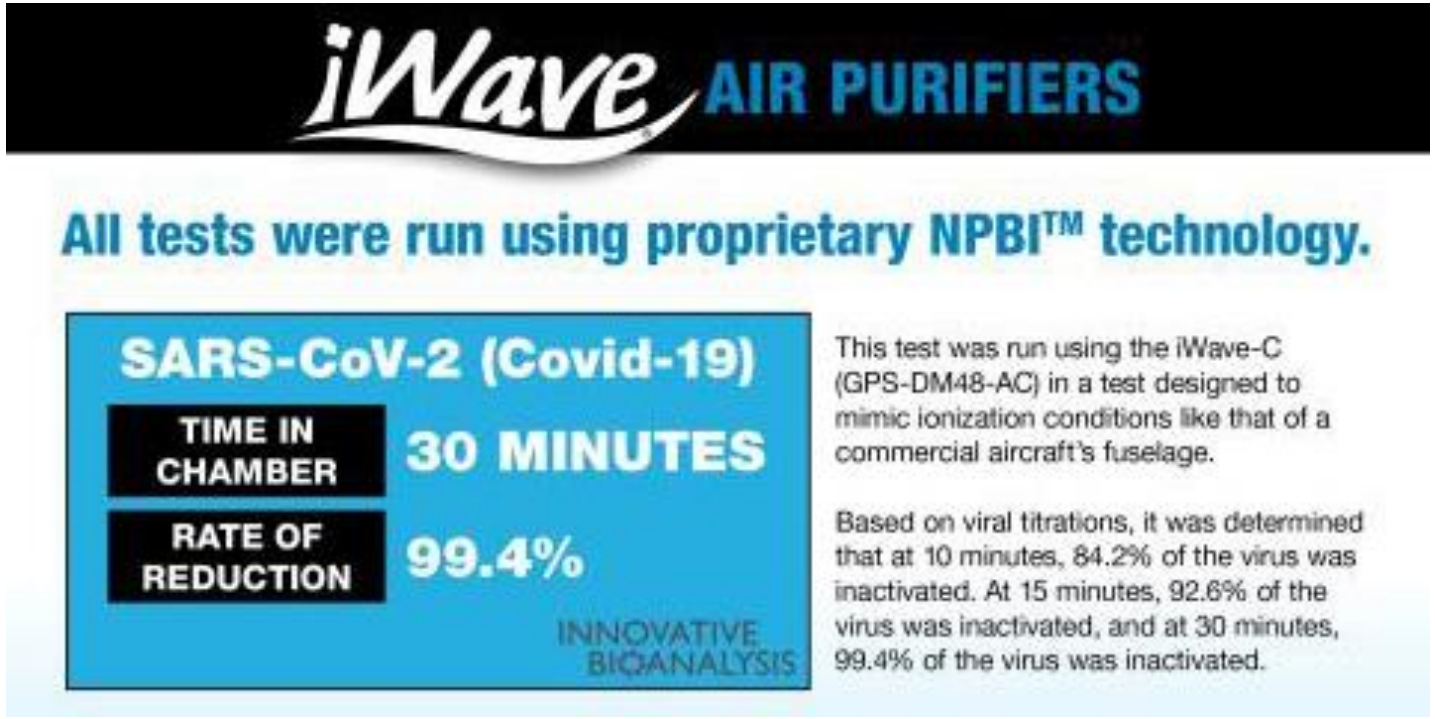
NEEDLE POINT BIPOLAR IONIZATION

- Not formerly on ASHRAE's list of recommendations, but another strategy gaining traction
- Using an electronic charge that creates + and – ions, airborne particles and pathogens—including COVID-19—are broken down into harmless compounds. Air is cleaned everywhere the ions travel, even in spaces unseen.
- Works when weather conditions makes it impractical to bring in more fresh air
- Satisfies ASHRAE Section 62.1 for Indoor Air Quality (IAQ)



NEEDLE POINT BIPOLAR IONIZATION (NPBI)

- Initial testing indicate the COVID-19 virus would be rendered 99.4% ineffective within 30 minutes



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Portable Air Cleaners

015 Size

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- HEPA Filtration
- Supplements your existing system—allowing for more air changes and better filtration
- Portable, plugs into any outlet

ANALYZING THE OPTIONS

RECOMMENDATION		
Increase ventilation rates	Do so up to the point your system can handle the increased capacity requirements and/or you stay in the 40%- 60% humidity range	Not practical in extreme weather conditions.
Upgrade air filters	Cost effective-easy retrofit	May require more frequent filter changing
Increase system run times	Simple programing change to BAS	
Consider portable room cleaners with HEPA filters	Portable Options—Simple Installation	
UV lighting	Is effective when increasing outside air is impractical. Will treat anything that comes in contact with the coil	Requires yearly bulb change
Needle Point Bipolar Ionization (NPBI)	Is effective when increasing outside air is impractical. Air is cleaned everywhere the ions travel, even in spaces unseen	Ion monitoring recommended to ensure device is working properly.

