Why Treat Indoor Air ?

XpenseSolutions
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- How can you improve your customer's experience?
  - Provide a customer friendly environment
    - Increase Customer Satisfaction
    - Longer Shopping Time – Higher Sales $$$
    - Comfort In Patient Rooms / Treatment Rooms
    - Comfort In Waiting Rooms

- How can you improve employee morale
  - Provide a safe working environment
    - Employee Satisfaction
    - Increased Productivity – Profitability

Process for Air Quality

- Step 1. Building Assessment
  - Develop understanding and inventory of your building HVAC System
  - Understand how your building is used
  - Measure existing air quality
  - Produce building assessment report

- Step 2. Specify Solution
  - Develop equipment specification based on existing HVAC system
  - Provide implementation plan
  - Review equipment specification and pricing
  - Sign purchase order

Process for Air Quality

- Step 3. Deploy
  - Install equipment based on agreed specification
  - Commission installation

- Step 4. Performance Review
  - Measure pre and post installation air quality

Step 5. Monitor Performance
  - Option 1. Install real time measurement and verification equipment
  - Option 2. Monthly service to measure and verify equipment performance
  - Provide Annual Report

The Result

Particulate Reduction Efficacy

NPBI AND PARTICLE PERFORMANCE

- Mechanical filtration is well suited to remove larger particles (1 micron and higher)
- All indoor air systems that rely on ventilation and filtration for clean indoor air have a *weakness*
- We care about the things that are present in the *weak point*
- NPBI addresses the *weakness*

UNDERSTANDING PARTICLE SIZES

Particles in the air are far smaller than a human hair or fine grain of sand.

ASHRAE defines particle sizes as **Coarse, Fine** and **Ultrafine.**

By number, over 99.9% of the particles in a typical atmosphere are below 1 µm (i.e., fewer than 1 particle in every 1000 is larger than 1 µm).

Source: ASHRAE Fundamentals Handbook

https://www.visualcapitalist.com/wp-content/uploads/2020/10/RelativeSizeofParticles-Infographic-1920px_v8.jpg

PARTICLE SETTLING RATES

Table 1 Approximate Particle Sizes and Time to Settle 1 m

Type of Particle	**Diameter, µm**	**Settling Time**
Human hair	100 to 150	3 to 1 s
Skin flakes	20 to 40	80 to 20 s
Observable dust in air	>10	<5.5 min
Common pollens	15 to 25	2 to 1 min
Mite allergens	10 to 20	6 to 1 min
Common spores	2 to 10	128 to 6 min
Bacteria	1 to 5	475 to 21 min
Cat dander	1 to 5	475 to 21 min
Tobacco smoke	0.1 to 1	13 days to 8 h
Metal and organic fumes	<0.1 to 1	>13 days to 8 h
Cell debris	0.01 to 1	171 days to 8 h
Viruses	<0.1	>13 days

Note: Spores, bacteria, and virus sizes are for the typical complete unit. As entrained in the air, they may be smaller (fragments) or larger (attached to debris, enclosed in sputum, etc.)
Based on information obtained from J.D. Spengler, Harvard School of Public Health, 1982.

2021 ASHRAE FUNDAMENTALS HANDBOOK: CHAPTER 11 Air Contaminants, Section 2 Particulate Contaminants

OUTDOOR AIR COMPOSITION BY PARTICLE SIZE

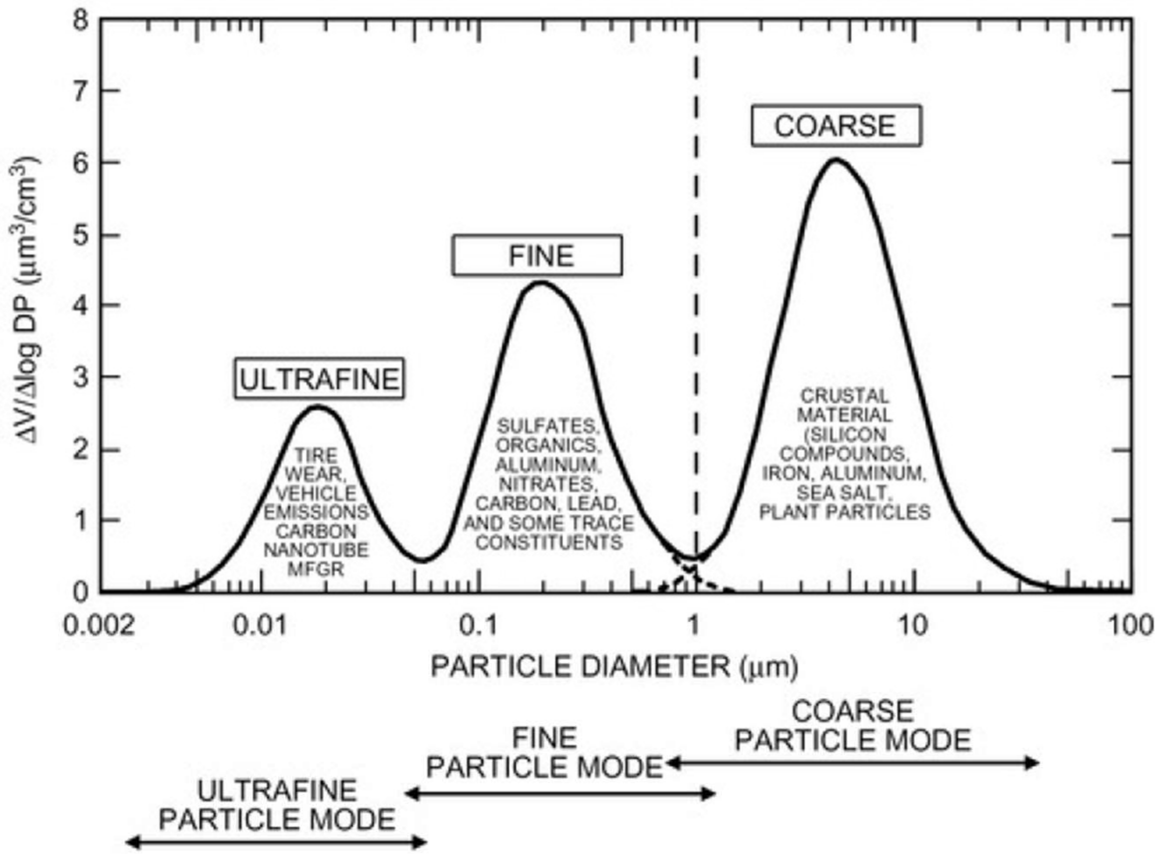


Figure 1. Typical Outdoor Aerosol Composition by Particle Size Fraction (adapted from Wilson and Suh 1997)

