Bi-Polar Ionization

What is the science behind it and what to consider?

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Facilities Management Conference

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HVAC Engineering Controls

- Increase OA (Ultra-Violet)
- Increase to MERV 13 for Filtration
- Ionization

Air Purification

What is ionization? How does it work?

Studies? EPA/ASHRAE/UL

Type of Bipolar equipment? Sizes/ portable?

Testing- ACI unit

What to consider-
- All options
- Your budget
- Life expectancy
- Your existing HVAC equipment
- Maintenance

Andy
Introduction – CDC & ASHRAE

Centers for Disease Control & Prevention (CDC)
- US Federal Agency, under the Department of Health and Human Services, and is headquartered in Atlanta, Georgia.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- **Mission:** “To serve humanity by advancing the arts and sciences of heating, ventilation, air conditioning, refrigeration and their allied fields.”
- “State-of-the-art” design criteria
- Epidemic Task Force for Schools and Universities
  www.ashrae.org/covid19
INDOOR AIR QUALITY IS A LARGE & GROWING SEGMENT

**U.S. IAQ Industry, $B All Technologies**

- 2019: 2.5
- 2020: 9.5
- 2025 Est.: 18

**Share of IAQ Industry by Technology 2020**

- HEPA: 40%
- UV: 25%
- IONIZATION: 20%
- OTHER: 15%

*Source: Management estimate prepared by outside consulting firm*
The air around us is filled with particles. A sunbeam through a window makes it possible to see some of these particles which can include dust, dander, smoke, and even certain viruses and bacteria.
### AIR QUALITY INDEX

- There is no standard defining what is good or bad indoor air quality.
- The EPA’s air quality index for outdoor air can be used as a proxy for indoor air.
- Think of the AQI as a yardstick that runs from 0 to 500. The higher the AQI index value, the greater the level of air pollution and the greater the health concern.

<table>
<thead>
<tr>
<th>AQI Category</th>
<th>Index Values</th>
<th>Breakpoints (µg/m³), 24 hr avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>0-50</td>
<td>0-12</td>
</tr>
<tr>
<td>Moderate</td>
<td>51-100</td>
<td>12.1-35.4</td>
</tr>
<tr>
<td>Unhealthy for Sensitive Groups</td>
<td>101-150</td>
<td>35.5-55.4</td>
</tr>
<tr>
<td>Unhealthy</td>
<td>151-200</td>
<td>55.5-150.4</td>
</tr>
<tr>
<td>Very Unhealthy</td>
<td>201-300</td>
<td>150.5-250.4</td>
</tr>
<tr>
<td>Hazardous</td>
<td>&gt;301</td>
<td>&gt;250.5</td>
</tr>
</tbody>
</table>

[https://www.epa.gov/outdoor-air-quality-data/air-data-basic-information](https://www.epa.gov/outdoor-air-quality-data/air-data-basic-information)
ASHRAE – Design Recommendations

General – Schools & Other Public Buildings

- **Temp. & Humidity**
  - Winter – 72F & 40%-50% RH
  - Summer – 75F & 50%-60% RH
    - Less humid air – viral droplets lose water content and become more aerosolized. This likely increases the rate of transmission.

- **Ventilation Design Criteria/Guideline**
  - Follow ASHRAE 62 for outside air requirements
  - During pandemic, disable any Demand Control Ventilation (DCV) and maximize outside air 24/7.

- **Filtration Design Criteria/Guideline**
  - Apply the highest Minimum Efficiency Reporting Value (MERV) for the HVAC units.
  - MERV 13 is recommended, if equipment can accommodate pressure drop.
ASHRAE – Design Recommendations Continued
Operation & Scheduling Guidelines during Pandemic

- **Cooling & Heating Equipment**
  - Change the start and end times to run at least 2 hrs before & after occupancy.
  - Consider running 24/7

- **Exhaust Fans – Turn on when DOAS is running**
  - Only school days
  - Goal is to flush the building with OA and create slight positive pressure.

- **Dedicated Outdoor Air Systems (DOAS)**
  - Run units 2 hrs before & after occupancy.
  - New units – “Purge/Flush” mode for operations to min. virus transmission.

