



Air Filtration Standards and Infection Control Solutions



PJ McGowan
Ketchum and Walton

1. Introduction – Particle Size and IAQ
2. Review of ASHRAE standards, testing, and HEPA filtration
3. ASHRAE Response to Coronavirus Pandemic
4. Retrofit Options per ASHRAE Guideline
 - * Efficiency upgrades and pressure drop
 - * Energy Costs vs. Upgrading Filtration
 - * UV light Options and sizing for “on-the-fly” elimination
 - * Portable and inline HEPA’s
5. New Technologies

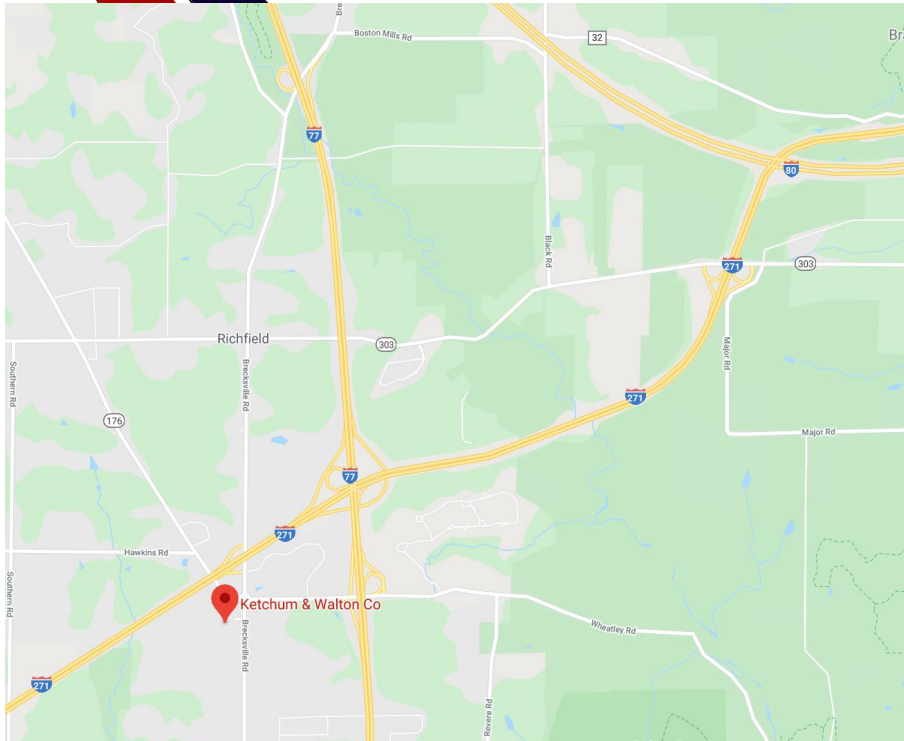
Questions?

Air Filtration Manufacturers List





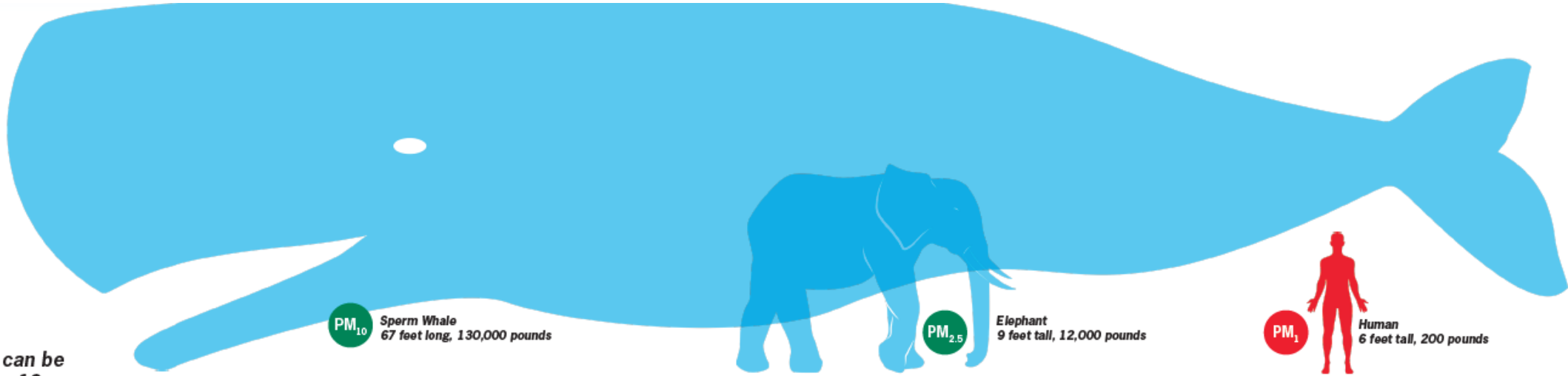
MANUFACTURERS' REPRESENTATIVES



Particle Matter (PM)

HEALTHY OR NOT
A MICROSCOPIC
DIFFERENCE

EXAMPLE OF
PARTICLES SIZES

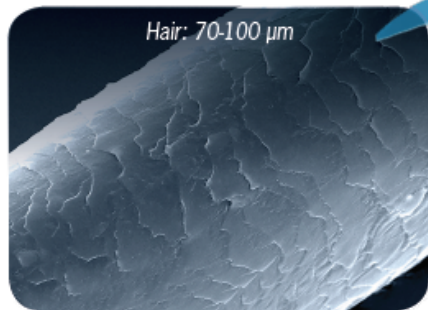


The smallest particles that can be seen with the naked eye are 10 μm and larger in size.
(1 μm is one thousandth of a millimeter.)

If a sperm whale was the size of PM_{10} ...

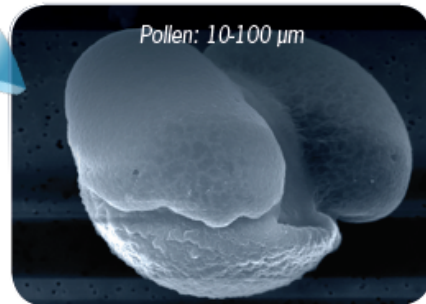
$\text{PM}_{2.5}$ would be as big as an elephant...

then PM_1 would be the equivalent of a human being.



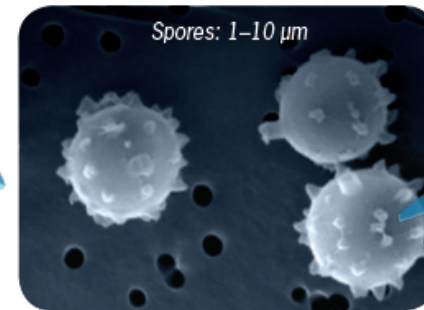
COARSE PARTICLES

Visible coarse dust and sand, leaves, hairs and other large organic particles.



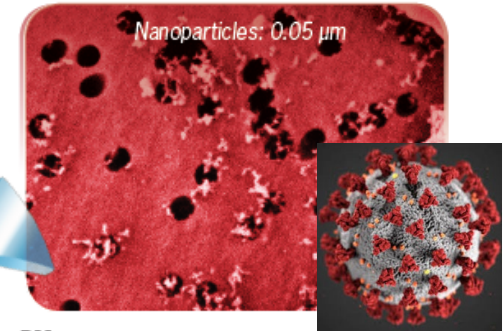
PM_{10}

Smoke, dust, dirt and pollen. Coarser fine dust and larger organic particles.



$\text{PM}_{2.5}$

Larger spores and other organic particles.



PM_1 – HEALTH AND HYGIENE

Very fine dust, combustion particles, nanoparticles, bacteria, viruses and smaller spores.

Why is Indoor Air Quality (IAQ) Important?

PM₁-PARTICLES: INVISIBLE AND VERY DANGEROUS!

COARSE DUST

Particles 10 µm in diameter and larger. The human body is able to "filter" coarse particles in the nose via the nose hairs and mucous membranes. Limited health impact.

PM₁₀

Particles 10 µm in diameter or smaller can reach the respiratory ducts and potentially cause decreased lung function.

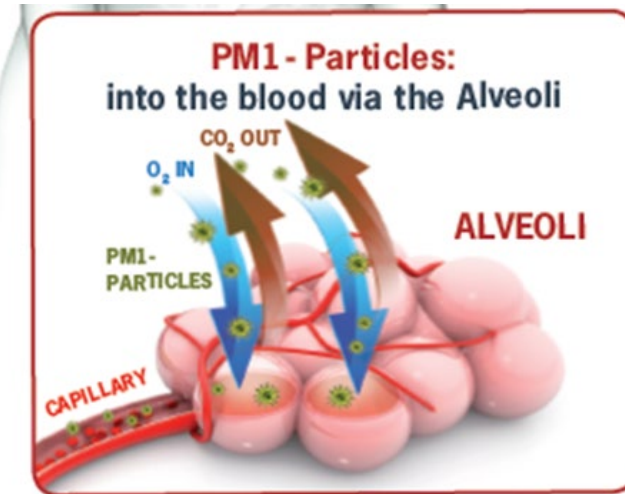
PM_{2.5}

Particles 2.5 µm in diameter or smaller can penetrate the lungs and cause decreased lung function, skin and eye problems, etc.