PARTICLE SIZE DISTRIBUTION IN THE ATMOSPHERE

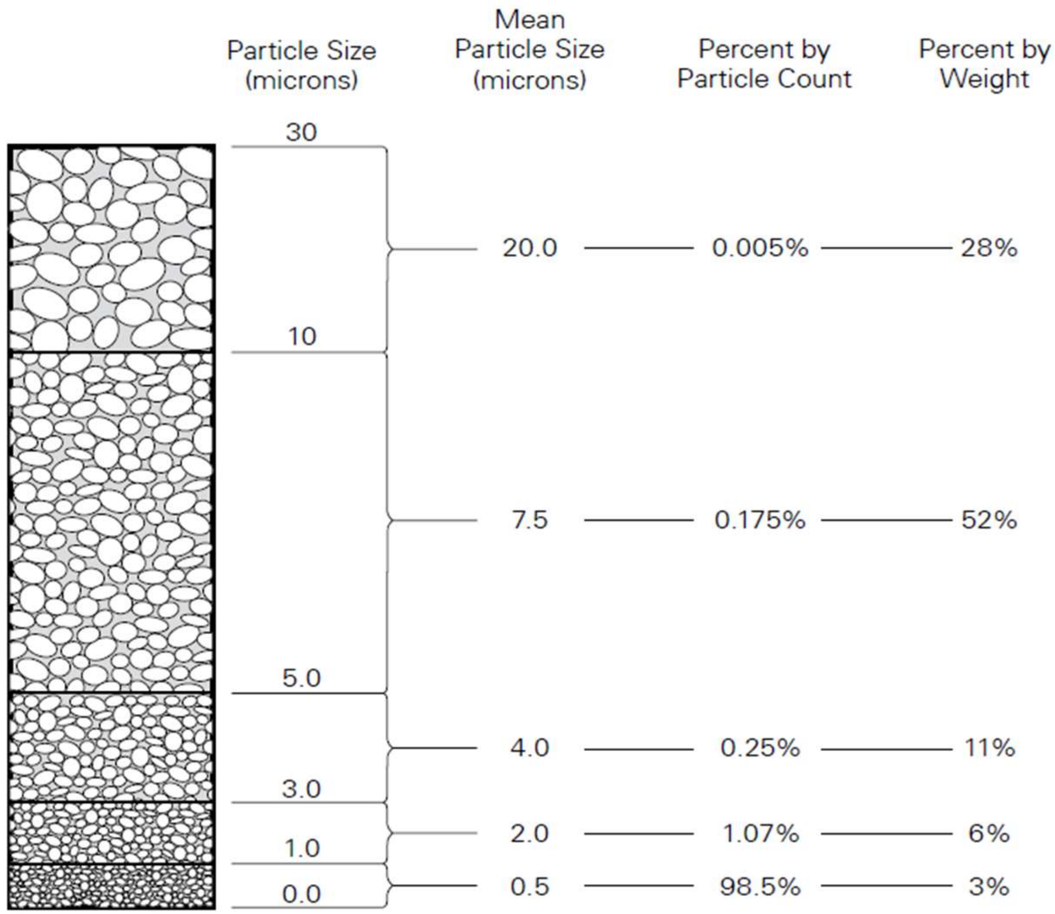
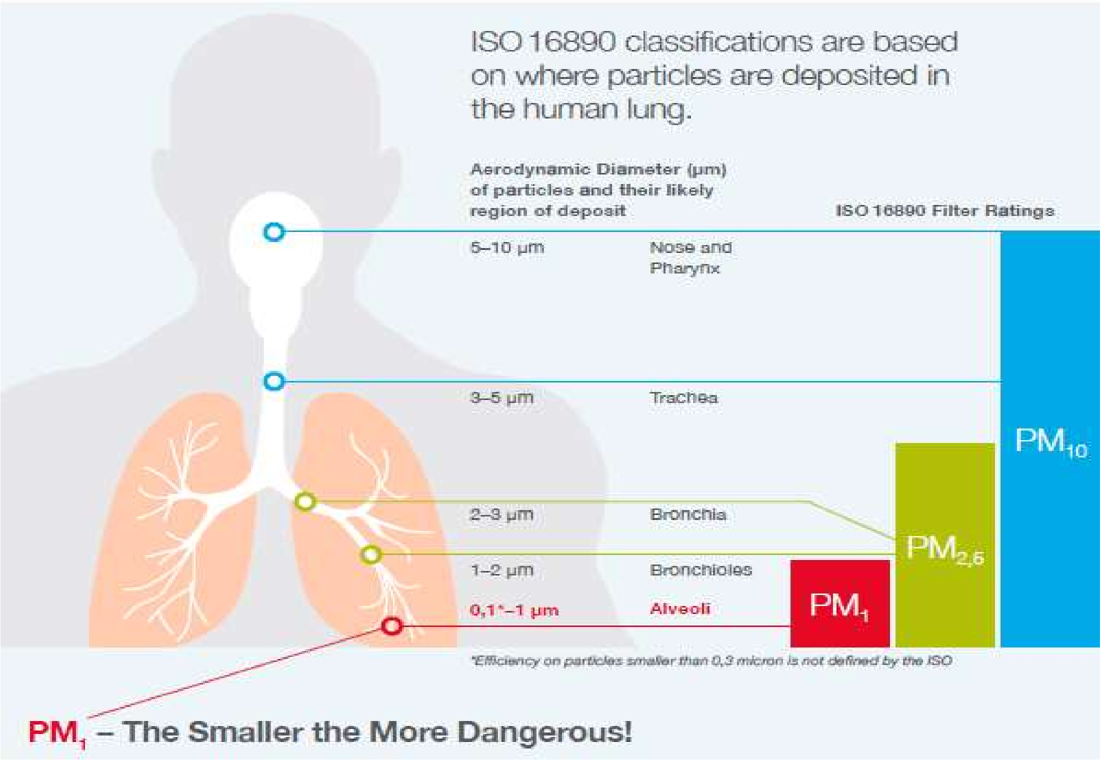


Figure 7.5-B Particle Size Distribution in the Atmosphere
Adapted from NAFA (2006), Figure 1.4.

