Source – cntraveler.com

Superior Air

Benefits & Data Analysis on Indoor Air Quality

WHITEPAPER

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MCI®

Product Development & Sustainability

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Introduction

Source – Earth.com

Problem

As the COVID-19 virus continues to bring public awareness to the risk of airborne viruses, indoor air quality has become an increasing concern for many individuals. To date, COVID-19 has been attributed as the underlying cause of death of nearly 756,962 people[1]. As of Oct. 2021, commercial office space is still averaging around 50% occupancy[2]. The COVID-19 pandemic has also caused the restaurant industry a drop in spending of around $27 billion from Feb. 2020 to April 2020, a 49.6% decrease[3]. Additionally, the United States is facing a workforce shortage, as Americans retire more frequently and at earlier ages than in previous years. The COVID-19 pandemic and all of its associated effects have created massive economic consequences, health problems, supply-chain issues, and, in some cases, customers are refusing to return to populated indoor facilities, like restaurants, office buildings, medical facilities, and schools.

Solution

COVID-19 has wreaked havoc on our health, economic stability, and daily life. Cutting-edge technology can help us return to an even safer business-as-normal. MCI set out to combine new and proven technologies to engineer a complete air purification system that will provide superior protection over stand-alone conventional HVAC purification and existing comparable products. This document outlines the process, technology, experiment, data analysis, and conclusions of our findings.

"Changes call for innovation, and innovation leads to progress." - Li Keqiang

Superior Air Treatment System

MERV 14 Pre-Filter

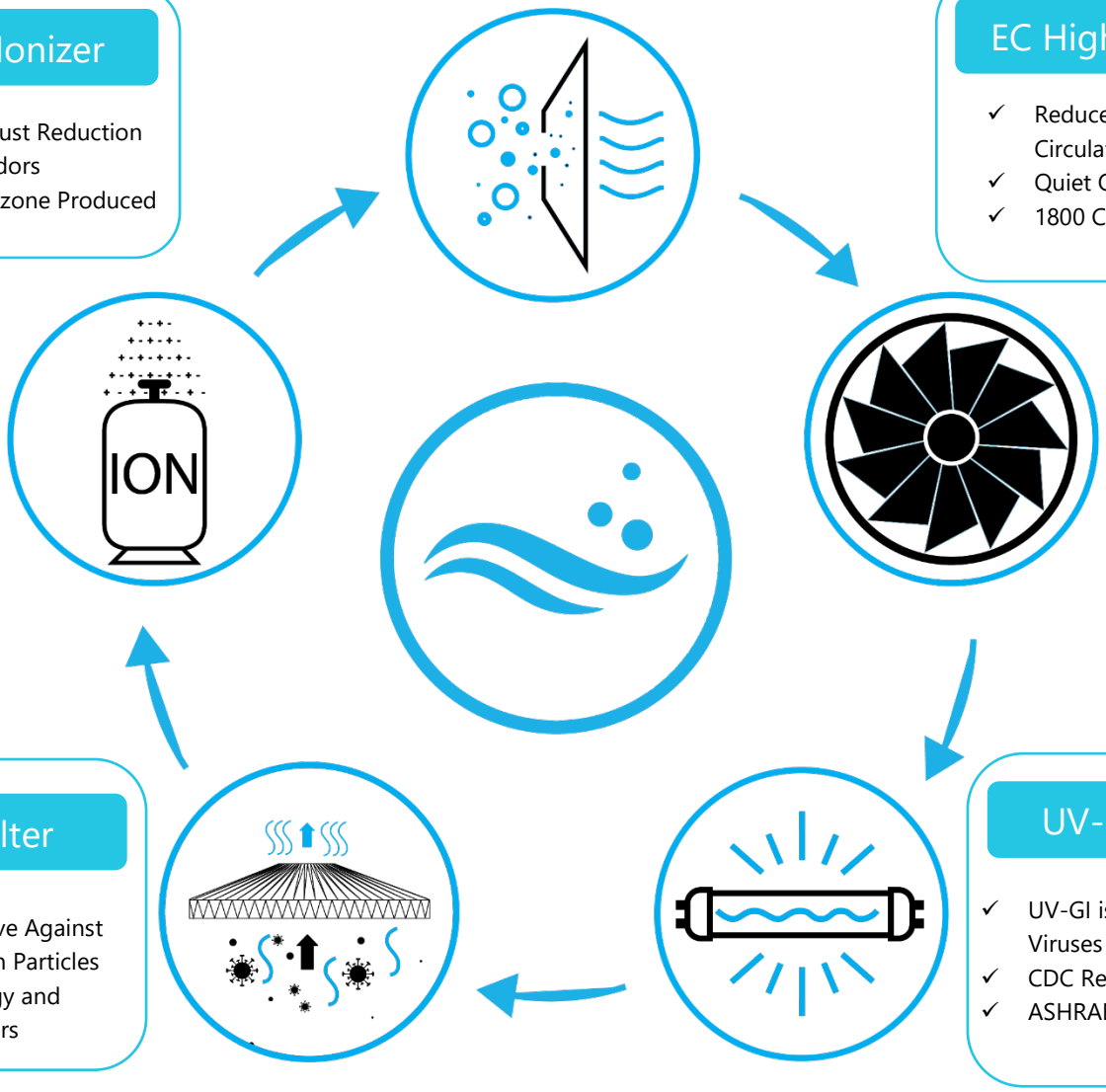
- ✓ Filters Pollen, Dust Mites, Mold, Spores
- ✓ > 90% Efficient for Particles 3-10 Microns