PM₁

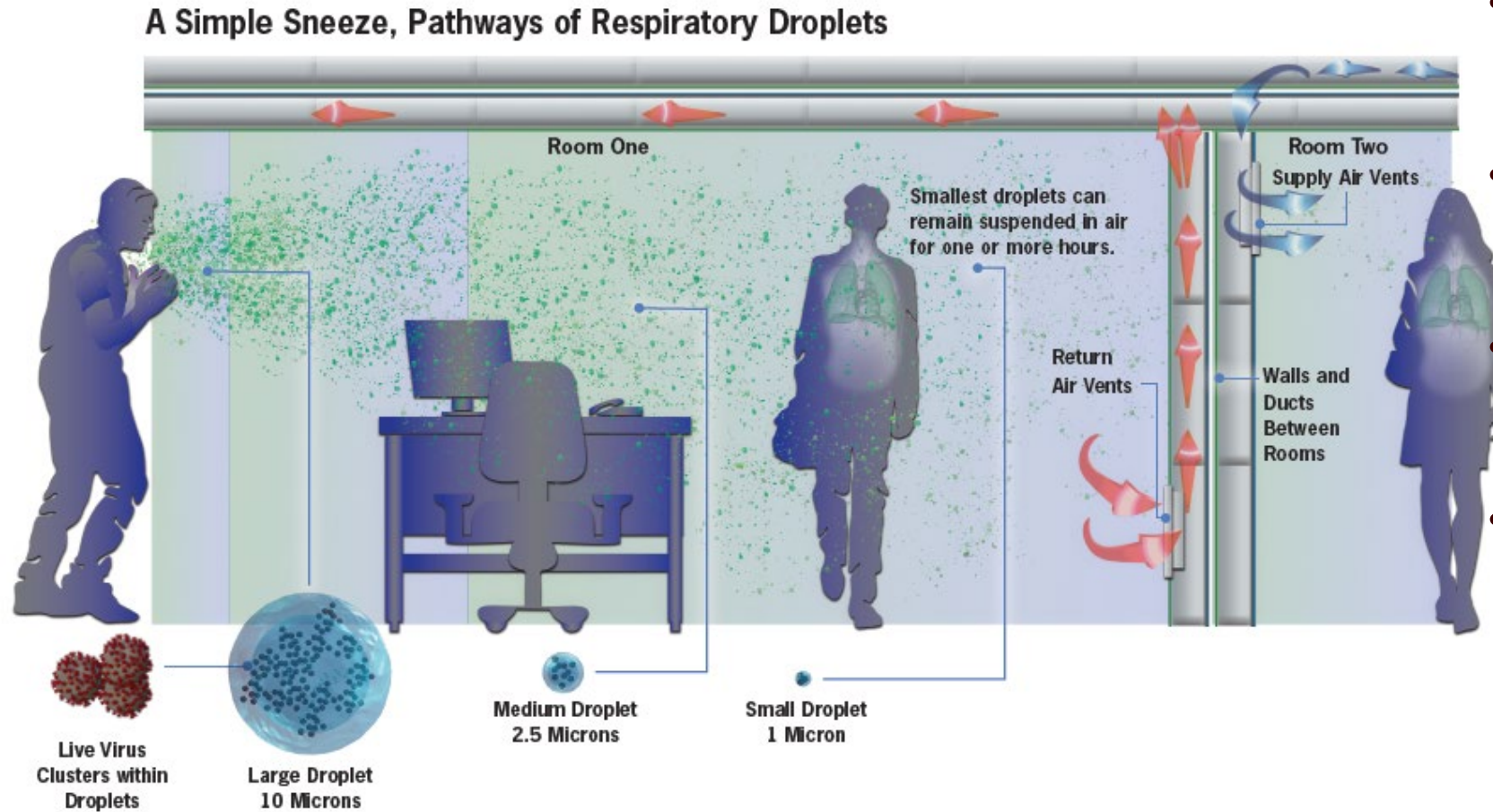
Particles 1 µm in diameter or smaller. A significant number of PM₁ particles are tiny enough to enter the blood stream and can be the cause of tumors, cardiovascular diseases, dementia, etc.

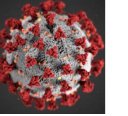


Scientists have linked the exposure of fine particles to:

- Cardiovascular disease
- Reproductive problems
- Impaired immune system
- Premature death
- Cancer
- Diabetes
- Asthma
- Alzheimer's

Airborne Transmission of Viruses



- Viruses are submicron particles that often travel via respiratory droplets that measure 0.50-15 micron.
- Studies show that submicron particles can carry enough virus to cause infection.
- SARS-CoV2 (COVID-19) is approximately 0.12-0.16 micron in diameter 
- The size of the droplet, the quantity of live viruses it contains, the time it remains suspended in the airstream, even the temperature and relative humidity are all critical variables when considering the likelihood of airborne contamination.

NHK WORLD

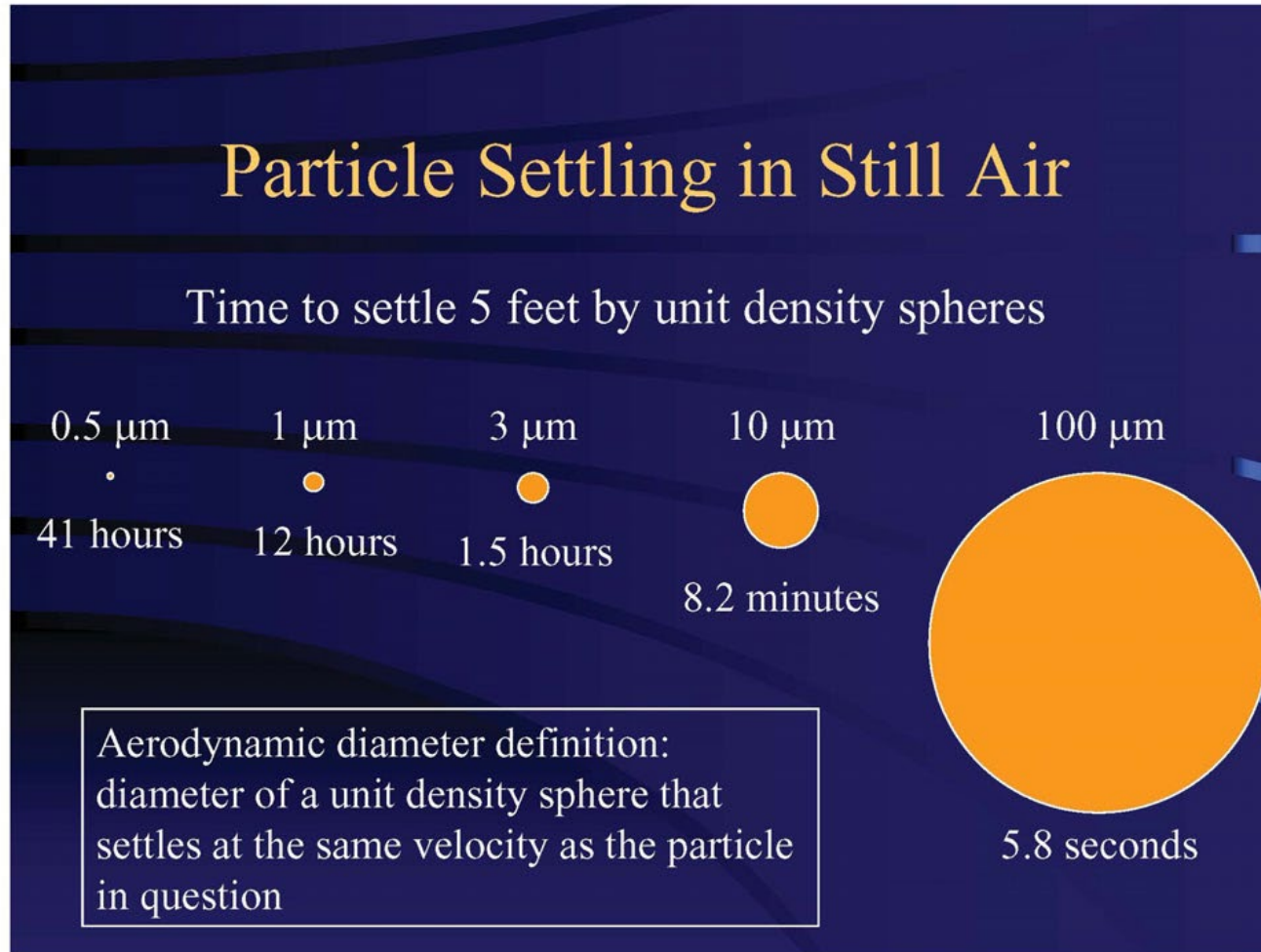
Fighting a Pandemic

20:00

Shows typical micro-droplet movement



Settling Times by Particle Size



- Comparative settling times by diameter for particles settling in still air.
- Droplet nuclei and small aerosols ($<10 \mu\text{m}$) can stay airborne and infectious for extended periods – several minutes, hours, or days.
- Large droplets (100 μm diameter) may shrink by evaporation, becoming an aerosol.
- Droplet nuclei caused by desiccation of droplets into aerosols.
- Ventilation can influence the transmission of droplet nuclei infectious aerosols.