AIRBORN PARTICLE DEPOSITION



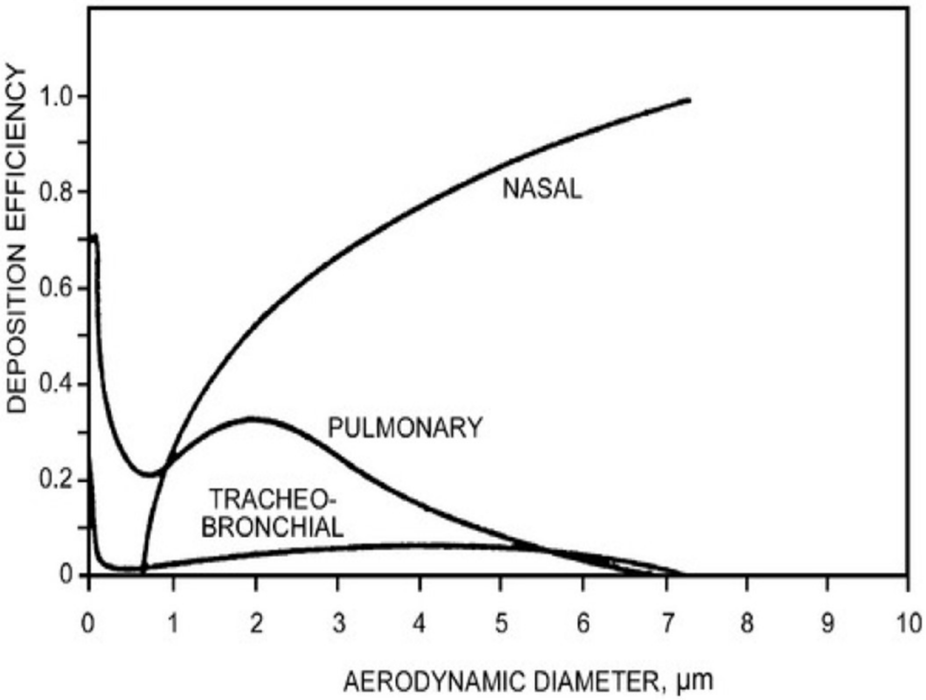
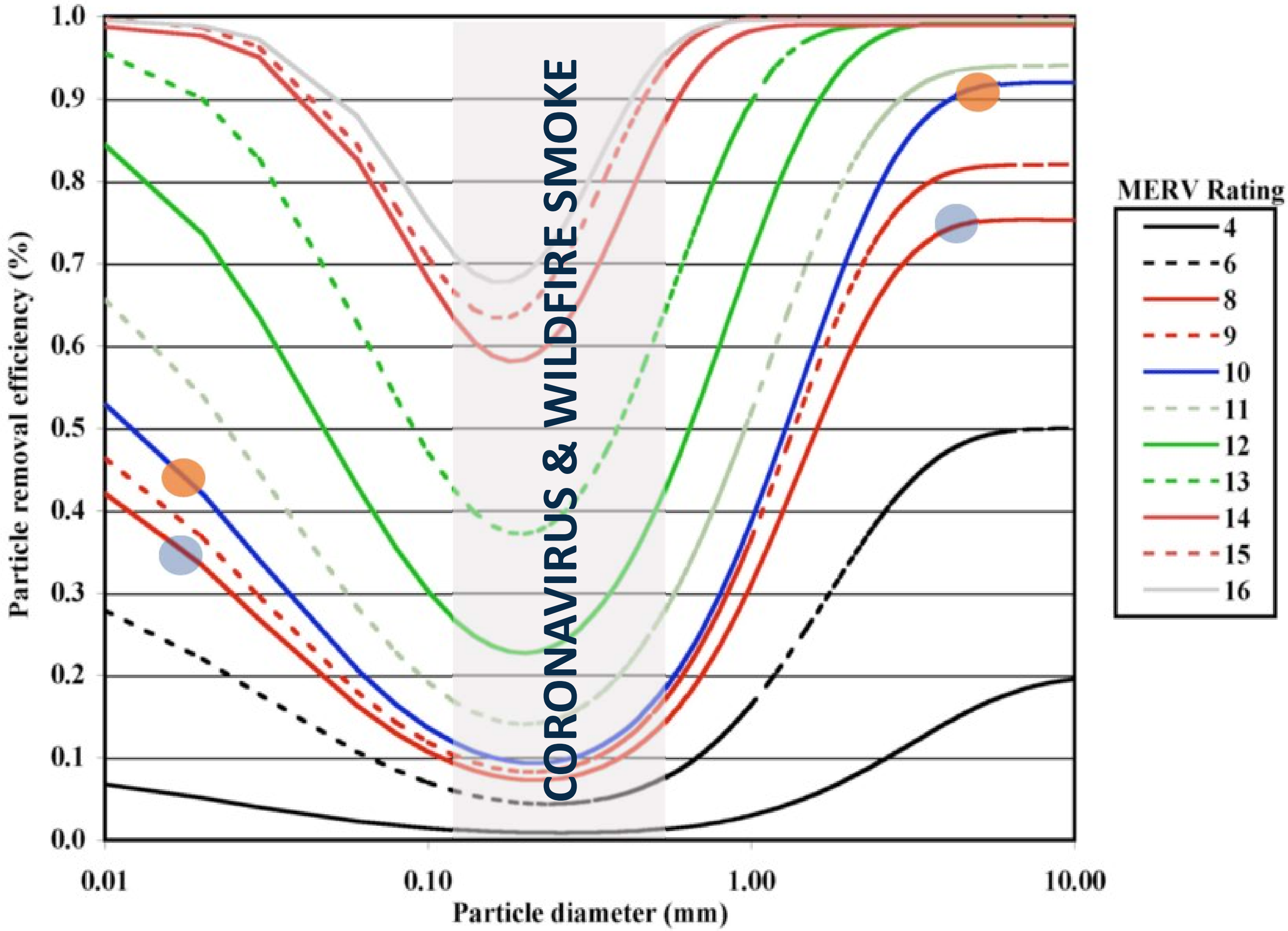


Figure 2. Relative Deposition Efficiencies of Different-Sized Particles in the Three Main Regions of the Human Respiratory System, Calculated for Moderate Activity Level (Task Group on Lung Dynamics 1966)

2021 ASHRAE FUNDAMENTALS HANDBOOK: CHAPTER 11 Air Contaminants, Section 2 Particulate Contaminants

NPBI AND PARTICLE PERFORMANCE



REGARDING LABORATORY NPBI™ PARTICLE TESTING

Test Background:

Testing was conducted at a third-party, A2LA accredited laboratory using the parameters further described herein. Please refer to test reports and support materials for specific test conditions and parameters.