Bi-Polar Ionizer

- ✓ Particle and Dust Reduction
- ✓ Neutralizes Odors
- ✓ No Harmful Ozone Produced

EC High Flow Fan

- ✓ Reduces Risk via Quick Circulation of Room Air
- ✓ Quiet Operation
- ✓ 1800 CFM



HEPA Filter

- ✓ 99.99% Effective Against .3 to 10 Micron Particles
- ✓ Reduces Allergy and Asthma Triggers

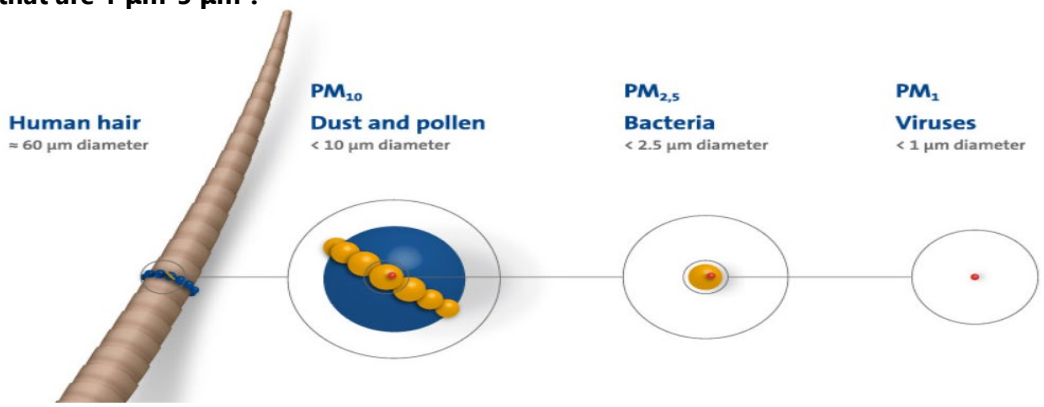
UV-GI System

- ✓ UV-GI is Proven to Inactivate Viruses and Pathogens
- ✓ CDC Recommended
- ✓ ASHRAE Recommended

Summary of Findings

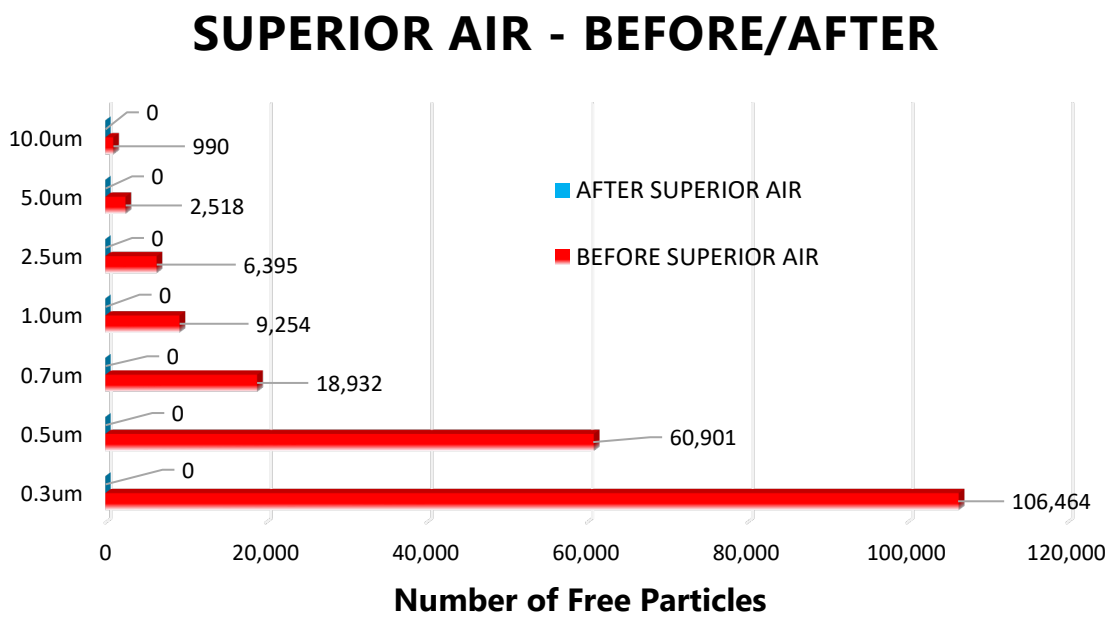
Particle Reduction Data

Particulates in the air can be comprised of many harmful pollutants such as viruses, bacteria, allergens, dander, dust, mold, smoke, and others. These particles in the air typically **range between .01 microns (µm) and 10 microns in diameter**. A micron or micrometer for reference is one-millionth of a meter ($1*10^{-6}$ m or .000001 meters). **Viruses are normally embedded in particles such as respiratory droplets that are 1 µm-5 µm[8].**



Therefore, we must test the contents of the air before the Superior Air unit is on and after to see its removal of the harmful air pollutants. To test the actual efficiency of the Superior Air system we performed a **single pass test**. We placed the high precision particle counter at the inlet of the Superior Air unit took readings then placed the particle counter at the outlet to test the performance. **The high precision particle counter could not register a single particle from .3µm-10µm after it passed through the Superior Air Treatment Process**. The data recorded shows a clear conclusion that **air passing through the Superior Air system** has a **particle reduction of near 100%.** The reason .3µm is the smallest diameter analyzed is that it is known as the MPPS (Most Penetrating Particle Size). **As particles get smaller or larger than .3µm it becomes easier to remove them from the air stream** due to fluid mechanics behavior.