ASHRAE Standards



ANSI/ASHRAE Standard 62.1-2016
(Supersedes ANSI/ASHRAE Standard 62.1-2013)
Includes ANSI/ASHRAE addenda listed in Appendix K

Ventilation for Acceptable Indoor Air Quality

See Appendix K for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org; Fax: 678-539-2129; Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

© 2016 ASHRAE ISSN 1041-2336



ANSI/ASHRAE Standard 52.2-2017
(Supersedes ANSI/ASHRAE Standard 52.2-2012)
Includes ANSI/ASHRAE addenda listed in Appendix H

Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

See Informative Appendix H for approval dates by the ASHRAE Standards Committee, the ASHRAE Technology Committee, and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org; Fax: 678-539-2129; Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

© 2017 ASHRAE ISSN 1041-2336



ANSI/ASHRAE/ASHE Standard 170-2017
(Supersedes ANSI/ASHRAE/ASHE Standard 170-2013)
Includes ANSI/ASHRAE/ASHE addenda listed in Appendix C

Ventilation of Health Care Facilities

See Appendix C for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the ASHE Board of Directors, and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org; Fax: 678-539-2129; Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

© 2017 ASHRAE ISSN 1041-2336



ASHRAE 62.2 Air Filter Highlights

“VENTILATION FOR ACCEPTABLE INDOOR AIR QUALITY”

FILTER REQUIREMENT OF MERV-8 PRIOR TO COOLING COIL

ASHRAE Air Filter Highlights 52.2 -2017

- Defines testing procedure for Air Filters
- MERV (Minimum Efficiency Reporting Value)
- MERV-A Rating (Appendix J)
- 5 Page Test Report REQUIRED

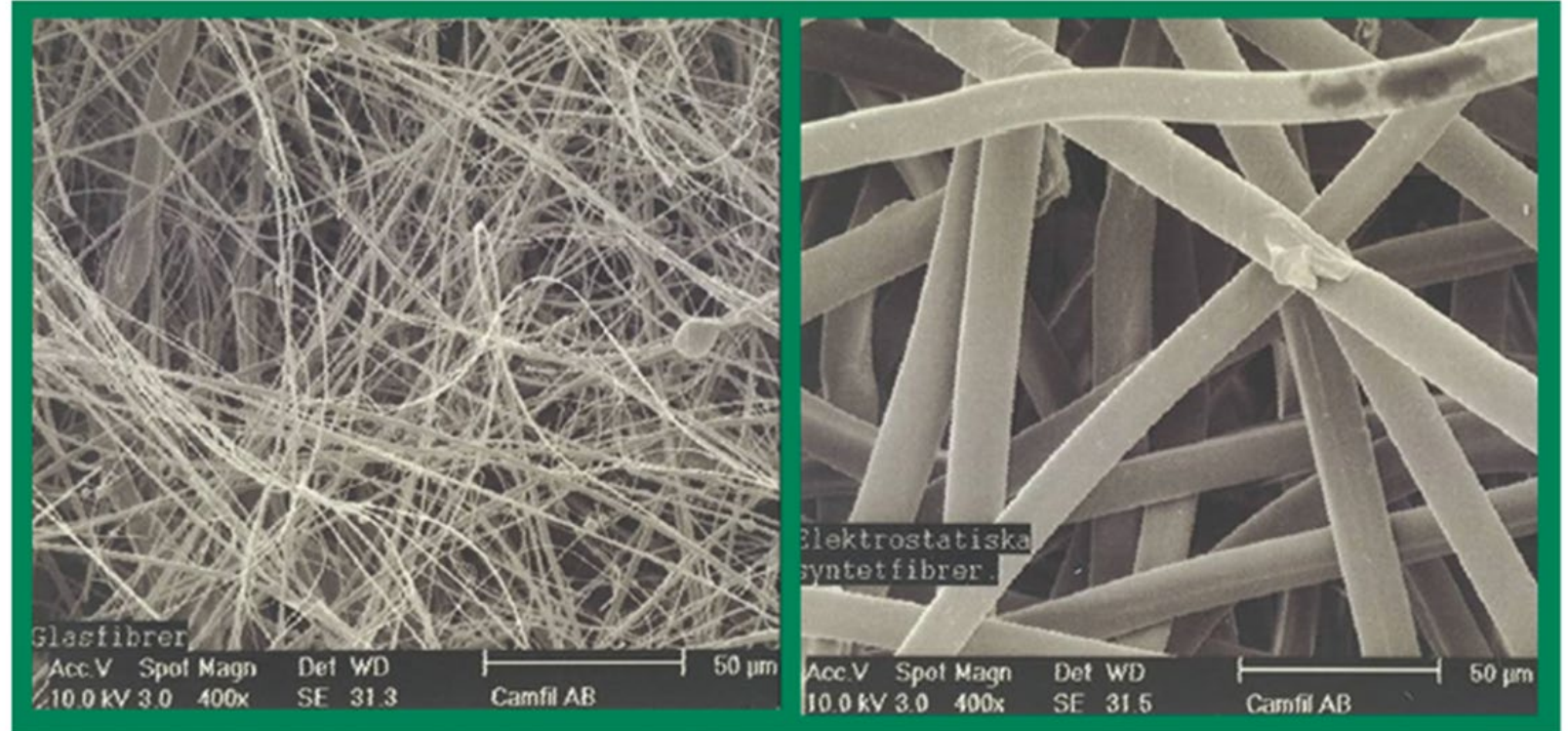
(MERV)	0.30 - 1.0	1.0 - 3.0	3.0 - 10.0
1	n/a	n/a	E3<20
2	n/a	n/a	E3<20
3	n/a	n/a	E3<20
4	n/a	n/a	E3<20
5	n/a	n/a	E3≥20
6	n/a	n/a	E3≥35
7	n/a	n/a	E3≥50
8	n/a	n/a	E3≥70
9	n/a	n/a	E3≥85
10	n/a	E2≥50	E3≥85
11	n/a	E2≥65	E3≥85
12	n/a	E2≥80	E3≥90
13	n/a	E2≥90	E3≥90
14	E1≥75	E2≥90	E3≥90
15	E1≥85	E2≥90	E3≥90
16	E1≥95	E2≥95	E3≥95

MERV-A, 52.2 Appendix J Test

ASHRAE 52.2 J1. :

“Appendix J presents a conditioning procedure to determine the magnitude of the efficiency loss a filter may realize in field applications”

Test procedure uses KCl to discharge static charge from synthetically charged media.



Fine fibers (left), manufactured from micro glass, capture particles through diffusion and interception. Sub-micron particles are held in place by Van De Waals force. Efficiency is consistent throughout the life of the filter. The coarse fibers of electret media (right) require a charge to attract and hold particles. Once the fibers become insulated with contaminant, or lose their charge, the filter efficiency drops. Filter fiber size is always an efficiency consideration.

MERV-A, 52.2 Appendix J Example

MERV 11 & 13 (90% .30-1.0 micron)
Variation of Course Charged Media

The SINTEF Lab tested MERV 11-A & 13-A against electrostatic charged MERV 13 (NOT MERV “A” RATED) media. After 8 weeks of operation the MERV 13 media performance was less than MERV 11-A.

“The MERV-A ratings more accurately predict filter efficiency over time so hospitals and design engineers should require MERV-A ratings when ordering or specifying filters.” – ASHE