Summary test conditions and parameters:

Using an AHAM standard size testing chamber (10ft x 10ft x 10ft), a duct system set-up following ASHRAE 52.2 standards, air mixing, 6 air changes per hour (ACH), using a calibrated cigarette to generate the sub-1-micron particles. Consult test reports for additional detail.

Disclaimer:

GPS Air™ makes every attempt to ensure that accepted industry test methods in controlled environments are utilized in the testing it commissions. The purpose of these tests is to isolate in these controlled conditions the impact on particulate reduction efficacy of a filter versus a filter used with our needlepoint bipolar ionization, NPBI™. Other tests run under similar circumstances achieved different but within the margin of error of the results herein.

Copies of the full test reports and test parameters are available upon request. The test results relate only to the specific filter tested under the specific conditions tested. Actual results may vary depending on changes to a number of variables impacting filter performance including but not limited to material type, static charge, dust loading, humidity, temperature, air velocity, particular size distributions, particulate type, and performance after additional hours of operation. Testing particulate reduction efficacy with filters and GPS NPBI™ technology is an evolving process, and additional testing will continue in the future.

Experimentation Design: Based on industry standards and real-world scenarios

Testing Lab

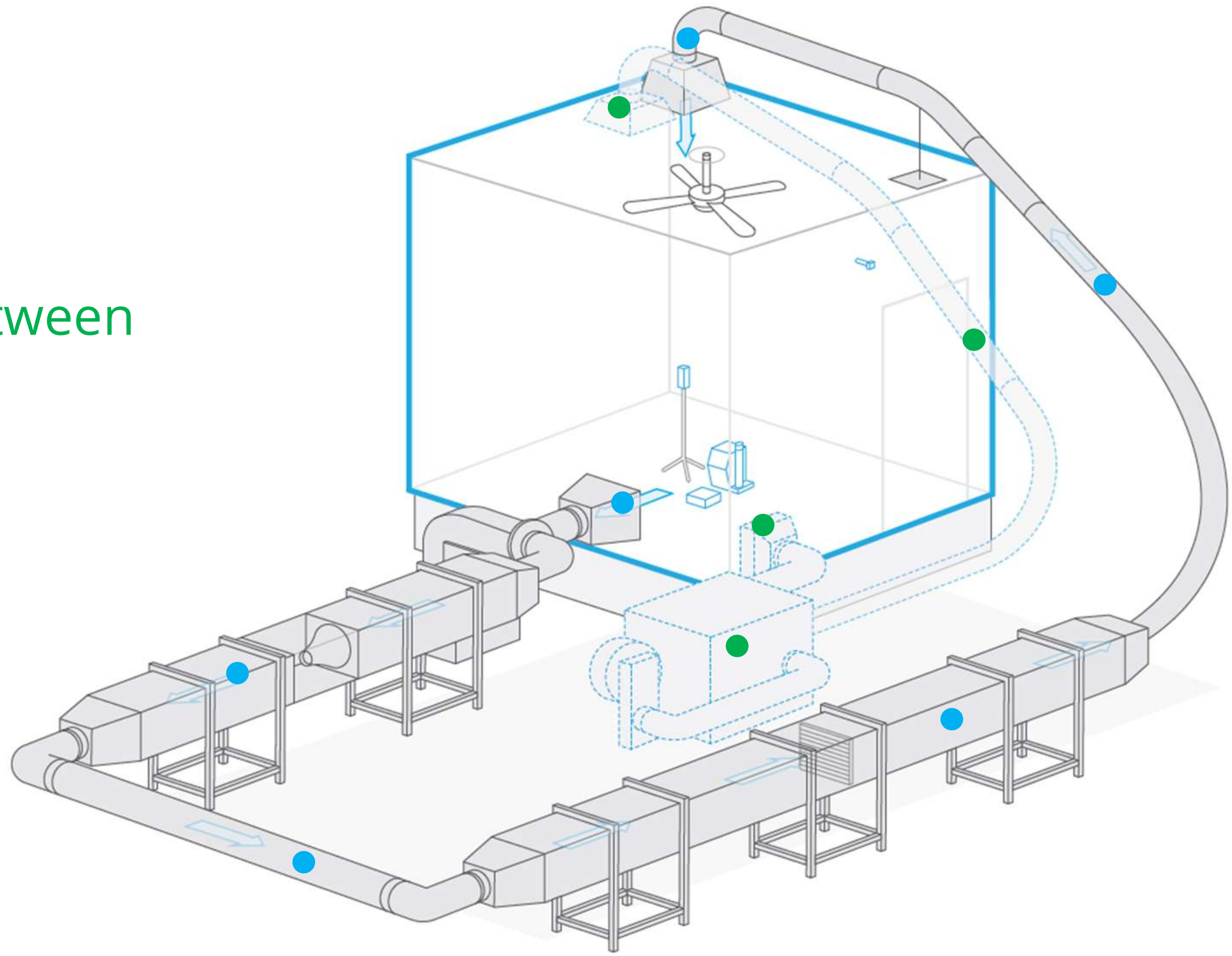
- Blue Heaven Technologies
  - Third party laboratory
  - A2LA accredited [ISO 17025, Cert. 6298.01]
  - AHAM standard size testing chamber
    - 10 ft x 10 ft x 10 ft
    - Air mixing
  - Testing and chamber set-up follows ASHRAE 52.2 standards
  - Both mass and particle count by size recorded

Experiment

- Calibrated cigarettes used as particulate type
  - Provides consistent starting points
  - Provides consistent particle size between 0.01 to 1 micron
  - Simulates field conditions like wildfire smoke
- Focus on benefits of NPBI + filtration vs. filtration alone
- Testing at 6 air changes per hour (ACH), consistent with ASHRAE recommendation
- Ion densities from 8K to 15K positive and negative ions/cc
  - Within the window of our real-world guidance of 2-20k

Two separate duct loops:

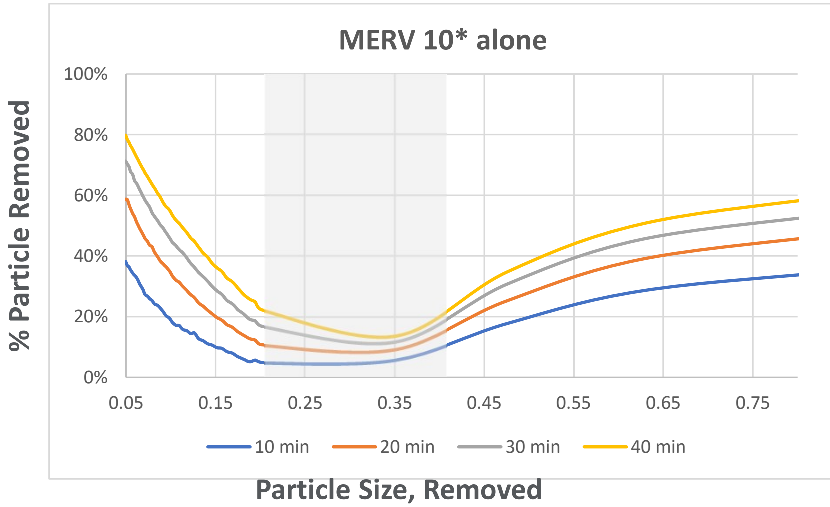
- Test Loop
- Cleaning loop used only between tests