100% Single Pass Particle Reduction



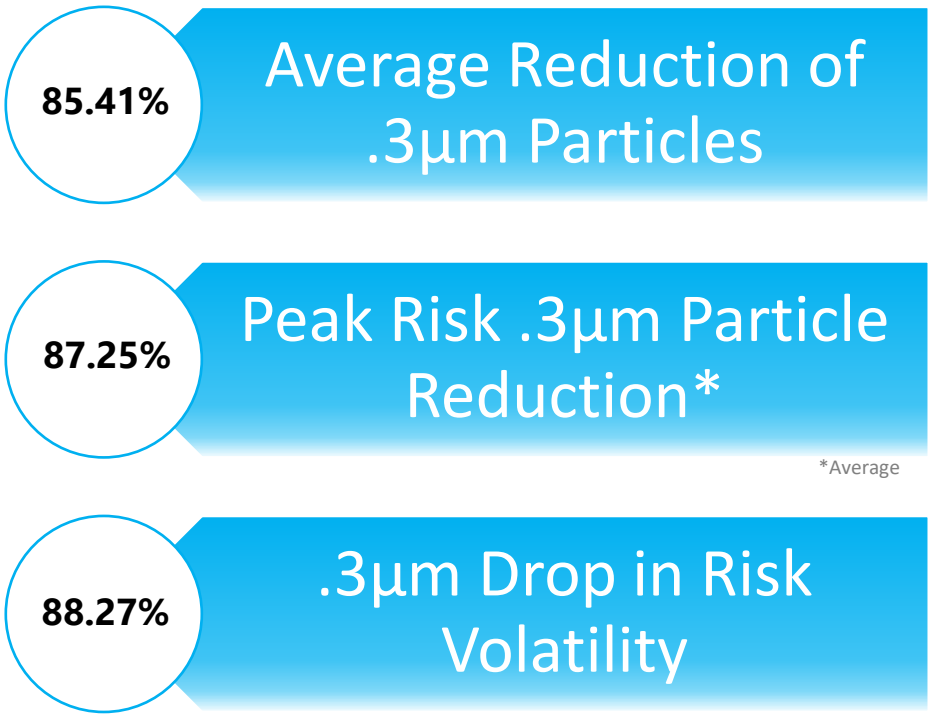
After testing the inlet air compared to the outlet air the next test was to compare the benefits on a **large room** from the Superior Air unit. The test was done in a room that is **62 ft long and 20 ft wide, with 10 ft ceilings.** That is **1,240 sq. ft** and brings the volume of air in the room to **12,400 cubic feet**. The **Superior Air unit has a flow rate of 1,800 cubic feet per minute** which means we will change over the air in the room **once every 6.9 minutes or 8.7 times per hour.**

ASHRAE (American Society of Heating Refrigerating, and Air Conditioning Engineers), who is federally recognized and the industry leader on engineering design and recommendations for their field, **recommends 6-12 air changes per hour in sensitive airborne infectious areas.**

The **CDC** (Center for Disease Control and Prevention) also **recommends 6-12 air changes per hour for airborne infection isolation rooms**. **Conventional HVAC systems only perform 2-3 ACH (Air Changes Per Hour) which means the air only turns over every 20-30 minutes[13].**

The room was in the center of an active business that performed manufacturing of metal/plastic products and included frequent traffic from visitors and activity from internal personnel. The goal was to **test the system under extreme conditions to ensure performance in demanding applications.** The particle counter was placed in the room for 7 days taking constant readings of the particles in the air. We then compiled the data and took an average of the 7 days to rule out any outliers from the data set. The particle counter remained in the room and the Superior Air unit was placed into the room and powered on. We performed the same test but with the unit on and recorded the data. Afterward, we averaged the data set and compared the performance of the Superior Air unit on an entire room.

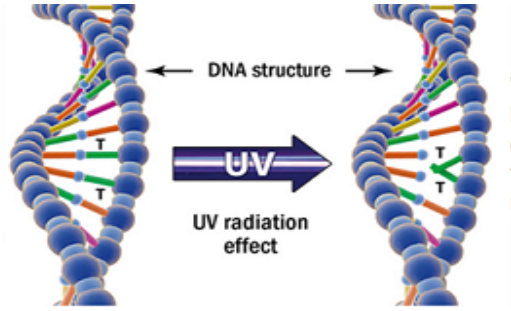
A summary of the results is below. On average there was a **reduction of 85.41% of .3µm particles.** Two additional key takeaways are the **87.25% reduction of .3µm particles at peak times of heavy employee traffic and an 88.27% drop in risk volatility**. **Stable and low particle counts correlate to a lower risk of infection and less influence on air pollutants by people in the area.**