https://www.ashe.org/compliance/ec_02_05_01/01/airfiltration

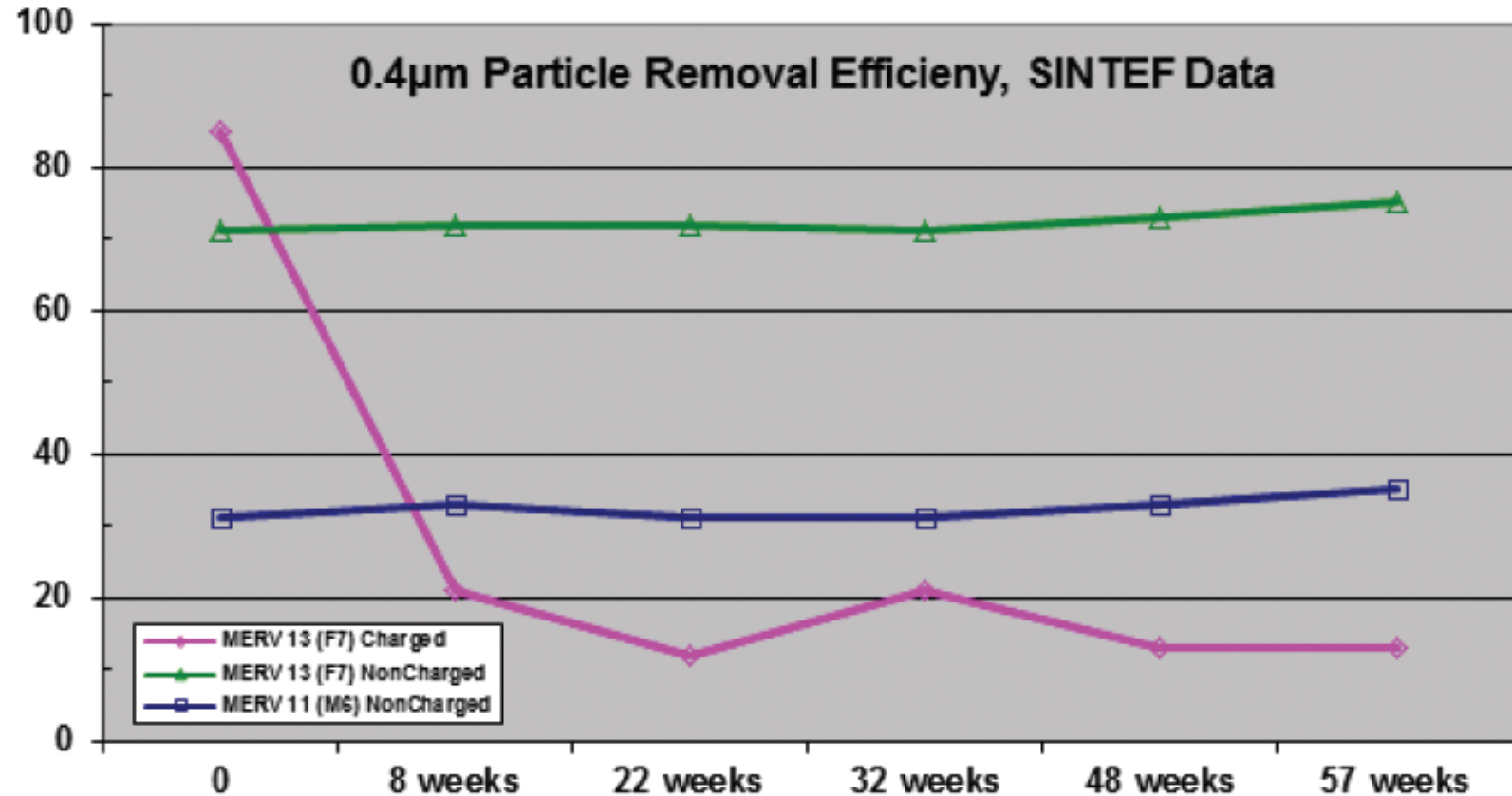
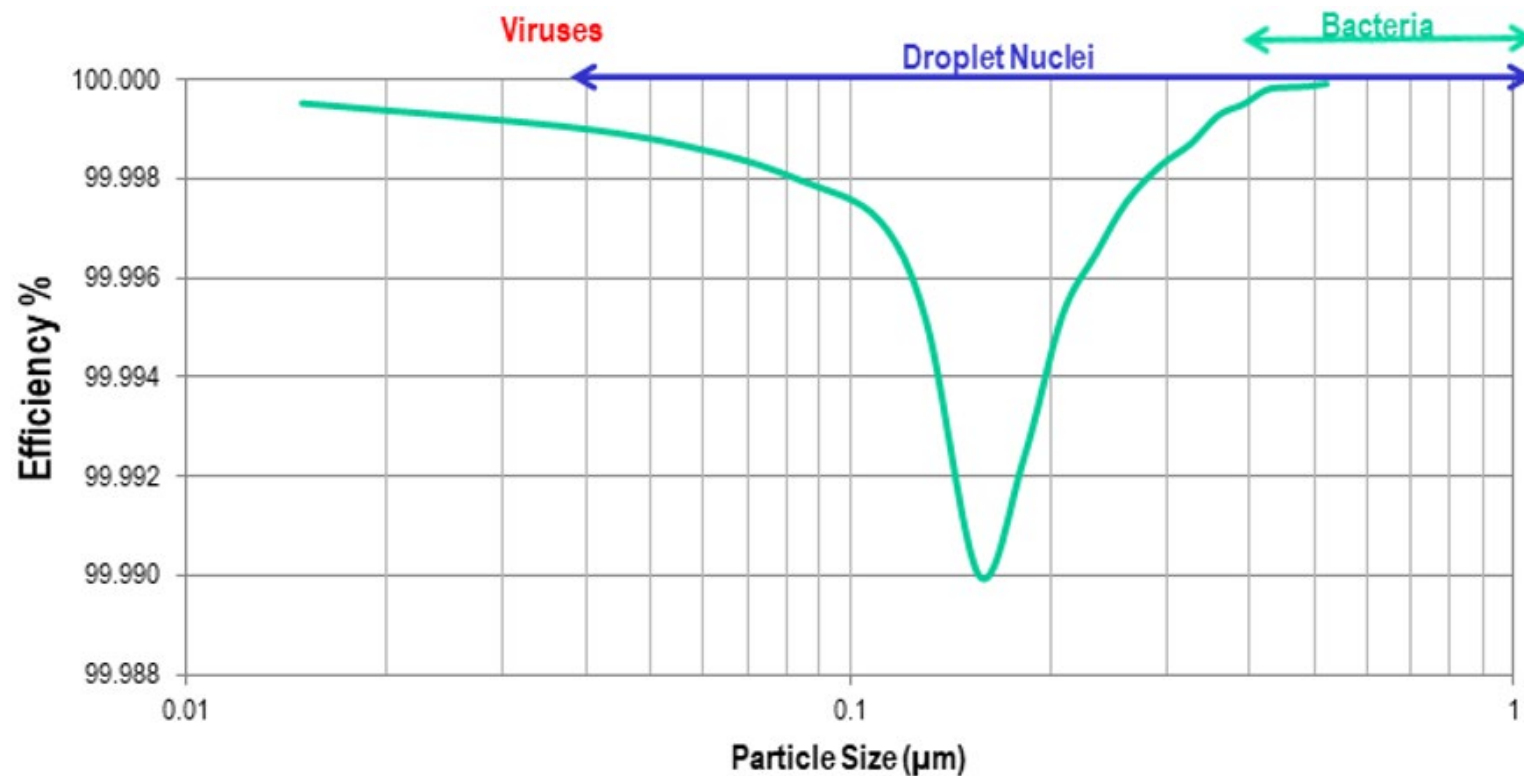


Figure 3. SINTEF air filter performance study

Most Penetrating Particle Size (MPPS)

- MPPS is 'typically' between 0.1 and 0.2 micron. It will vary with velocity but at 'normal' design for a terminal filter this range is accurate 80% of the time
- H14 filter at 90 fpm/0.45m/s it is 0.17/0.18 micron.
- The MPPS is always identified in Camfil's factory scan test and noted on the HEPA filter label.



ASHRAE Response to Coronavirus Pandemic

COVID 19 GUIDANCE



COVID 19 GUIDANCE



The following guidance is developed as healthcare facilities prepare for COVID patients, and is based on input from ASHE, ASHRAE Technical Committee for Healthcare and ASHRAE/ASHE Standard 170 Committee.

This guidance represents personal opinions and ASHRAE and ASHE are not responsible for the use or application of this information.

March 22, 2020



ASHRAE Position Document on Infectious Aerosols

Approved by ASHRAE Board of Directors
April 14, 2020

Expires
April 14, 2023

© 2020 ASHRAE
1791 Tullie Circle, NE • Atlanta, Georgia 30329-2305
404-636-8400 • fax: 404-321-5478 • www.ashrae.org

ASHRAE's COVID-19 Statements

Statement on airborne transmission of SARS-CoV-2: Transmission of SARS-CoV-2 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.

Statement on operation of heating, ventilating, and air-conditioning systems to reduce SARS-CoV-2 transmission: 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. Unconditioned spaces can cause thermal stress to people that may be directly life threatening and that may also lower resistance to infection. In general, disabling the heating, ventilating, and air-conditioning systems is not a recommended measure to reduce the transmission of the virus.

ASHRAE Position Document on Infectious Aerosols



HVAC Strategies for Non-Healthcare

- **Improve central air and other HVAC filtration to MERV 13-A Filters or highest level achievable**
- Add in duct, air handling unit mounted, or upper-room UVGI
- Increase outdoor air ventilation (disable demand-controlled ventilation and open outdoor air dampers to 100% as indoor and outdoor conditions permit)
- Keep HVAC Systems running 24/7
- Add portable room air cleaners with HEPA
- Maintain temperature and humidity as applicable to the infectious aerosol of concern
- Bypass energy recovery ventilation systems that leak potentially contaminated exhaust air back into the outdoor air supply

ASHRAE Epidemic Task Force - Schools



Now is the time to prepare when Schools/Offices are EMPTY!

- Hire local trades to clean, maintain and upgrade building HVAC Systems
- Maintain relative humidity of less than 70%
- Modify controls to maximize outdoor air flow but check the heating and cooling capacity of the unit. Use floor standing fan/filter units if necessary, for comfort.
- Enable Full-Economizer, disable Demand Control Ventilation
- CO2 between 800-1000 PPM
- 15 CFM/Person in occupied areas
- Avoid recirculating previously exhausted contaminants when ventilating.
- **Install MERV 14-A Filters where capable**

Challenge: Should employers protect the workplace equivalent to that of schools?

MERV 13 1", 2" & 4" Filtration



- Synthetic Fiber Media
- MERV 13 (**NO MERV-A Rating**)
- 1" Depth has 9.2 sq. ft. in 24x24x1
- 2" Depth has 17.3 sq. ft. in 24x24x2
- 4" Depth has 27.5 sq. ft. in 24x24x4
- Designed for packaged equipment with 1", 2" and 4" tracks
- Specifiable Product to meet LEED design requirements
- Max Pressure drop of 1.50" Static Pressure

SIZE	MERV 13
1" High Capacity Pleat	0.32" ISP*
2" High Capacity Pleat	0.41" ISP*
4" High Capacity Pleat	0.33" ISP*

*ISP, initial static pressure drop on 350 fpm 1", 500 fpm 2" & 4"

MERV 15 2" & 4" Filtration

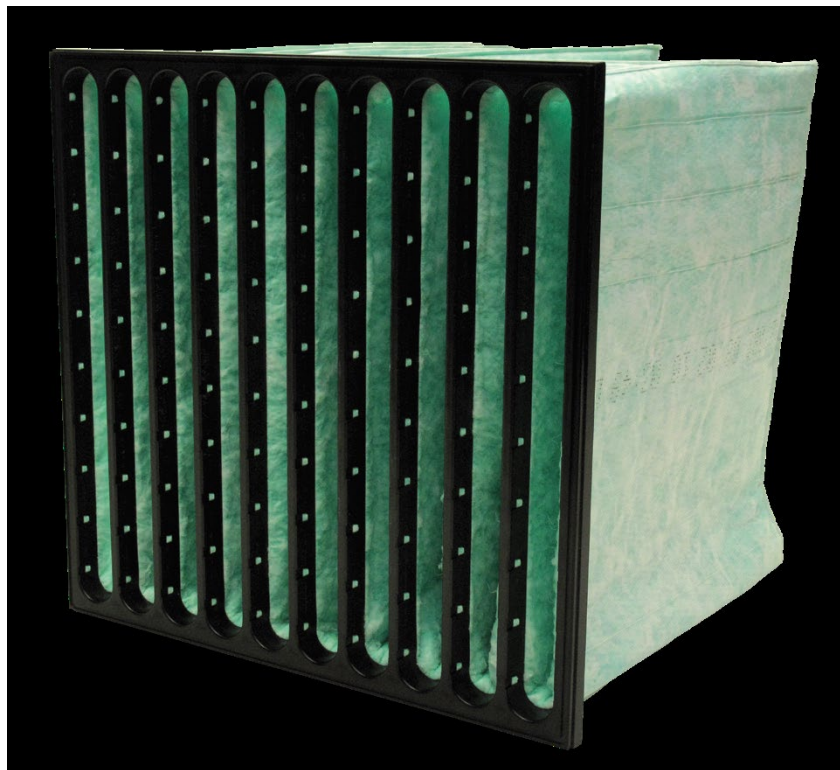


- Synthetic Fiber Media
- MERV 11, 13 and 15 (**NO MERV-A Rating**)
- 2" Depth has 54 sq. ft. in 24x24x2
- 4" Depth has 77 sq. ft. in 24x24x4
- Designed for packaged equipment with 2" and 4" tracks
- Specifiable Product to meet LEED design requirements
- Max Pressure drop of 1.50" Static Pressure