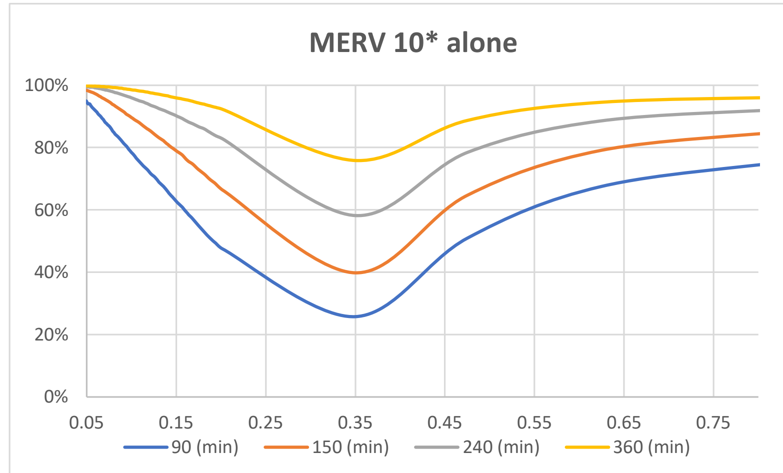


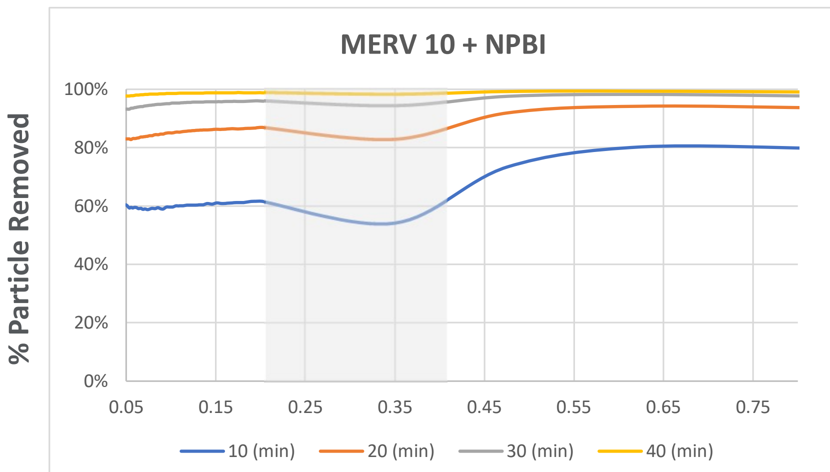
GPS

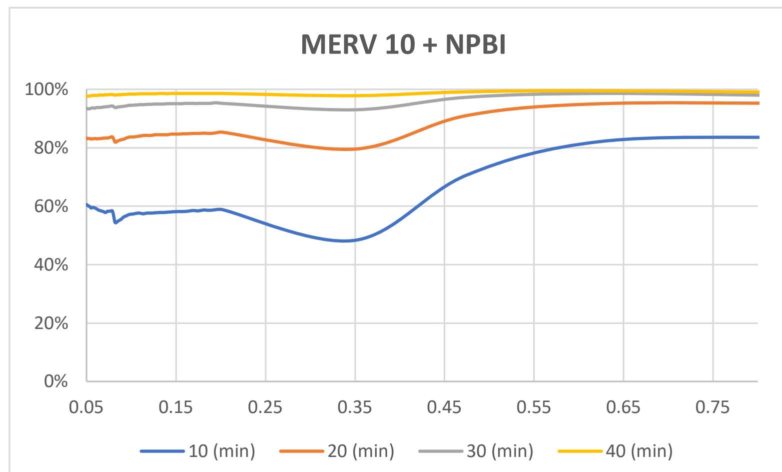
Deeper Look: Confirmation of the hypothesis: A MERV10* filter