Ultraviolet Germicidal Irradiation Dose Data

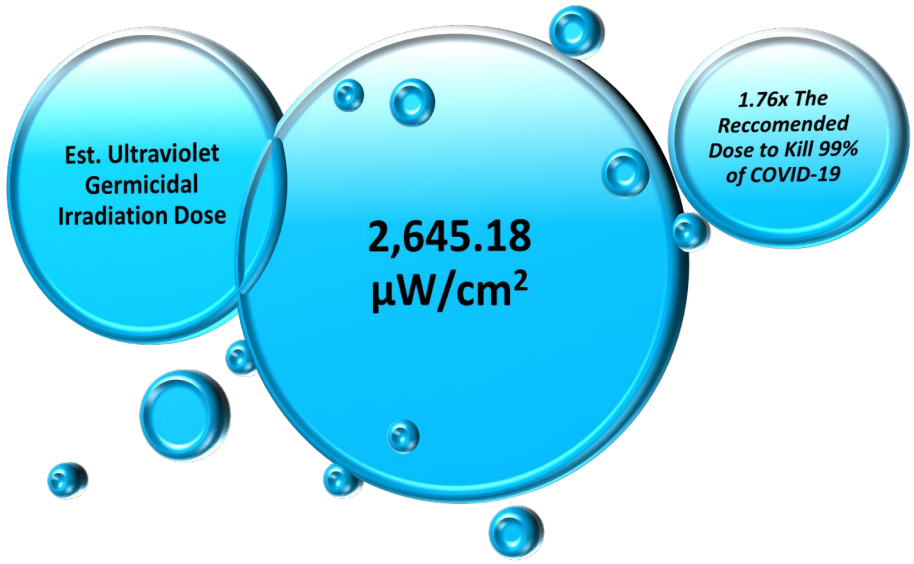
Since the onset of COVID-19, UV-C has become one of the most in-demand technologies around the world. Both the U.S. Centers for Disease Control and Prevention (CDC) and ASHRAE now recommend UV-C to help mitigate the spread of the COVID-19 virus.[4]

Superior Air's Ultraviolet Germicidal Irradiation (UV-GI) system uses 254-nanometer wavelength light to **damage the DNA and RNA of viruses and other microorganisms rendering them inactive (unable to infect).**



When exposing microorganisms to UVC light, the light penetrates through their cell wall and disrupts the structure of their DNA molecules, prohibiting reproduction.
Source – UG2.com

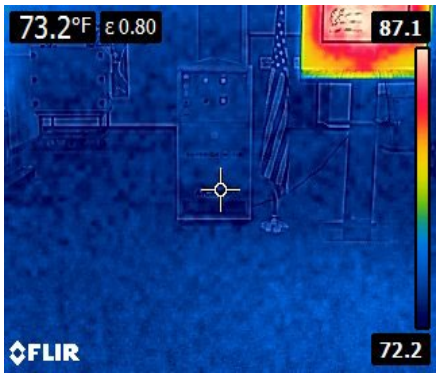
Using a high accuracy UV-C intensity meter we estimated the **one pass dose** a microorganism such as **bacteria or viruses** could experience. It is vital to give a **high dose** to fully inactivate the target microorganism. The data shows **one pass** of air will **not only satisfy but exceed ASHRAE's recommendation of 1500 µJ/cm² to inactivate 99% of the COVID-19 virus[5].**



The highly engineered combination of **advanced filtration and DNA/RNA inactivation technology** is the core of Superior Air's purification process. Not only does the data reflect that we **filter out harmful air pollutants** but we also **inactivate the contents of the air passing through**. The longer the contact time the larger the dose so as these particulates get captured in the pre and post-filters the **UV-GI system is constantly rendering the pathogens unable to replicate or cause negative side effects to the people around it.**

Thermal Imaging Data

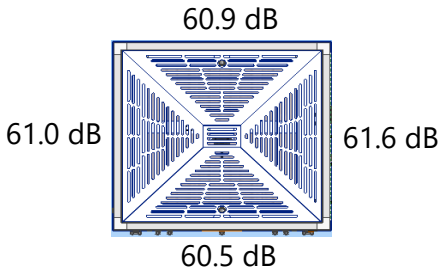
UV-GI bulbs produce energy, some of which is in the form of heat. Heating and cooling are a large expense to many institutions with large indoor spaces that need to be climate controlled. Due to this, we wanted to make sure we are not adding significant costs to the user's HVAC operation. To determine the heat energy produced we used a thermal imaging camera to take pictures during operation. The thermal imaging data below shows that there was **only a .6 °F difference between the intake and outlet which will not add recognizable costs to the HVAC operation.**



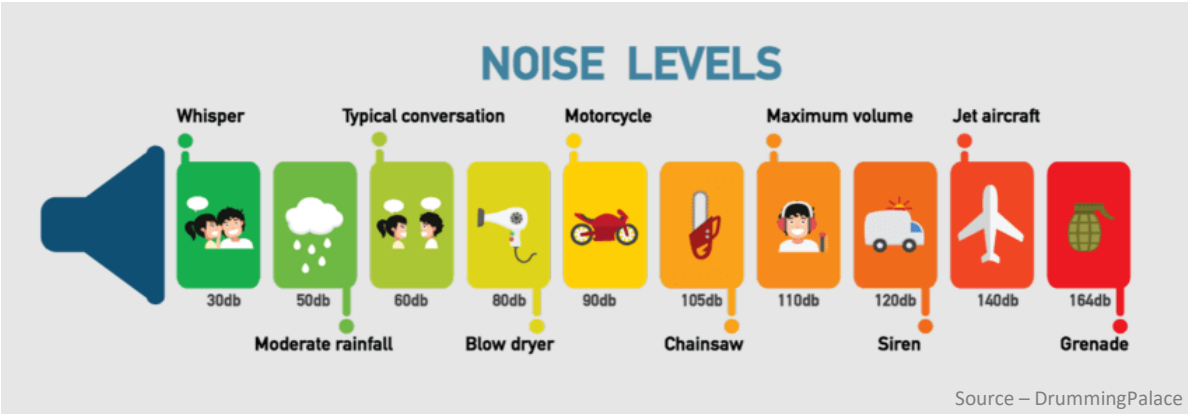
Only a .6 °F difference between the intake and outlet