SIZE	MERV 13	MERV 15
2" Minipleat	0.50" ISP	0.30-0.60" ISP*
4" Minipleat	0.40" ISP	0.30-0.50" ISP*

*ISP, initial static pressure drop on 500 fpm airflow, depends on manufacturer

MERV- 13, 14 & 15 Filter Solutions



- Pocket style filter
- **DOES NOT REQUIRE A PRE-FILTER**
- MERV 10A, 11A, 13-A, 14-A and 15-A
- 12", 15", 22" and 30" Depths available, deeper the better
- Available perimeter gasketing

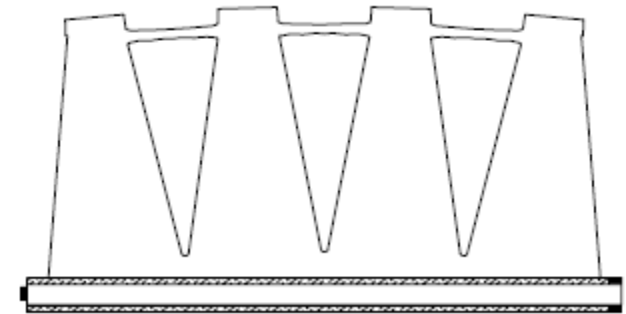
12", 15", 22", 30" Deep	ISP @ 500 FPM
MERV 13-A	0.52", 0.48", 0.38", 0.34"
MERV 14-A	0.67", 0.55", 0.47", 0.41"
MERV 15-A	0.81" (15"), 0.62" (22"), 0.53" (30")

MERV-16 Filter Solutions



- 4 V-bed Cartridge Filter, should use with a pre-filter
- MERV 11A, 13-A, 14-A and 16-A
- 12" Deep
- Radial Inlet and Outlet adds 30% more surface area
- Available perimeter gasketing
- 450 gram Dust Holding Capacity MERV 14-A

12" Deep	ISP @ 500 FPM
MERV 11-A	0.21"
MERV 13-A	0.25"
MERV 14-A	0.27"
MERV 16-A	0.60"

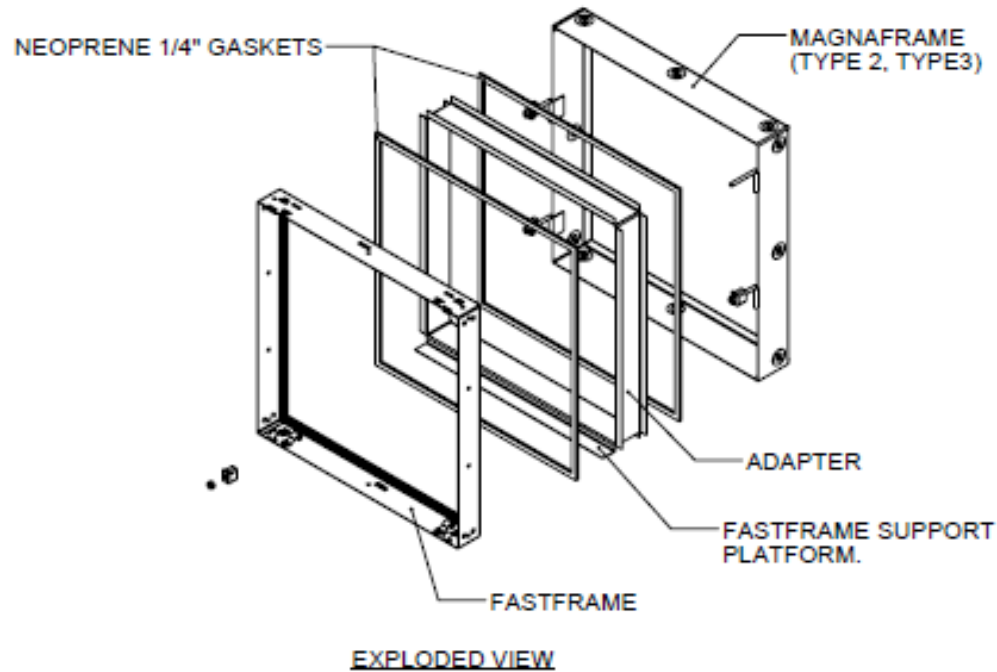


HEPA/ULPA Box Filter Solutions

- V-Bank HEPA Filter
- 2000 CFM of Airflow @ 0.8 ISP
- 2400 CFM of Airflow @ 1" ISP
- High Capacity HEPA Filter
- 2000 CFM of Airflow @ 1.3" ISP
- Gasket or Gel Seal
- Individually Factory Tested per IEST
- Requires retro-fit in Air Handlers to achieve true HEPA filtration – HEPA Latching System, no bypass



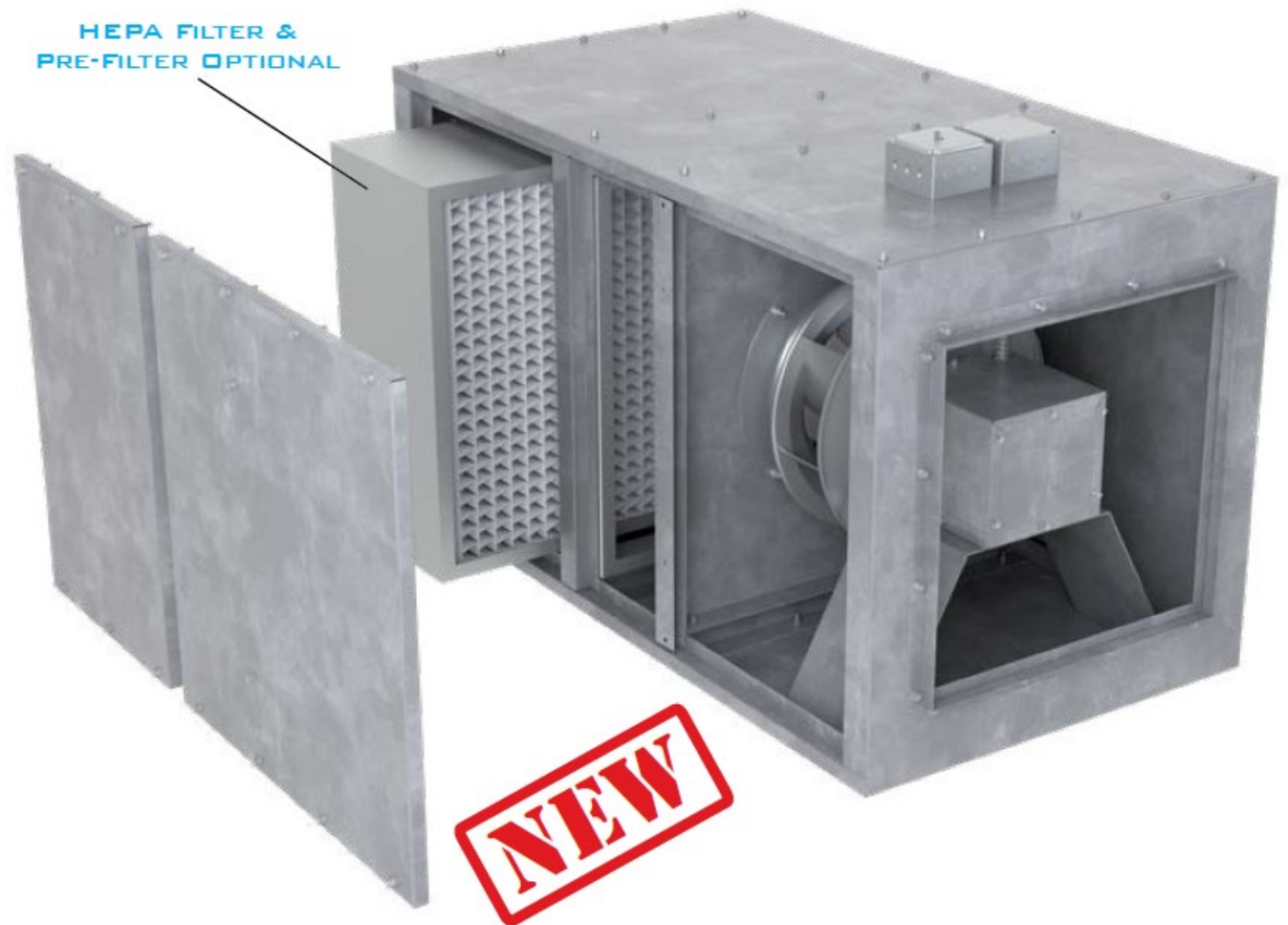
HEPA Filter Frame Solutions



- Camfil Combination HEPA and ASHRAE Filter Frame
- Provides flexibility to upgrade to HEPA filters
- HEPA frames are larger in size and more rigid
- Specifiable for new custom Air Handling Units