- **Energy Recovery Systems**
  - Some systems allow for exhaust air transfer from the exhaust airstream to the supply airstream. Depending on system configuration, this may be cause for concern.
  - Discontinue use/forget everything you have learned about saving energy!
Aerosolized Risk [In Buildings]

Infectious droplets can remain suspended in the air for prolonged periods, depending on their size.

- **20 micron** took 4 min to fall to the floor (bacteria).
- **10 micron** took 17 min to fall to the floor (spores).
- **1-3 micron** remained suspended indefinitely (viruses).

**FEET**

<table>
<thead>
<tr>
<th>1 – 3 ft</th>
<th>3 – 5 ft</th>
<th>5 – 160 ft +</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 micron took 4 min to fall to the floor (bacteria)</td>
<td>10 micron took 17 min to fall to the floor (spores)</td>
<td>1-3 micron remained suspended indefinitely (viruses)</td>
</tr>
</tbody>
</table>

J.W. Tang, Y. Li, I. Eames, P. K. S. Chan, G. L. Ridgway, Factors involved in the aerosol transmission of infection and control of ventilation in healthcare premises. Department of Microbiology, The Chinese University of Hong Kong, Prince of Wales Hospital, Hong Kong; Department of Mechanical Engineering, The University of Hong Kong, Pokfulam, Hong Kong; Department of Mechanical Engineering, University College London, London UK School of Public Health.
Aerosolized Risk [HVAC Systems]

Recirculated viruses, mold and bacteria. Minimal VOC reduction by typical filtration.
THE RELATIVE SIZE OF PARTICLES

From the COVID-19 pandemic to the U.S. West Coast wildfires, some of the biggest threats now are also the most microscopic.

A particle needs to be 10 microns (µm) or less before it can be inhaled into your respiratory tract. But just how small are these specs?

Here’s a look at the relative sizes of some familiar particles:

- **HUMAN HAIR**: 50-180 µm
- **FINE BEACH SAND**: 90 µm
- **GRAIN OF SALT**: 60 µm
- **WHITE BLOOD CELL**: 25 µm
- **GRAIN OF POLLEN**: 15 µm
- **DUST PARTICLE (PM10)**: <10 µm
- **RED BLOOD CELL**: 7-8 µm
- **RESPIRATORY DROPLETS**: 5-10 µm
- **DUST PARTICLE (PM2.5)**: 2.5 µm
- **BACTERIUM**: 1-3 µm
- **WILDFIRE SMOKE**: 0.3-0.7 µm
- **CORONAVIRUS**: 0.1-0.3 µm
- **ZIKAVIRUS**: 0.045 µm
- **T4 BACTERIOPHAGE**: 0.225 µm

Wildfire smoke can persist in the air for several days, and even months.

Pollen can trigger allergic reactions and hay fever—which 1 in 5 Americans experience every year. (Source: report health)

Respiratory droplets have the potential to carry smaller particles within them, such as dust or coronavirus.

The visibility limits for what the naked eye can see hovers around 10-40 µm.
Current State - What we know...

- **Transmission**
  - Droplets still the primary concern (6 ft +/-), but risk from airborne transmission is significant
  - Masks are effective (Reduced risk of infection by 50%, w/ ionization goes to 70%-80%)

- **Virus Size/ Particulate Removal**
  - Virus is 0.12 micron, but they tend to “clump” into larger particles (focus is now on particles > 1 micron).
  - It’s more reasonable to view viral size in terms of a distribution of different particle sizes.

<table>
<thead>
<tr>
<th>MERV Rating</th>
<th>Filter Droplet Nuclei Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>17%</td>
</tr>
<tr>
<td>5</td>
<td>27%</td>
</tr>
<tr>
<td>6</td>
<td>32%</td>
</tr>
<tr>
<td>7</td>
<td>41%</td>
</tr>
<tr>
<td>8</td>
<td>56%</td>
</tr>
<tr>
<td>9</td>
<td>62%</td>
</tr>
<tr>
<td>10</td>
<td>65%</td>
</tr>
<tr>
<td>11</td>
<td>73%</td>
</tr>
<tr>
<td>12</td>
<td>83%</td>
</tr>
<tr>
<td>13</td>
<td>90%</td>
</tr>
<tr>
<td>14</td>
<td>95%</td>
</tr>
<tr>
<td>15</td>
<td>96%</td>
</tr>
<tr>
<td>16</td>
<td>97%</td>
</tr>
</tbody>
</table>