Sound/Noise Data

Fans can be quite loud and disruptive in areas such as office buildings and education. To test the sound produced we took readings 6 ft away around the unit. **Utilizing sound deadening and reflecting engineered materials** the Superior Air unit only produces sound at levels equivalent to normal conversation. At 1800 CFM, Superior Air is **the quietest in its class.**



*The Superior Air unit is **equivalent to normal conversation volume level,** which will not be disruptive in office, school, or hospital settings.*



Source – DrummingPalace

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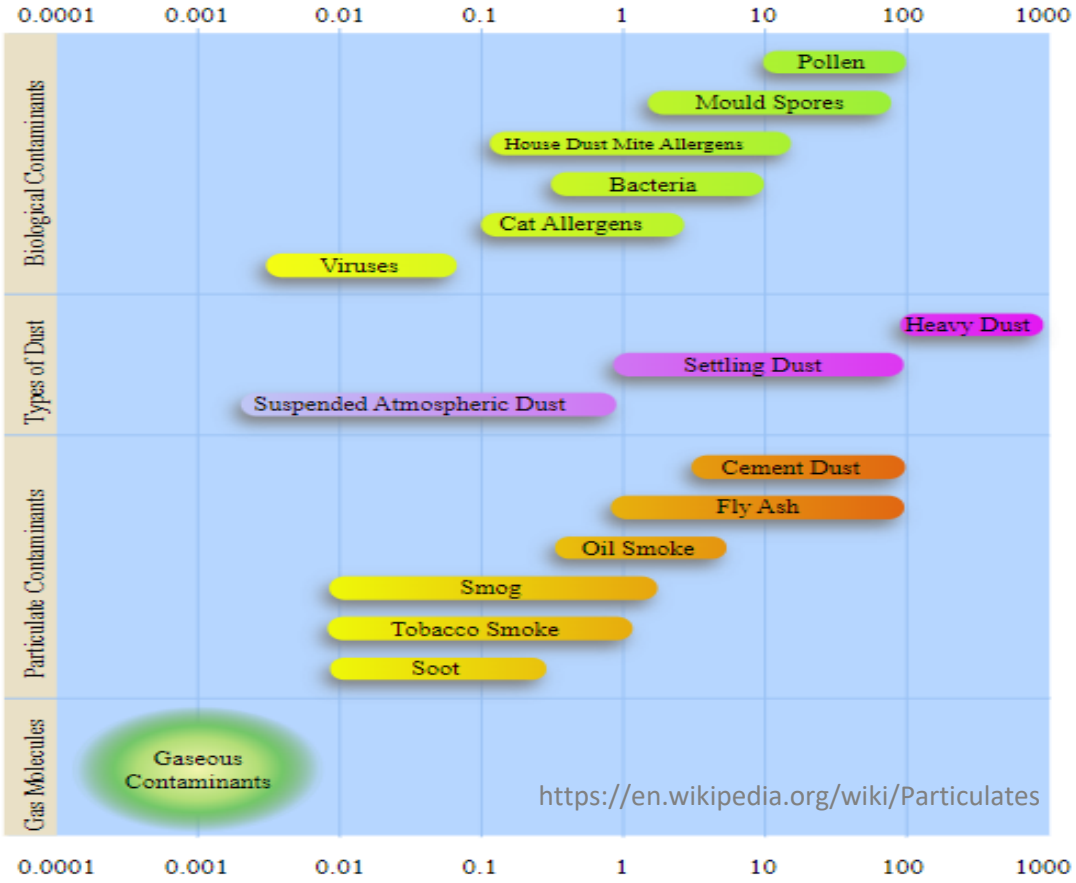
Technology



The Superior Air system utilizes a MERV 14 filter. MERV is an acronym for Minimum Efficiency Reporting Values. A filter's MERV rating corresponds to its ability to **capture particles between .3 and 10 microns (µm)**. MERV 14 filters, like the one installed as a standard on the Superior Air unit, are required to have the following minimum efficiencies:

.3 - 1 µm 75%-84%
1 – 10 µm 90% or better

MERV 14 filters are used in **general surgery rooms, inpatient hospital rooms, and superior commercial buildings.** The benefit of the MERV 14 filter is to **reduce**[6]:

- Pollen
- Dust Mites
- Sanding Dust
- Textile/Carpet Fibers
- Mold/Spores
- Dust Lint
- Cement Dust
- Legionella
- Lead Dust
- Humidifier Dust
- Coal Dust
- Nebulizer Dust
- Bacteria
- Tobacco Smoke
- Auto Fumes
- Sneeze Nuclei
- Pet Dander
- Face Powder