*Tested performance under ASHRAE 52.2



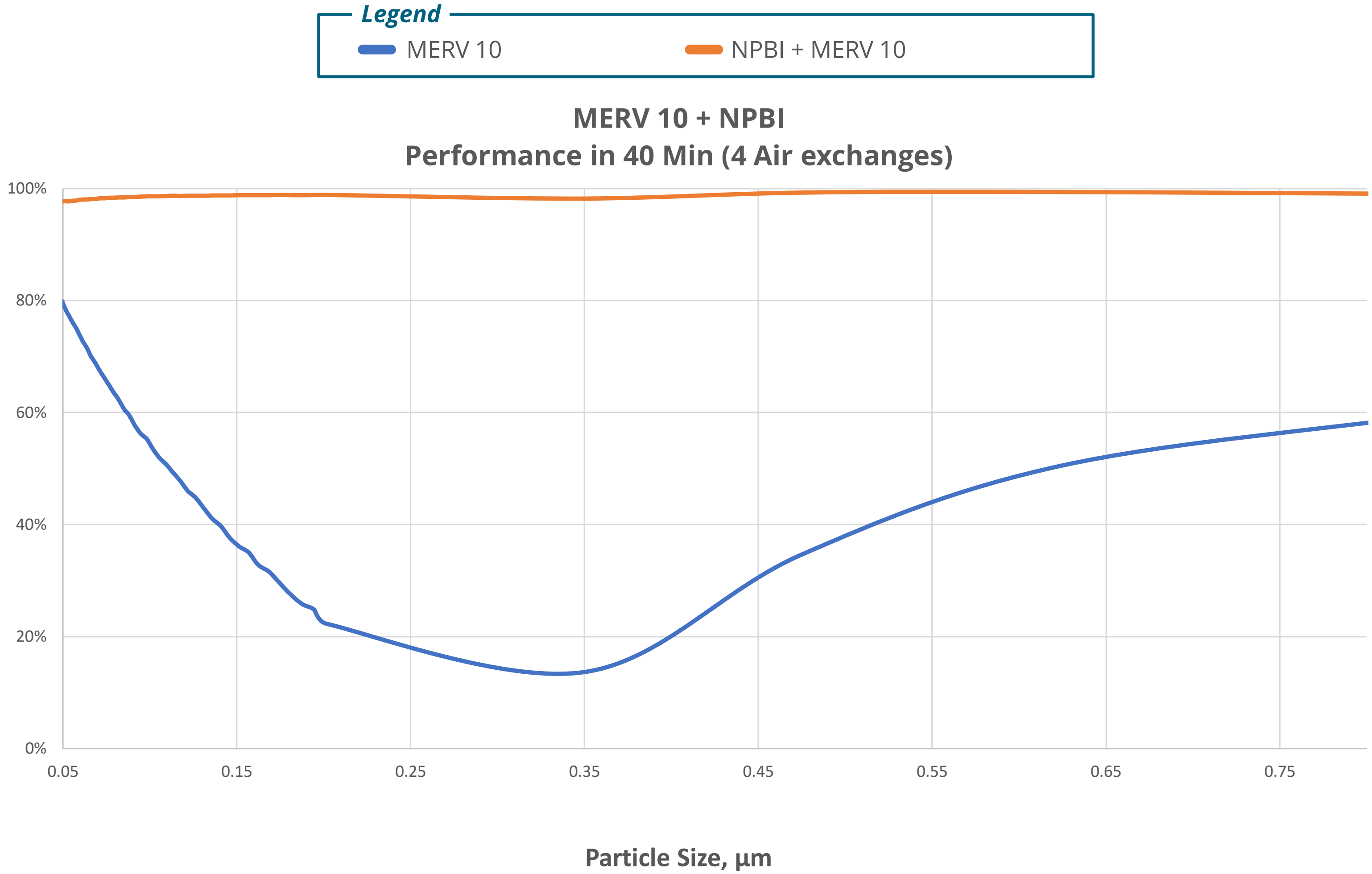






Deeper Look: Confirmation of the hypothesis: A MERV10* filter

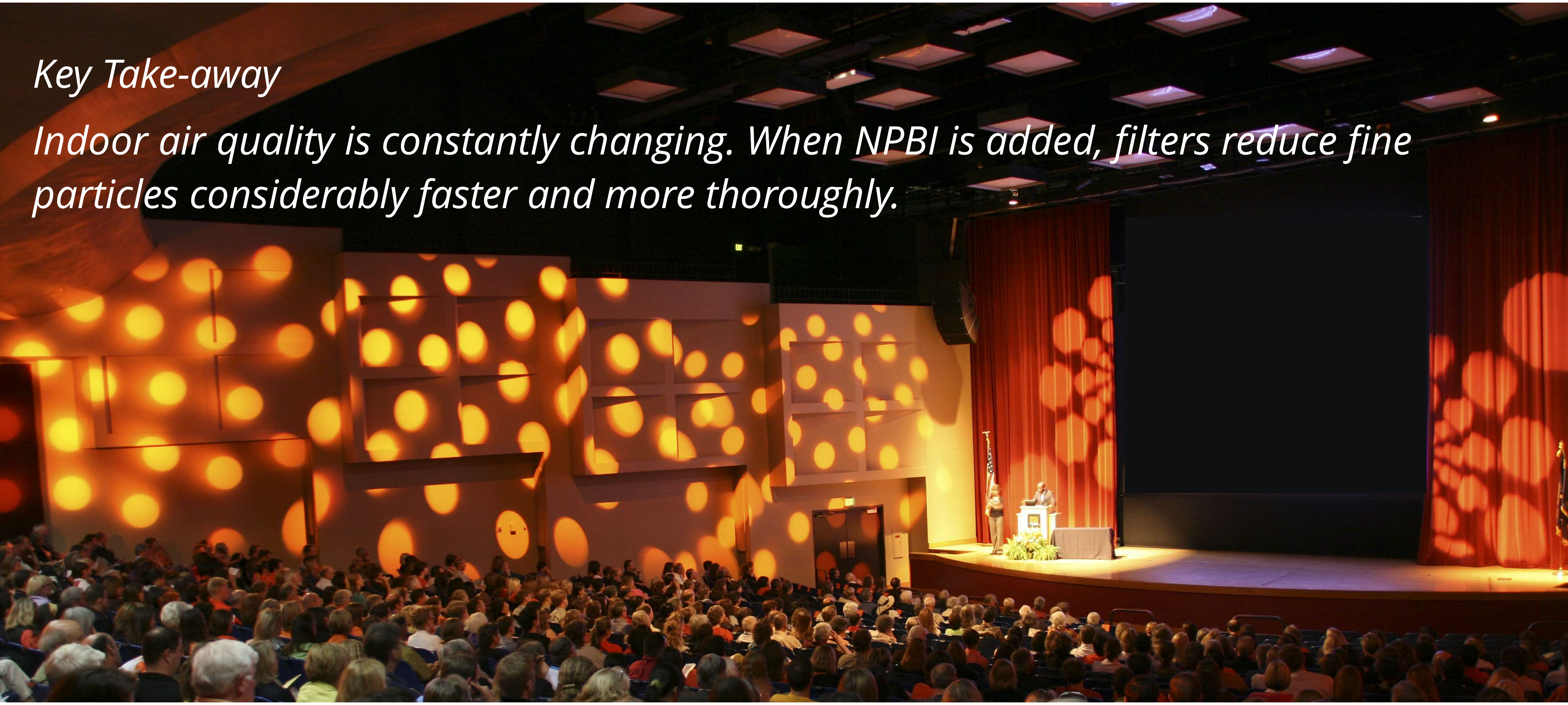
*Tested performance under ASHRAE 52.2



NPBI COMBINED WITH FILTRATION

Key Take-away

Indoor air quality is constantly changing. When NPBI is added, filters reduce fine particles considerably faster and more thoroughly.