**Distribution of SARS-CoV-2**

- % micron or larger: 80%
- % < 1 micron: 20%
A Closer Look at HVAC Engineering Controls

Treat Your Air: Evidence Based Methodologies

- DILUTION
- FILTRATION
- ULTRAVIOLET
- IONIZATION
Dilution

- Introduce additional clean air into your building so that the percentage of virus particles in your air (if a sick occupant is in the building) is decreased to reduce risk
- Seasonal impacts to your space (Winter/Summer)
- Utility cost impacts
- Maintenance cost impacts
- Equipment wear
# Filtration

- Increased maintenance & utility costs
- Increased risk to equipment wear & facility worker exposure

<table>
<thead>
<tr>
<th>MERV Rating</th>
<th>Air Particles size</th>
<th>Air Particles size</th>
<th>Air Particles size</th>
<th>Filter Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.03 to 1.0 microns</td>
<td>1.0 to 3.0 microns</td>
<td>3 to 10 microns</td>
<td>Removes These Particles</td>
</tr>
<tr>
<td>MERV 1</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>Fiberglass &amp; Aluminum Mesh</td>
</tr>
<tr>
<td>MERV 2</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>Pollen, Dust Mites, Spray</td>
</tr>
<tr>
<td>MERV 3</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>Paint, Carpet Fibres</td>
</tr>
<tr>
<td>MERV 4</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>Cheap Disposable Filters</td>
</tr>
<tr>
<td>MERV 5</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>20% - 34%</td>
<td>Mold Spores, Cooking Dusts,</td>
</tr>
<tr>
<td>MERV 6</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>35% - 49%</td>
<td>Hair Spray, Furniture Polish</td>
</tr>
<tr>
<td>MERV 7</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>50% - 69%</td>
<td>Better Home Box Filters</td>
</tr>
<tr>
<td>MERV 8</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>70% - 85%</td>
<td>Lead Dust, Milled Flour, Auto</td>
</tr>
<tr>
<td>MERV 9</td>
<td>&lt; 20%</td>
<td>Less than 50%</td>
<td>85% or Better</td>
<td>Fumes, Welding Fumes</td>
</tr>
<tr>
<td>MERV10</td>
<td>&lt; 20%</td>
<td>50% to 64%</td>
<td>85% or Better</td>
<td>Superior Commercial Filters</td>
</tr>
<tr>
<td>MERV 11</td>
<td>&lt; 20%</td>
<td>65% - 79%</td>
<td>85% or Better</td>
<td>Bacteria, Smoke, Many</td>
</tr>
<tr>
<td>MERV 12</td>
<td>&lt; 20%</td>
<td>80% - 90%</td>
<td>90% or Better</td>
<td>Viruses</td>
</tr>
<tr>
<td>MERV 13</td>
<td>Less than 75%</td>
<td>90% or Better</td>
<td>90% or Better</td>
<td></td>
</tr>
<tr>
<td>MERV 14</td>
<td>75% - 84%</td>
<td>90% or Better</td>
<td>90% or Better</td>
<td></td>
</tr>
<tr>
<td>MERV 15</td>
<td>85% - 94%</td>
<td>90% or Better</td>
<td>90% or Better</td>
<td></td>
</tr>
<tr>
<td>MERV 16</td>
<td>95% or Better</td>
<td>90% or Better</td>
<td>90% or Better</td>
<td></td>
</tr>
</tbody>
</table>
Filtration [Effect on Influenza A Virus]

* HEPA was not part of the study above. It’s a graphical representation of 99.97% efficiency HEPA filter (defined by DOE) with particulates in 0.3µm which is the toughest size to catch.