The **High-Efficiency Particulate Absorbing (HEPA)** filter is an ultrafine fiber filter that is **99.99% efficient at removing .3 µm particles.** These particles are the hardest to remove; they are known as the Most Penetrating Particle Size (MPPS). The HEPA filter is extremely effective when it comes to removing MPPS, in addition to many other capabilities.[7] **A common misconception about HEPA filters is that since they are rated at .3 µm, they must not be able to capture COVID-19 or other viruses because these viruses are much smaller than .3 µm.** This assumption is incorrect for two main reasons: first, viruses are almost always embedded in particles such as respiratory droplets that are much bigger (1 µm - 5 µm),[8] and second, HEPA filters catch particles in several ways, as depicted below[7].

Filtration Mechanisms

Source - Wikiwand

Interception

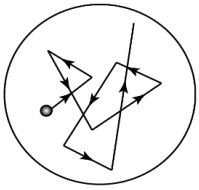
Interception is where the particle comes into contact with the filter fibers while following its natural path.

Inertial Impaction

Inertial impaction occurs with larger particles because they cannot follow the curvature of the fiber, instead their **inertia causes a collision into the filter fiber**.

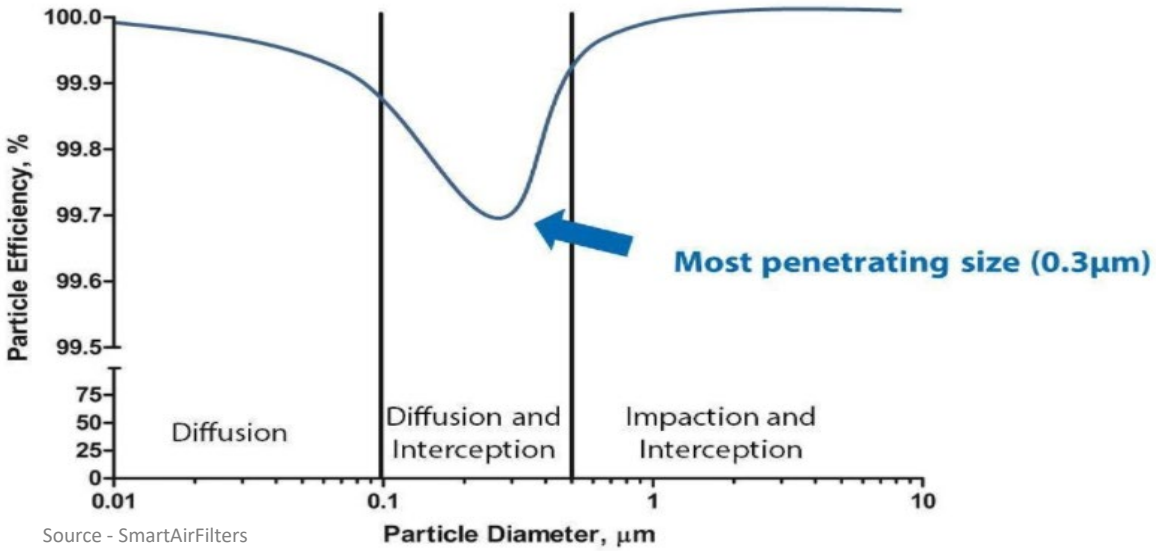
Diffusion

Diffusion is the physics mechanic that explains the ability of the HEPA filter to catch smaller particles easier than larger particles. Diffusion Occurs in particles below .3 microns because they have such little mass that they get knocked around like a pinball when they collide with gas molecules. This is known as Brownian Motion.



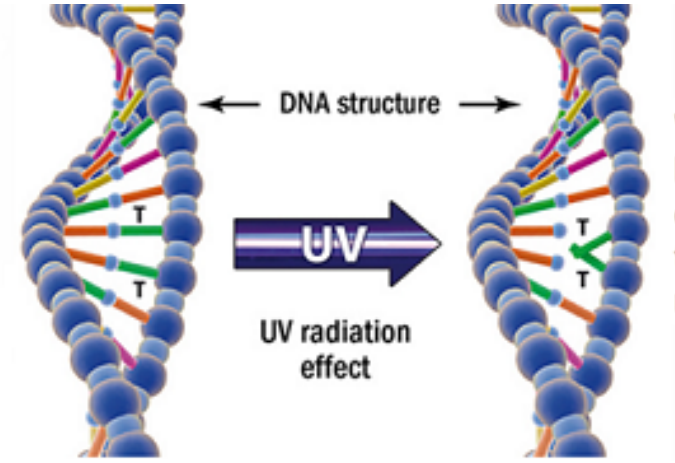
Brownian Movement

This explains why claims about HEPA filters not having the ability to remove particles smaller than .3 µm are incorrect. Even at its weakest points, HEPA filtration is above 99.6% efficiency[9].