Packaged Housing Solutions

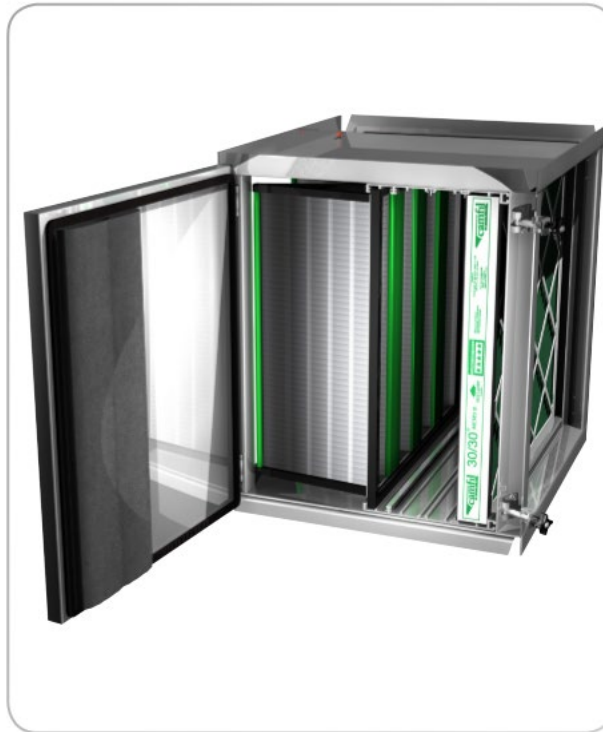
- Twin City Fan, DSI 140-X Inline HEPA
- Packaged Solution to add HEPA or high level MERV-A filtration
- Accounts for added pressure drop 500-2000 CFM
- 0.75 HP, 120V EC Motor with Speed Controller



Side-Access Housing Solutions



GlidePack UniTrack 25 shown.



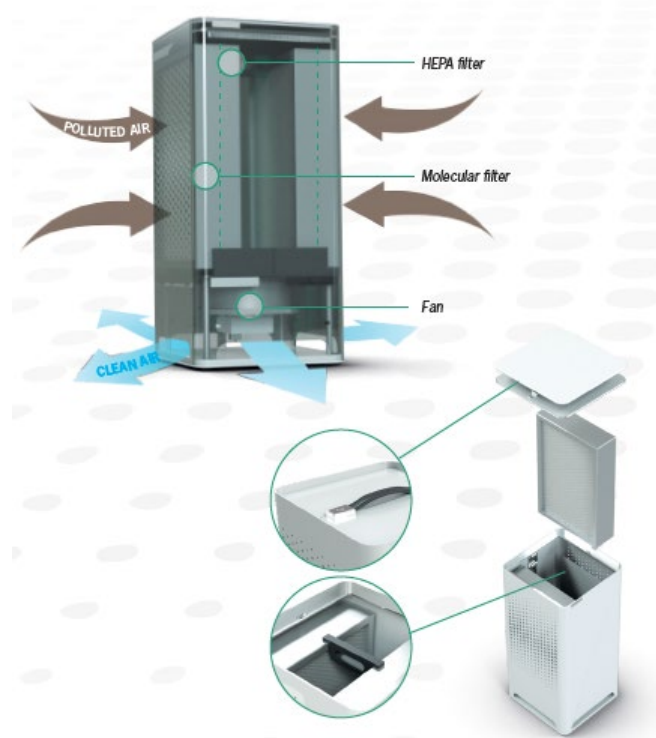
Positive sealing integrity in a side-access filter housing for absolute filters



Top: Swing bolts and equal-bearing clamps ensure an airtight filter to housing seal.

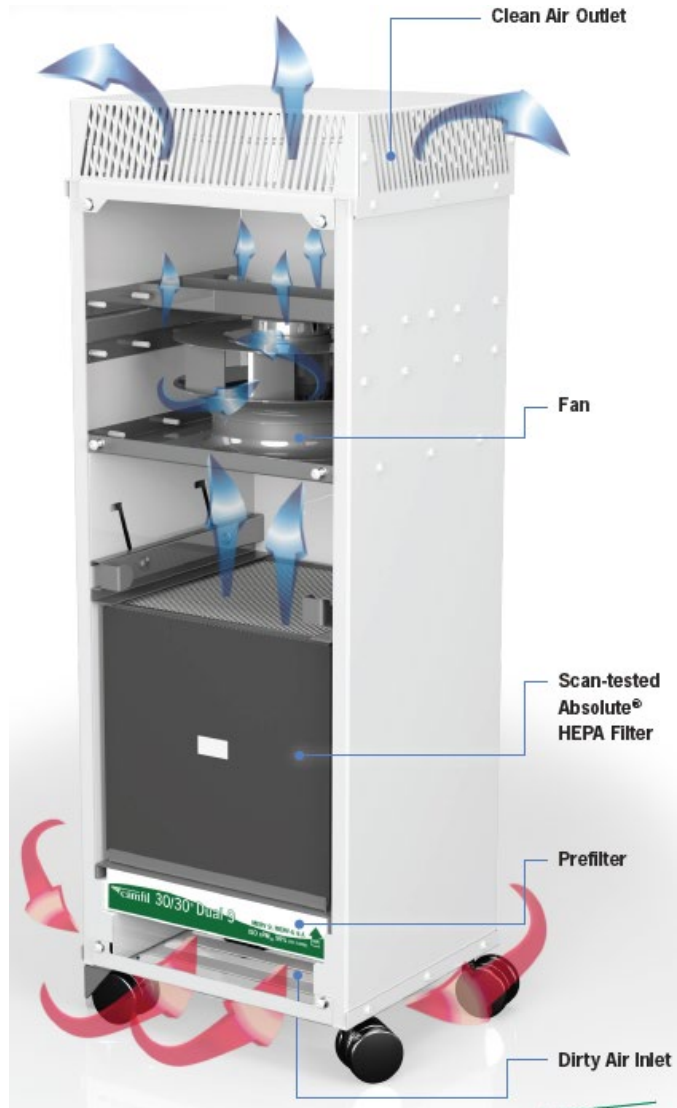
Bottom: Doors include swing-hinge, or may be completely removed from the housing.

In-Room Filtration Solutions

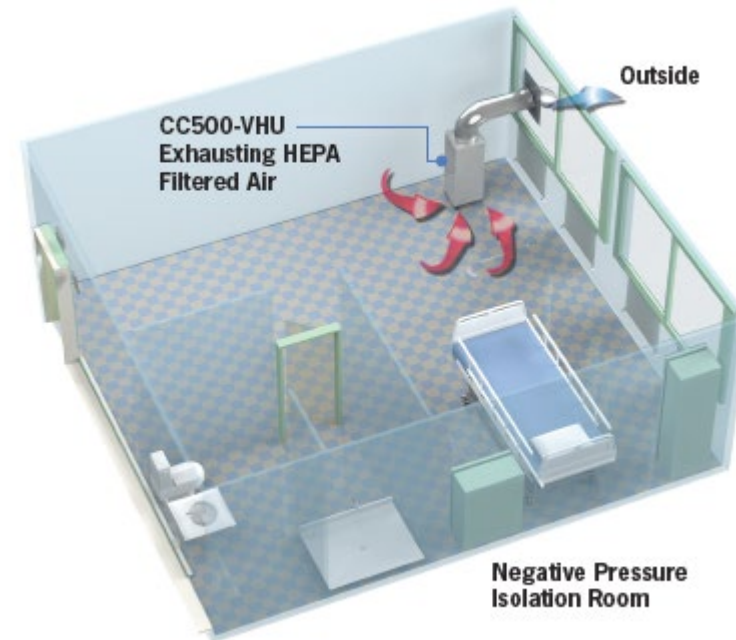


- HEPA Recirculation Unit Provides HEPA filtration for up to 500 sq. ft.
- Filters also have imbedded molecular media to help reduce odors and gaseous containments
- Adjustable speed control

In-Room Filtration Solutions



- VHU Provides HEPA filtration for up to 500 sqft.
- The backward curved fan delivers up to 12 air changes per hour (ACH) in 2500 ft³ as an in-room HEPA air purifier
- 120v plug-in connection.





"Suppose that we hit the body with a tremendous, whether it's ultraviolet or just very powerful light," Trump said at the White

Ultraviolet Energy (UV-C)



- 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.
- The majority of modern UVGI lamps create UV-C energy with an electrical discharge through a low-pressure gas (including mercury vapor) enclosed in a quartz tube, similar to fluorescent lamps.
- Roughly 95% of the energy produced by these lamps is radiated at a near-optimal wavelength of 253.7 nm.
- UV-C light-emitting diodes (LEDs) are emerging for use.
- Types of disinfection systems using UV-C energy:
 - In-duct air disinfection
 - Upper-air disinfection
 - In-duct surface disinfection
 - Portable room decontamination