Ultra-Violet

- UV lamps create high energy UV rays that scramble and destroy the viruses
  - UV-C band (at 254nm) are the most predominant used against bacteria & viruses

![UV-C light sanitizes by permanently damaging the DNA of bacteria & viruses](image)
## Ultra-Violet [Effectiveness]

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Pathogenic name</th>
<th>Known, Published UVC value for pathogen reduction</th>
<th>FILTER EFFICIENCY</th>
<th>UVC-only Pathogen reduction/air pass</th>
<th>Pathogen reduction UVC + filtration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>UVGI $\text{K m}^3/\text{J}$</td>
<td>$\mu\text{W/cm}^2$</td>
<td>MERV 8</td>
<td>MERV 10</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Pseudomonas aeruginosa</td>
<td>0.5721</td>
<td>0.005721</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>TB / Tuberculosis</td>
<td>Mycobacterium tuberculosis</td>
<td>0.4721</td>
<td>0.004721</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Corona Virus</td>
<td>Coronavirus</td>
<td>0.3770</td>
<td>0.00377</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Legionella</td>
<td>Legionella pneumophila</td>
<td>0.1930</td>
<td>0.0019296</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Acinetobacter</td>
<td>Acinetobacter baumannii</td>
<td>0.1280</td>
<td>0.00128</td>
<td>42</td>
<td>44</td>
</tr>
<tr>
<td>Flu</td>
<td>Influenza A &amp; B</td>
<td>0.1190</td>
<td>0.00119</td>
<td>30</td>
<td>31</td>
</tr>
<tr>
<td>Staph / MRSA</td>
<td>Staphylococcus aureus</td>
<td>0.1130</td>
<td>0.00113</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td>Avian Flu</td>
<td>Avian Influenza Virus</td>
<td>0.1060</td>
<td>0.00106</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Measles</td>
<td>Measles</td>
<td>0.1051</td>
<td>0.001051</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Chicken Pox</td>
<td>Varicella Zoster</td>
<td>0.105</td>
<td>0.00105</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Strep</td>
<td>Streptococcus pyogenes</td>
<td>0.8110</td>
<td>0.00811</td>
<td>29</td>
<td>31</td>
</tr>
</tbody>
</table>

Airborne Pathogen Reduction Rates at specific MERV filter + UVC Fixture ratings
Ultra-Violet [Air Handling Units]

UVC Dose = Intensity x Exposure (dwell) Time
UVC energy is cumulative

Disinfection is accomplished by exposing a pathogen to:

**High-intensity** UVC energy for a short time period,
i.e. 2000 µW for only 1 second

**Low-intensity** UVC energy for long time period,
i.e. 20 µW for 100 seconds

NOTE: A 60W lamp is rated at 2047 µW @ 7°, or 200 µW @ 38°

Air Disinfection vs. Surface Disinfection

- Air moves through AHU at 500 f/m (@ 40° F)
- Contaminated cooling coil are stationary, and therefore receive

  **1/2 second moving air exposure**

- A high-intensity dose of UVC is required to achieve the desired level of disinfection. Therefore must generate 4000 µ to achieve 2000 µ intensity in 1/2 sec dwell time.

- A low-intensity dose of UVC energy is all that is required!
Ultra-Violet [In Space]
Ultra-Violet [Considerations]

**Pros:**
- Options for in room and in unit technologies
- Equipment protection from mold and mildew
- Quick kill of pathogens that are exposed to the light
- Long track record for medical use in virus & bacteria control

**Cons:**
- Installation costs
- Equipment, electrical, install, reflective linings, safeties
- Increased utility costs
- Increased bulb replacement costs
- UV Lights will continue to glow and be “on” after effectiveness degrades (Replace 1-2 years per MFG.)
- Safety risks
- 12-24 week lead times
What is Bi-Polar Ionization?

- uses electric voltage to convert oxygen molecules to charged atoms that inactivate airborne contaminants. These negatively and positively charged atoms, called ions, are effective against viruses, bacteria, and mold.

- the charged particles surround the microbe and break it down. In the case of viruses, the ions induce a chemical reaction on the cell membrane surface. They envelop the COVID-19 virus and puncture the protein spikes on its membrane, neutralizing them.

- the ions attach to contaminants and enlarge them enough to be trapped by the HVAC system filters.
WHAT IS AN ION?
An ion is an atom or a molecule that is positively or negatively charged – meaning it must either gain or relinquish electrons in order to become neutral.

WHAT IS IONIZATION?
Ionization is the process of using voltage to electrically charge air molecules, thus creating ions.
IONS OUTDOORS

Ions occur naturally everywhere in the outdoors. Ions are created with energy from rushing water, crashing waves and even sunlight — and they are constantly working to clean our air.
There are lower concentrations of ions indoors.