Source - SmartAirFilters

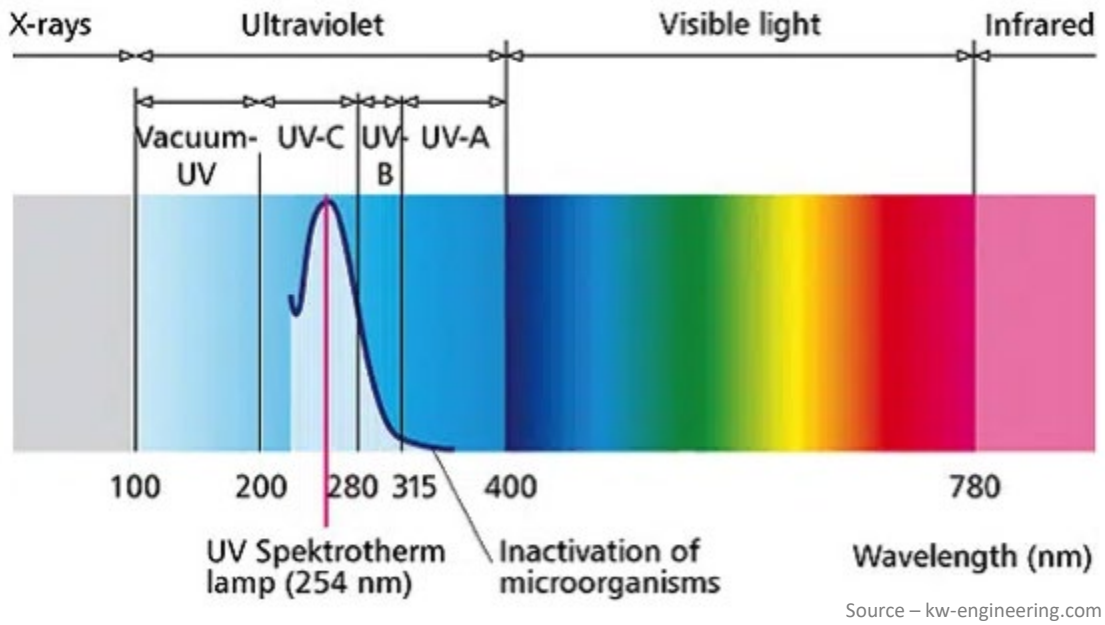
Ultraviolet Germicidal Irradiation (UV-GI) is a type of ultraviolet light that is naturally **damaging to the DNA and RNA of microorganisms** including **pathogens, viruses, bacteria, protozoa, fungi, yeasts, and algae**.



When exposing microorganisms to UVC light, the light penetrates through their cell wall and disrupts the structure of their DNA molecules, prohibiting reproduction.

Source – UG2.com

UVGI **inactivates** these microorganisms and **destroys their ability to multiply and cause disease**.



Source – kw-engineering.com

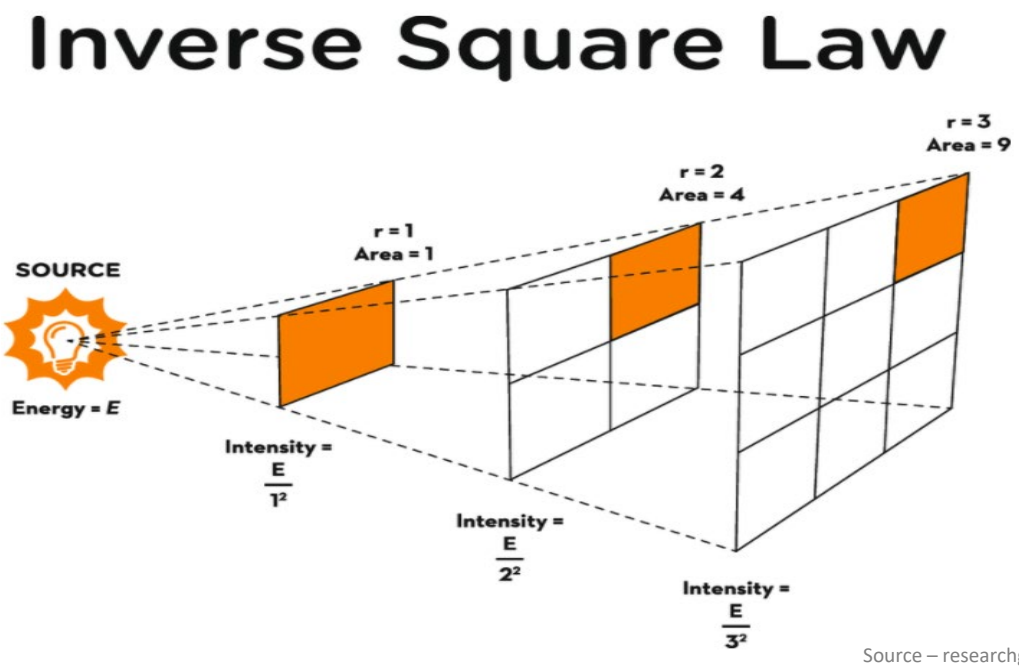
As indicated by the image above, UV-GI operates **optimally at a 254nm wavelength** to inactivate microorganisms. We use the term "inactivate" instead of "killed" because viruses are not alive; they cannot replicate their genetic material and thus cannot be killed, only inactivated. We monitored a multitude of factors to engineer an optimum UV-GI system, including contact time, irradiation density, relative humidity, and temperature. To determine how much ultraviolet light exposure is needed to inactivate a microorganism, we studied the incidence energy of that specific target. To effectively inactivate a specimen, we ensured that more energy was applied than the incidence energy of the specimen in question.