ASHRAE Position Document on Infectious Aerosols

Approved by ASHRAE Board of Directors
April 14, 2020

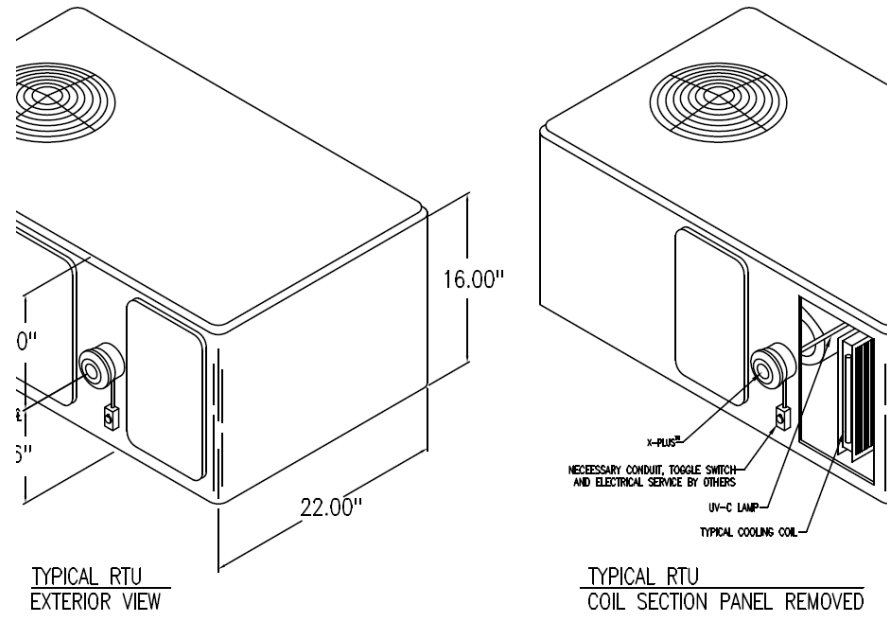
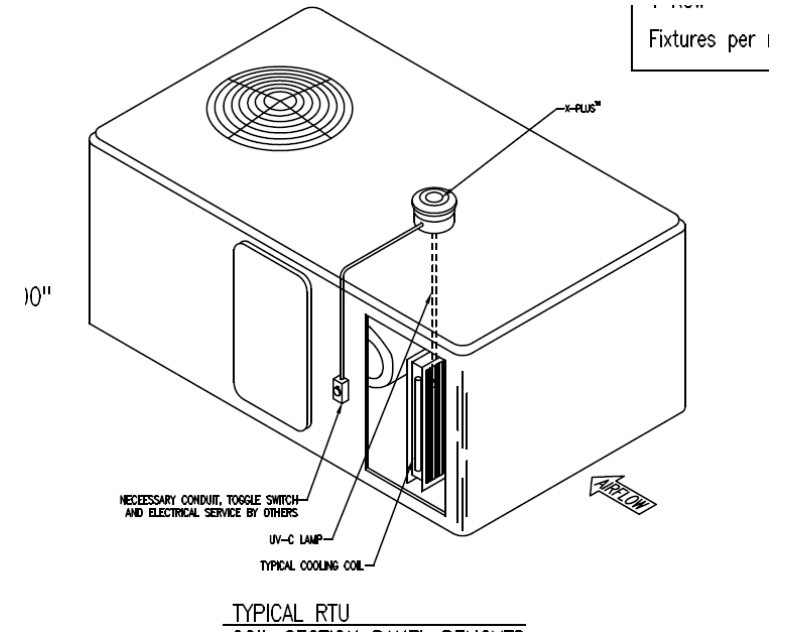
Expires
April 14, 2023

3.2 Ventilation and Air-Cleaning Strategies

The design and operation of HVAC systems can affect infectious aerosol transport, but they are only one part of an infection control bundle. The following HVAC strategies have the potential to reduce the risks of infectious aerosol dissemination: air distribution patterns, differential room pressurization, personalized ventilation, source capture ventilation, filtration (central or local), and controlling temperature and relative humidity. While UVGI is well researched and validated, many new technologies are not (ASHRAE 2018). (Evidence Level B)

Ventilation with effective airflow patterns (Pantelic and Tham 2013) is a primary infectious

The entire ultraviolet (UV) spectrum can kill or inactivate microorganisms, but UV-C energy (in the wavelengths from 200 to 280 nm) provides the most germicidal effect, with 265 nm being the optimum wavelength. The majority of modern UVGI lamps create UV-C energy at a near-optimum 254 nm wavelength. UVGI inactivates microorganisms by damaging the structure of nucleic acids and proteins with the effectiveness dependent upon the UV dose and the susceptibility of the microorganism. The safety of UV-C is well known. It does not penetrate deeply into human tissue, but it can penetrate the very outer surfaces of the eyes and skin, with the eyes being most susceptible to damage. Therefore, shielding is needed to prevent direct exposure to the eyes. While *ASHRAE Position Document on Filtration and Air Cleaning* (2018) does not make a recommendation for or against the use of UV energy in air systems for minimizing the risks from infectious aerosols, Centers for Disease Control and Prevention (CDC) has approved UVGI as an adjunct to filtration for reduction of tuberculosis risk and has published a guideline on its application (CDC 2005, 2009).⁷ (Evidence Level A)

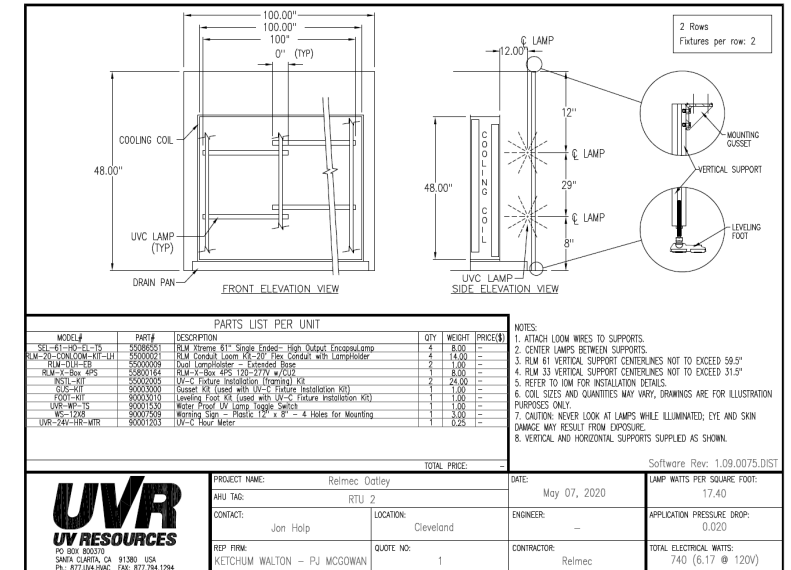
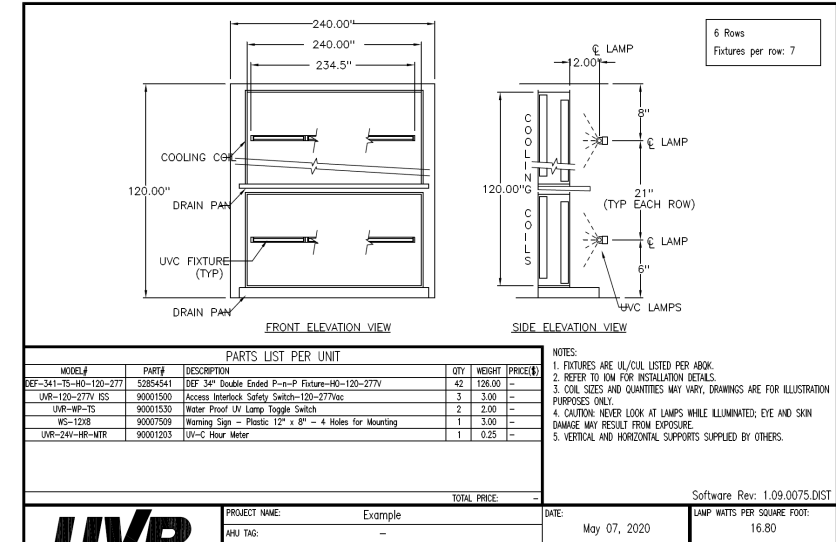
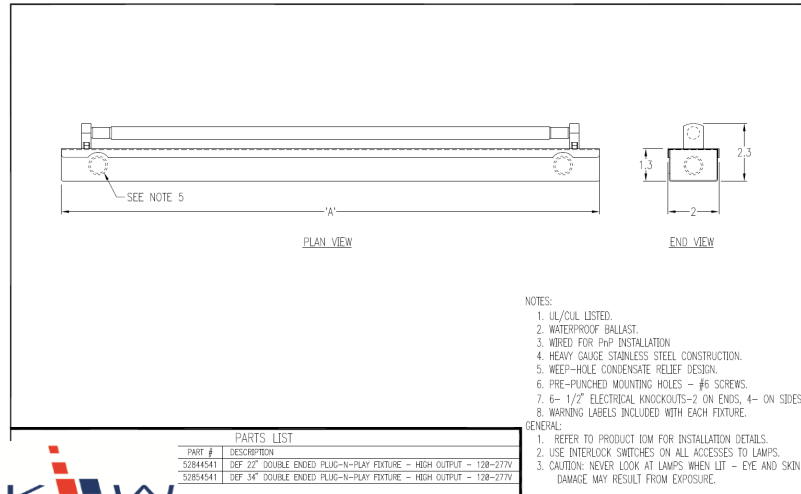
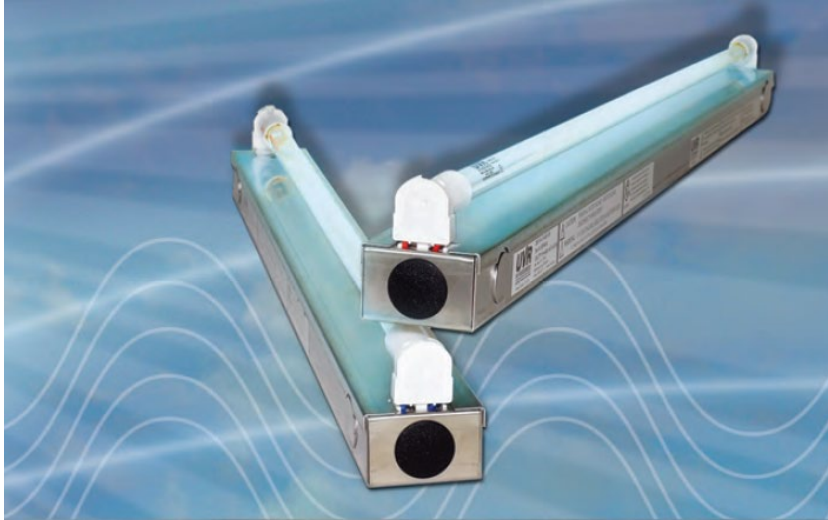