Ventilation for Acceptable IAQ

- What is acceptable IAQ
- Ventilation for acceptable IAQ
- Case studies

What is acceptable IAQ

Contaminants of Concern

- Building Generated
- Biological
- Outdoor Generated
- Occupant Generated

→

Maintain Contaminants Below Threshold Limits

- Reduce
- Replace
- Remove

→

Follow Applicable Industry Standards, Rating Systems & Codes

- OMC
- IMC
- ASHRAE 62.1

Contaminants of concern

Building Generated

- VOCs
- Other Chemicals

Biological

- Within Building Envelope
- In Intake Plenums
- In Supply Air Plenums

Outdoor Generated

- Via HVAC System
- Infiltration building envelope
- Location of building

Occupant Generated

- Body Odor
- Pathogens
- Particulate

Contaminants – TLV's

Reduce	Replace	Remove
• Building materials • Proper Filtration • Building envelope • Building pressurization	• Provide outside air • Measure • Air change rates	• Filtration • Ultraviolet Germicidal Irradiation • Air cleaning technologies

Applicable codes

OBC	OMC	ASHRAE 62.1
• Ohio Building Code • Current Code 2017 • Strict interpretation of International building code • OBC references OMC	• Ohio Mechanical Code • Current adoption 2017 • Strict interpretation of International mechanical code • References ASHRAE 62.1 - 2016	• Ventilation for acceptable Indoor Air Quality • Specifies outside airflow rates

ASHRAE 62.1-2016

1. PURPOSE

1.1 The purpose of this standard is to specify minimum ventilation rates and other measures intended to provide indoor air quality that is acceptable to human occupants and that minimizes adverse health effects.

specify minimum ventilation rates

ASHRAE 62.1-2016

6.2 Ventilation Rate Procedure. The outdoor air intake flow (V_{ot}) for a ventilation system shall be determined in accordance with Sections 6.2.1 through 6.2.7.

Objective: Determine V_{ot}

6.2.1 Outdoor Air Treatment. If outdoor air is judged to be unacceptable in accordance with Section 4.1, each ventilation system that provides outdoor air through a supply fan shall comply with the following sections.

OA is suitable

6.2.2.1 Breathing Zone Outdoor Airflow. The outdoor airflow required in the breathing zone of the occupiable space or spaces in a *ventilation zone*, i.e., the breathing zone outdoor airflow (V_{bz}), shall be no less than the value determined in accordance with Equation 6.2.2.1.

OA/ person + OA/ Floor area

$$V_{bz} = R_p \cdot P_z + R_a \cdot A_z$$

ASHRAE 62.1-2016

6.1.2 IAQ Procedure. This performance-based design procedure (presented in Section 6.3), in which the building outdoor air intake rates and other system design parameters are based on an analysis of contaminant sources, contaminant concentration limits, and level of perceived indoor air acceptability, shall be permitted to be used for any zone or system.

Meet contaminant concentration

Perceived IAQ

Notes:

1. Appendix D includes steady-state mass-balance equations that describe the impact of air cleaning on outdoor air.
2. Measurement of the contaminants may be useful

Case Studies - University

Project Overview

- Large fitness center (10,000 Ft^2)
- Single zone ducted VAV unit
- NPBI installed in the AHU
- TVOC Sensors installed in space and AHU

Project Goals

- Increase IAQ
- Monitor IAQ at reduced ventilation levels
- Reduce energy consumption

Case Studies - University

NORMAL OA POSITION

	SPACE IONS (PPM)	DUCT IONS (PPM)	SPACE TVOC (PPM)
Before	350	600	600
After	12,000	24,000	475

REDUCED OA POSITION

	SPACE IONS (PPM)	DUCT IONS (PPM)	SPACE TVOC (PPM)
Before	300	550	650
After	13,500	26,000	490

In Progress

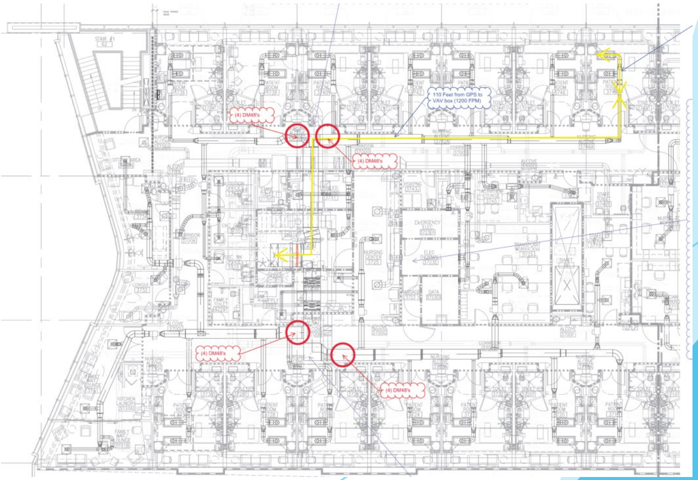
Case Studies - Healthcare

Project Overview

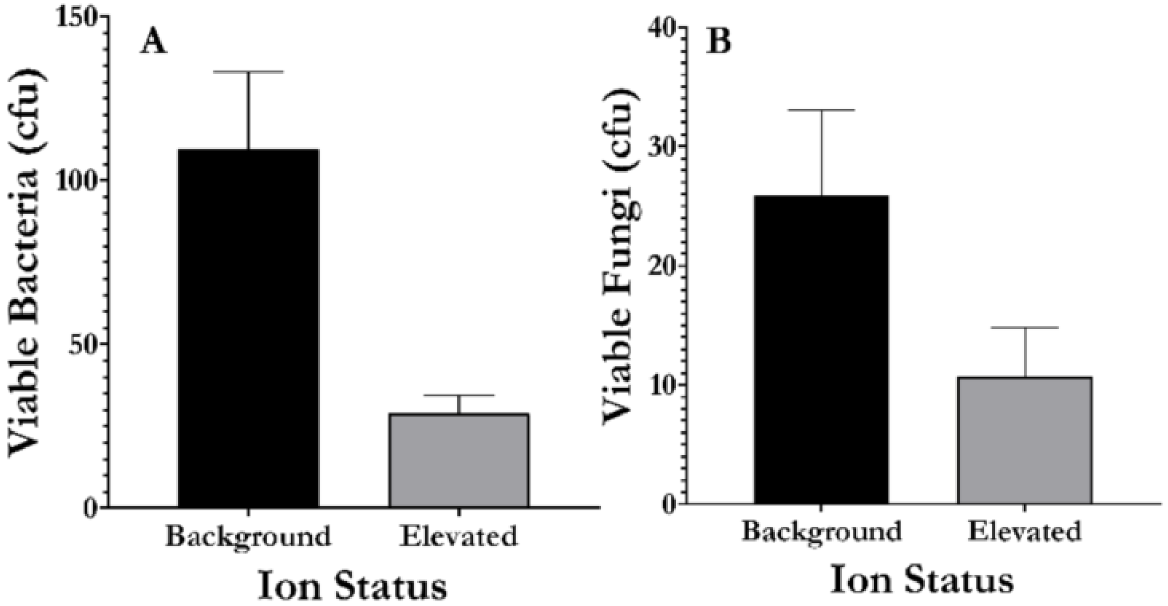
- Patient tower, bone marrow transplant floor
- Two large VAV air handlers
- 16,000 Ft^2
- Vacuum pumps used to collect air samples