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GENERAL HVAC SYSTEM OPERATION AND MAINTENANCE RECOMMENDATIONS

- Make sure dampers, filters, and economizer seals and frames are intact and clean and are functional and responding to control signals
- Check to see that zone and air temperature, humidity, and CO2 sensors are calibrated and accurately reporting environmental conditions to the BAS or local controllers
- Make sure air handling systems are providing adequate airflow, there are no blockages, and air from the air handling system is reaching each occupied space

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BUILDING AUTOMATION CONSIDERATIONS

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CONTROLS STRATEGIES

- Print out current value setpoints & adjustable values prior to making changes
- Back up BAS and system settings prior to making changes
- Review and modify
  - Disable Demand Control Ventilation
  - Set sequence of operations to increase ventilation based on equipment
  - Set sequence of operations to flush building before and after occupied times
  - Review schedules and alarms
- Review performance trends
- Monitor IAQ:
  - Air filter status (differential pressure)
  - CO2 measurements to ensure effective dilution
  - Temperature & Humidity levels
  - Particulate sensors
  - Air Ionization monitoring (if ionization is implemented)

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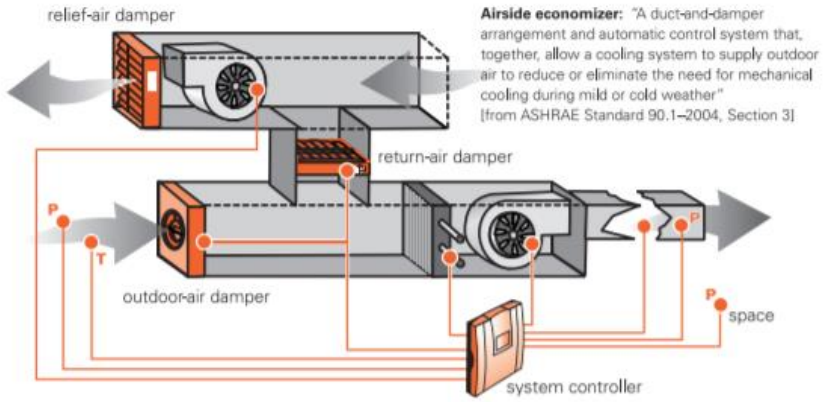
CONTROLS STRATEGIES (cont.)



- Economizer Controls Strategies
  - Dry-bulb Change Over
  - Enthalpy Change Over
  - Differential Drybulb
  - Differential Enthalpy
  - "Integrated" systems can economize and provide mechanical cooling at the same time

- Example BAS ventilation strategies for centralized air handler VAV systems
  - Increase discharge air temperature (max 60 F)—VAV boxes open fully and it requires more time to satisfy space temperatures resulting in more air changes
    - NOTE: Any discharge air temperature over 55 degrees will no longer dehumidify.
  - Modulate outdoor air damper based on space temperatures
    - When space conditions are satisfied open 3% every 15 minutes
    - When space conditions are exceeding set point by 1 degree or relative humidity is over 60% close 6% every 5 minutes

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GENERAL HVAC SYSTEM OPERATION AND MAINTENANCE RECOMMENDATIONS (cont.)

- Pressurization—Maintain slightly positive pressure as compared to outside.
  - Maintain equal pressures on each floor of multi-story office buildings.
  - Tall buildings must take into consideration stack effect & wind effect.
    - Stack effect can be reversed between summer & winter and pressurization may need to be adjusted throughout the year
    - Wind speed & pressure in the upper part of a tall building can be significantly higher than lower levels
  - Be aware that changes made to increase outdoor air ventilation can affect the pressurization of a space or building.

- Exhaust Systems—Should run as normal, with the following additional guidance:
  - Run 2 hours before and after occupied periods
  - Bathroom exhaust systems should run 24/7
  - Garage exhaust systems should run during occupied hours
  - Turn on elevator cab ventilation, where possible

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PRACTICAL IMPLICATIONS FOR BUILDING OWNERS, OPERATORS, AND ENGINEERS

- Even the most robust HVAC system cannot control all airflows and completely prevent dissemination of an infectious aerosol or disease transmission by droplets or aerosols
- An HVAC system's impact will depend on source location, strength of the source, distribution of the released aerosol, droplet size, air distribution, temperature, relative humidity, and filtration
- Strategies for prevention and risk mitigation require collaboration among designers, owners, operators, industrial hygienists, and infection prevention specialists

RULE #1 AND RULE #2

#1

- *If a system's designer can tell you how their design works, there is a chance it will work.*

Otherwise... no chance.

#2

- *If a system's operator understands what the designer tells them about the way their system works, there is a chance it will work.*

Otherwise...no chance.

Find a resource who not only understands how your system was designed to function but can describe how your system should be operated in a manner that is easy for you the operator to understand.

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CONTACT INFORMATION

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