Indoor ion concentrations are typically under 2,000 ions per cubic centimeter (cc).

The highest outdoor ion concentrations are in the tens of thousands of ions per cc, at higher elevation or near rushing water.

*In-room ion density is dependent on a variety of factors, including ionizing equipment, proximity of the ionizing equipment to the occupied space, airflow rates and path of ductwork within the building.
NEEDLEPOINT BIPOLAR IONIZATION

is a lower-voltage form of ionization that uses carbon fiber needles to release positive and negative ions.

Higher-energy forms of ionization result in the breaking apart of molecules and production of byproducts, including ozone.
Dust, dander, smoke, viruses and bacteria often go unseen in the air.

Various studies have demonstrated the potential benefits of reduced airborne particles, which could include:

- improved air quality
- diminished HVAC strain
- decreased exposure to dust and allergens.

Needlepoint bipolar ionization reduces particulate matter by introducing ions into the airstream, causing particles to cluster together for easier filtration by your HVAC system.
NPBI technology can make a MERV 8 filter perform like a MERV 13 filter.

MERV measures a filter’s ability to capture particles of varying sizes. It stands for Minimum Efficiency Reporting Value and ranges from 1 to 20. The higher a system’s MERV rating, the more effective — and more expensive — a particular filter is.

NPBI is verified by Blue Heaven Labs, a third-party laboratory, to enable MERV 13 efficiency using only MERV 8-level filtration.

Buying replacement MERV 13 filters would cost substantially more than MERV 8 filters … in perpetuity.
Needlepoint bipolar ionization has been shown to reduce certain viruses and bacteria:

- In the air and on surfaces
- At various ion densities
- In large chambers
- On a variety of specimens

Contact manufacturer for performance results.
NPBI technology can enhance your ion density to help deliver cleaner indoor air

*In-room ion density is dependent on a variety of factors, including ionizing equipment, proximity of the ionizing equipment to the occupied space, airflow rates and path of ductwork within the building.
1. Air passes through your existing duct system, over the ionizer.

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2. The ionizer produces positive and negative ions that are carried by the airstream through the ductwork and into the room.

*In-room ion density is dependent on a variety of factors, including ionizing equipment, proximity of the ionizing equipment to the occupied space, airflow rates and path of ductwork within the building.
1. Air passes through your existing duct system, over the ionizer.

2. The ionizer produces positive and negative ions that are carried by the airstream through the ductwork and into the room.

3. These ions seek out and combine with particles, forming larger clusters that are more effectively captured by the HVAC system.

*In-room ion density is dependent on a variety of factors, including ionizing equipment, proximity of the ionizing equipment to the occupied space, airflow rates and path of ductwork within the building.*
FACTORS THAT NEGATIVELY IMPACT IONIZATION IN THE SPACE

The ionizer mounted far away from the space it’s treating

Slow moving or stagnant air flow

Complex airflow path
Ionization [Effectiveness]

- Surface sample testing against SARS-CoV-2
  - 84.2% in 10 minutes
  - 92.6% in 15 minutes
  - 99.4% in 30 minutes

- Testing against other pathogens
  - E.Coli – 15 minutes – 99.68%
  - MRSA – 30 minutes – 96.24%
  - C. Diff – 30 minutes – 86.87%
  - TB – 60 minutes – 69.01%
Is it safe?

- **EPA**
  - Bipolar ionization has the potential to generate ozone and other potentially harmful by-products indoors, unless specific precautions are taken in the product design and maintenance. If you decide to use a device that incorporates bipolar ionization technology, EPA recommends using a device that meets UL 2998 standard certification (Environmental Claim Validation Procedure (ECVP) for Zero Ozone Emissions from Air Cleaners).

- **Harmful Byproducts?**
- **Ozone?**
Ionization [Safety Considerations]

- Verify UL ratings for “Ozone Free” generation
  - (UL 2998) – Required under ASHRAE 62.1-2019 Section 5.7.1 for air purifiers applying to all UV, Ionizers, etc.