Project Goals

- Determine impact of air cleaning technology
- Testing performed by infectious control group
- Reduce hospital acquired infections (HAI’s)



Case Studies - Healthcare



In Progress

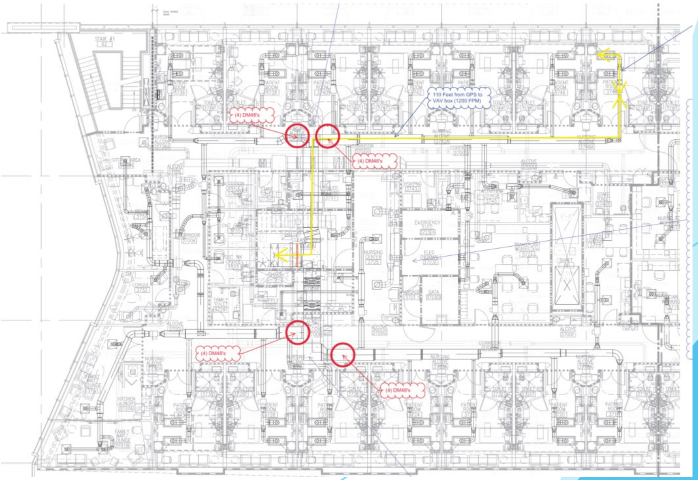
Case Studies - Transportation

Project Overview

- 20,000 Ft^2 work area
- Large rooftop unit
- Vacuum pumps used to collect air samples
- Swabs used to collect surface samples

Project Goals

- Determine impact of air cleaning technology
- Testing performed by independent IAQ professional
- Reduce bacteria and fungus



Case Studies - Transportation

Before

#1	Swab (1.00 in2)	Organism	Spore Estimate	Mycelial Estimate
	S1 - Work Area Air Fill Station N11 Dock	Aspergillus|Penicillium	Heavy	Trace
		Chaetomium	Very Heavy	Many

#2	Swab (1.00 in2)	Organism	Spore Estimate	Mycelial Estimate
	S2 - Work Area N11 Dock East	Chaetomium	Very Heavy	Many

#3	Swab (1.00 in2)	Organism	Spore Estimate	Mycelial Estimate
	S3 - Work Area N11 Dock South	Aspergillus|Penicillium	Heavy	Trace
		Chaetomium	Very Heavy	Many

After

#1	Swab (1.00 in2)	Organism	Spore Estimate	Mycelial Estimate
	S4 - Work Area Air Fill Station N11 Dock	No Fungi Detected		

#2	Swab (1.00 in2)	Organism	Spore Estimate	Mycelial Estimate
	S5 - Work Area N11 Dock East	No Fungi Detected		

#3	Swab (1.00 in2)	Organism	Spore Estimate	Mycelial Estimate
	S6 - Work Area N11 Dock South	No Fungi Detected		

XpenseSolutions
Energy Advisory Services
www.XpenseSolutions.com

President and Founder

XpenseSolutions Energy Advisory Services and XPS Solutions IAQ

John J. Verdile, President and Founder of XpenseSolutions, has partnered with clients to develop comprehensive indoor air quality and energy programs that address cost, operational and process efficiency goals for over 29 years.

In March 2005, Mr. Verdile formed XpenseSolutions, a company focused on **reducing its client's total cost of energy.**

John has designed and managed energy procurement / risk management programs for clients with an annual energy spend from $25,000 over $125 million annually.

As Director of Energy Consulting for the one of the nation's largest integrated energy companies, he was responsible for managing an $800+ million energy portfolio.

John has developed demand side energy efficiency projects that range in size from $10,000 to over $15 million per project for commercial, industrial and healthcare clients.

Support Staff

- **Certified Energy Managers (CEM)** – Certified by the Association of Energy Engineers - A Certified Energy Manager is an individual who optimizes the energy performance of a facility, building or industrial plant.
- **Principal Engineers (PE)** - A principal engineer is a trained and educated engineer that is in charge of the implementation of projects given by a company.
- **Contract and Energy Bill Auditors** – Experts in review and analysis of energy supply and distribution contracts and billing rates.

XpenseSolutions
Energy Advisory Services

Boards and Committees
Board of Directors, Cleveland Engineering Society 1998 - 2007
The Visiting Committee, Fenn College of Engineering at Cleveland State University 2003 –2005

Featured Speaker
Ohio Hospital Association (OHA)
MAGNET – Manufacturing Advocacy & Growth Network
The Cleveland Engineering Society (CES)
Manufactures Education Council (MEC)
Ohio Public Facility Managers Association (OPFMA)
Association of Energy Engineers (AEE)
American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
Ohio Association of Realtors
Ohio Public Utilities Commission (PUCO)
General Electric Lighting Institute (GE)
Building Owners and Managers Association (BOMA)
The Greater Cleveland Partnership/Council of Smaller Enterprises (GCP/COSE)

Biographical Information

Peter Eno
Vice President, Sales – Midwest
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440.823.4057 PEno@gpsair.com

Peter Eno is a 35-year veteran of the HVAC Industry from Cleveland, Ohio. Presently VP of Sales-Midwest at GPS Air.

- He has experience as a Senior Account Manager at FirstEnergy Corp working on large energy savings projects.
- Senior Sales Engineer with the Carrier Corporation developing large Design Build Mechanical projects.
- Manager Business Development and Senior Sales Engineer with Refrigeration Sales Corporation focused on growing the VRF business, the last 8 years primarily focused on Improving the IAQ (Indoor Air Quality) Sector.
- After joining the GPS team, his passion for IAQ has increased with broader understanding of the efficacy and positive results of Needle Point Bipolar Ionization Technology. Peter is 40 years happily married to his wife Nancy and is soon to be a grandfather by one of his three grown and married children and one new Granddaughter

Ben Arnett

9/16/2022

Lab, Healthcare & IAQ Solution Provider
CriticalAire

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Columbus, OH 43229

With 15 years HVAC industry experience including: 11 years engineering design experience and 4 years technical sales, Ben Arnett has had a varied career. Today, he leads CriticalAIre's Columbus and Cleveland Offices focusing on critical environments and indoor air quality of buildings. He engages clients from engineers, contractors and owners to provide solutions.

Ben brings the mindset of an entrepreneur to his work. His drive and persistence coupled with his past design experiences have helped him and his team build relationships and implement solutions with high profile clients throughout Ohio.

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