UV-C Solutions

Small to Medium RTU's

UV-C Solutions

Large RTU's – Built-up AHU's



UV-C In-Duct Air Disinfection

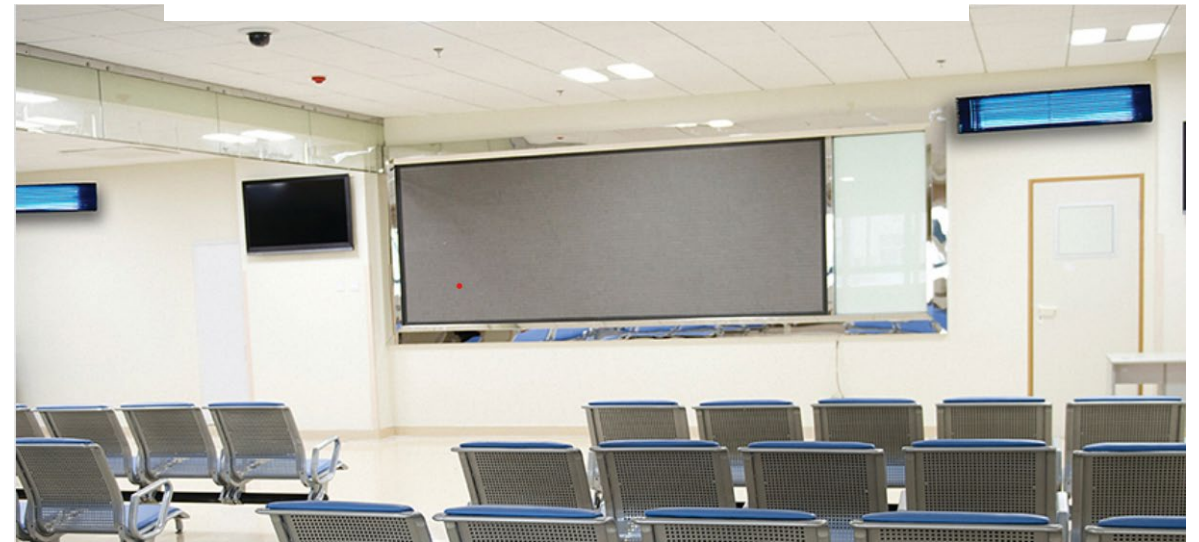
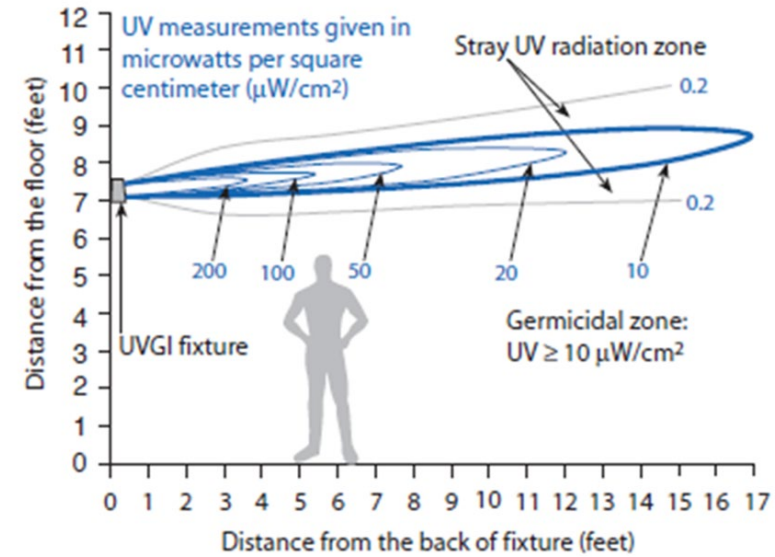
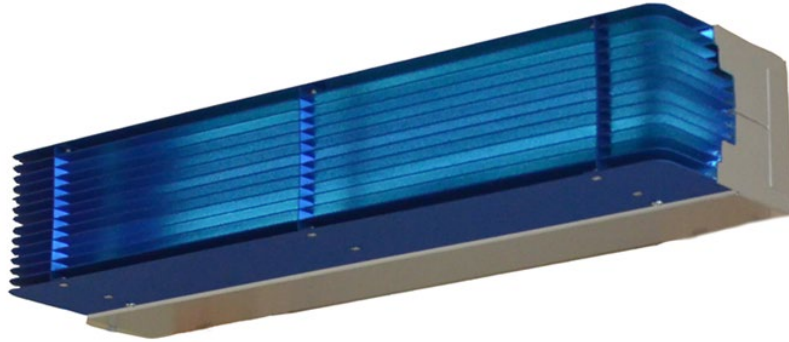


- Banks of UV-Lamps installed inside HVAC systems or associated ductwork
- Requires high UV doses to inactivate microorganisms on-the-fly as they pass through the irradiated zone due to limited exposure time
 - Systems typically designed for 500 fpm moving airstream
 - Minimum irradiance zone of two feet
 - Minimum UV exposure time of 0.25 second
- Should always be coupled with mechanical filtration
 - MERV 8 filter for dust control
 - Highest practical MERV filter recommended
 - Enhanced overall air cleaning with increased filter efficiency



UV-C Solutions

In-Room UV Solutions



New Technology – Electronic Air Cleaners

Rev 0002282014

Phenomenal Aire Cold Plasma Generator Technology Questions & Answers

Features & Benefits of the Phenomenal Aire CPG Technology

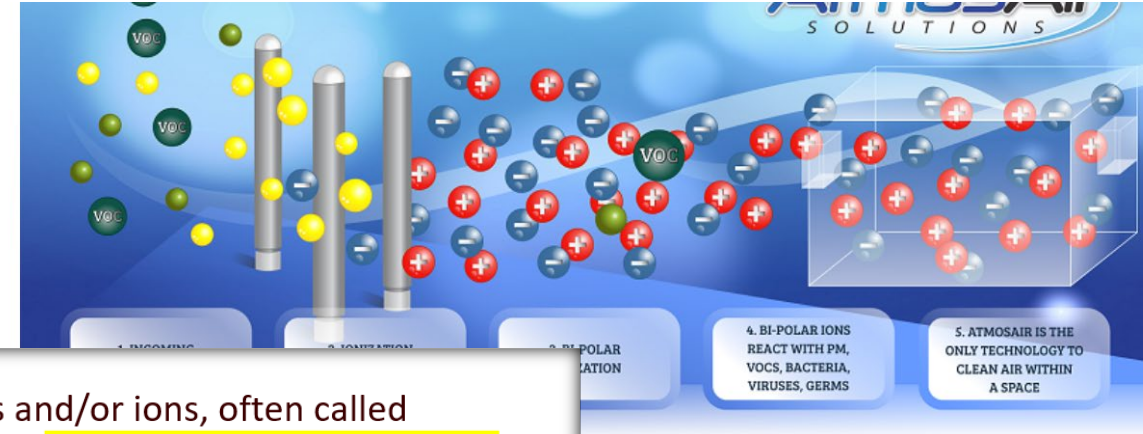
- Creates natural ions in the HVAC system and in the living space
- Kills Mold, Viruses, Bacteria & Fungus
- Eliminates VOC's (Volatile Organic Compounds), Allergens, Static Electricity, Smoke & Odors
- No annual UV Bulb replacement (No replacement parts at all)
- No Harm to the HVAC System
- Produces no detectable O-Zone
- Outperforms the Competition



1. What is an ion and how are ions "created" made?
 - a. External forces can easily displace a neutral atom. (Remember they are very

"Filtration technologies that generate electrical fields and/or ions, often called *electronic filters*, have been documented to range from relatively ineffective to very effective in reducing particles substantially, including reductions from levels being above to levels being below the associated regulatory exposure limits for reducing health risks set by recognized cognizant authorities."

- ASHRAE Position Document on Filtration and Air Cleaning



Environmental Topics

Laws & Regulations

About EPA

Search EPA.gov

Indoor Air Quality (IAQ)

Indoor Air Quality Home

IAQ by Building Type

and Collaborate

Ozone Generators that are Sold as Air Cleaners

CONTACT US

SHARE



CHEMICAL	FORMULA	Electron Volt
Xylene*	C_8H_{10}	7.89
Styrene*	C_8H_8	8.46
Methyl Ethyl Ketone*	$C_5H_{10}O$	9.52
Ammonia*	NH_3	10.07
Acetaldehyde*	CH_3CHO	10.23
Ethyl Alcohol*	C_2H_5OH	10.48
Formaldehyde*	CH_2O	10.88
Oxygen	O_2	12.07

* Typical contaminants of concern as contained within ASHRAE 62.1
• Electron Volt Energy greater than 12EeV, creates ozone (O_3)

CORONA DISCHARGE TUBE

nano Induct™

Best odor control purifier.

Control odors while reducing viruses, bacteria, and mold with this powerful whole house air purifier.

Shop Now



Bi-Polar® 2400

Best allergy relief purifier.

Attack allergens, mold, and mycotoxins while reducing viruses, bacteria, and mold with this versatile whole house air purifier.

Shop Now





MANUFACTURERS' REPRESENTATIVES

3046 Brecksville Rd.
Richfield, OH 44286
330-865-4855

PJ McGowan
(cell) 216-338-3096

Zac Burgess
(cell) 330-554-9800