<table>
<thead>
<tr>
<th>CHEMICAL</th>
<th>FORMULA</th>
<th>Electron Volt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xylene*</td>
<td>C₈H₁₀</td>
<td>7.89</td>
</tr>
<tr>
<td>Styrene*</td>
<td>C₈H₈</td>
<td>8.46</td>
</tr>
<tr>
<td>Methyl Ethyl Ketone*</td>
<td>C₃H₈O</td>
<td>9.52</td>
</tr>
<tr>
<td>Ammonia*</td>
<td>NH₃</td>
<td>10.07</td>
</tr>
<tr>
<td>Acetaldehyde*</td>
<td>CH₃CHO</td>
<td>10.23</td>
</tr>
<tr>
<td>Ethyl Alcohol*</td>
<td>C₂H₅OH</td>
<td>10.48</td>
</tr>
<tr>
<td>Formaldehyde*</td>
<td>CH₂O</td>
<td>10.88</td>
</tr>
<tr>
<td>Oxygen</td>
<td>O₂</td>
<td>12.07</td>
</tr>
</tbody>
</table>

* Typical contaminants of concern as contained within ASHRAE 62.1
- Electron Volt Energy greater than 12Ev, creates ozone (O₃)
WHAT IS OZONE?

Ozone (O₃) is a natural gas that can be helpful or harmful depending on its location in the atmosphere.

In the upper atmosphere, ozone is protective, reducing the amount of harmful UV radiation reaching the Earth’s surface.

Ozone in the lower atmosphere is linked to respiratory damage that increases with frequency and duration of exposure.

ASHRAE’s Environmental Health Committee advises that “the introduction of ozone to indoor spaces should be reduced to as low as reasonably achievable.”

sources:
EPA.gov Indoor Air Quality (IAQ)
ASHRAE Filtration/Disinfection
### UL OZONE SAFETY STANDARDS

**UL 867**

- Threshold of 50 ppb (parts per billion), proven not to produce harmful levels of ozone.
- Recognized by the California Air Resources Board as a safety standard and referenced by the CDC for consumers who desire this type of technology.

**UL 2998**

- Threshold of 5 ppb (parts per billion), certified to have zero ozone emissions.
- Recommended by ASHRAE, EPA and the Department of Education, and preferred by the CDC for consumers that desire this type of technology.
What to consider?

- Existing HVAC Systems
- Products? Alternatives?
- Budget?
- Maintenance?
- Life Expectancy?
Commonly Discussed/ Deployed

- Upgrade filtration
- UV (Ultraviolet) lighting
- Ionization
- In-room filtration
- System Modifications
- Measurement/ Monitoring
- Verification of Results
Holistic Approach to IAQ

○ Complete what is feasible in a timely manner
  • You can’t complete everything overnight

○ Develop a short and long term IAQ Plan

○ Dilution/Filtration/UV Light/Ionization are one piece of the puzzle
  • Done in cooperation with Administrative and Engineering controls as well as PPE to reduce overall viral load long after a pandemic

Measuring Success

○ IAQ assessments prior to and after the installation of engineering controls
  • LEEDS-CO, CO2, PM10, TVOC’s, Formaldehyde
  • Surface/Air sampling for SARS-CoV-2 (Covid-19)
    • Qualitative (presence/Absence)
Ionization [Options]
Manufacturers may offer velocity calculation tools to assist you in determining the best mounting position for the ionizer, in order to optimize the delivery of ions in a wide variety of applications.

### Velocity Calculator

<table>
<thead>
<tr>
<th>Rectangular</th>
<th>Round</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CFM</strong></td>
<td>2000</td>
</tr>
<tr>
<td><strong>Width</strong> (inches)</td>
<td>20</td>
</tr>
<tr>
<td><strong>Height</strong> (inches)</td>
<td>18</td>
</tr>
<tr>
<td><strong>Area</strong> (square feet)</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Velocity</strong> (feet per minute)</td>
<td>800</td>
</tr>
</tbody>
</table>

### Calculate:

1. Airflow velocity
2. Time to supply diffuser
3. Whether time is sufficient for optimal ion delivery
What matters most is not how many ions are produced at the source, but rather how many ions join the airstream and are present in the space.
Before proceeding on a technology...

- Ensure you objectively evaluate each within the context of your specific application(s).
- In addition to 1st cost, consider ongoing costs via maintenance, repairs, and energy costs.
- Consider performance validation. This applies to upfront evaluation (independent labs) AND potential before/after testing for any installation.
Questions?