Does UV-GI have the ability to inactivate COVID-19? Absolutely, ASHRAE recommends a dose of 1500 µJ/cm^2 to inactivate 99% of SARS-CoV-2 in the air[5].

There are several UV-C/UV-GI products on websites and in retail locations including Amazon and Walmart. Unfortunately, some retailers of these units **do not understand enough about the engineering behind them. They can also mislead the consumer by claiming the unit has benefits that are not accurate, or only accurate under very specific circumstances.**

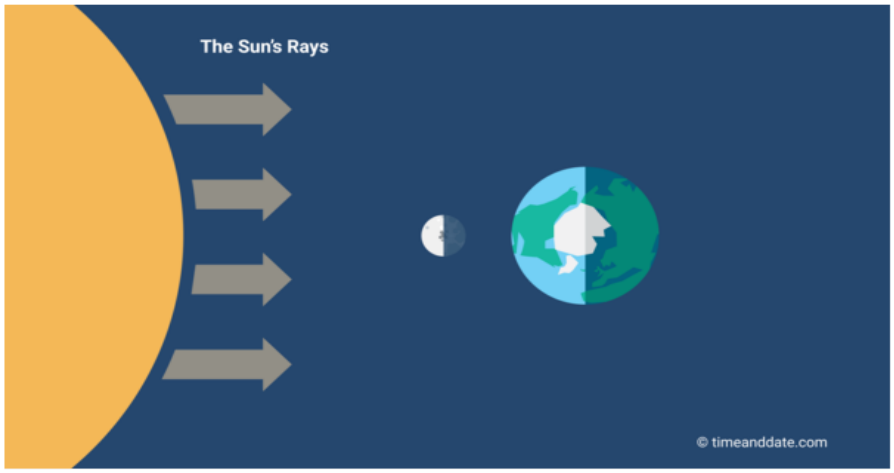
Ultraviolet Germicidal Irradiation intensity is a value requiring close attention because this value determines the amount of **contact time** needed to inactivate a microorganism.

It is also important to consider the **distance the bulb will be from the general area where microorganisms are being inactivated.** The intensity of light follows what is called the **inverse square law**, which is a mathematical proportion of the intensity of light at the distance away from the target object. **This means that as the distance from a light source increases, the intensity of light is equal to a value multiplied by $1/d^2$.**



Source – researchgate.net

There is a dark spot on the moon at all times because only one side receives direct sunlight; when a single light source hits a microorganism, it experiences the same thing, an unirradiated portion. The Superior Air system set out to change this by using **marine-grade aluminum**, a **highly reflective material**. This takes advantage of the same principle as spreading out your food in the microwave to heat faster. This is because there is **more surface area to absorb energy**, **we can get 1.75 times the irradiation from our UV-GI system** because we use an **all-aluminum** encapsulating compartment that is **applying energy over the whole microorganism and not just the front-facing portion.**



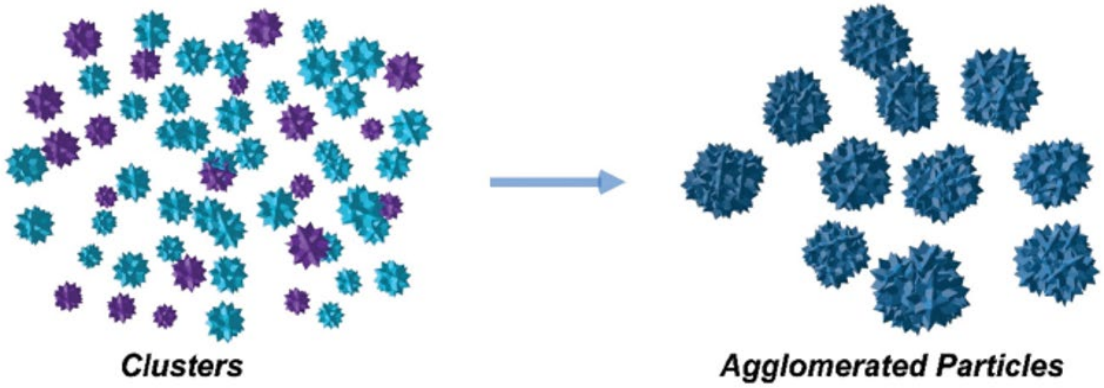
Bi-Polar Ionization produces high concentrations of positively and negatively charged oxygen ions that can cause agglomeration between particles. It accomplishes this by splitting various molecules in the air from high energy. Ions occur naturally; they are an atom or molecule with a net electric charge due to the loss or gain of one or more electrons. When these molecules separate, the **opposite charges attract** with the surrounding air particles and they **stick together settling them to the ground away from your respiratory system.** Particles **over 10µm can not be generally inhalable**[15], which points to why an ionizer is a crucial piece to making sure we are producing larger and larger particles to **reduce their impact on our health**. **Agglomeration is the accumulation of particles sticking to other particles. This is the main function of the Superior Air system's bipolar ionization system.** Agglomeration adds mass to the particles which help them **sink to the floor,** where they can be vacuumed up and are less likely to enter our lungs. The larger the particle, the less time it stays airborne; **very small particles can stay airborne almost indefinitely**[14]**.**

Particle settling time in still air

Particle size (µm)	Time required to settle 8 ft
100	8 secs
10	13 mins
1	19 hrs
0.1	79 days
0.01	Infinite

Source – ResearchGate

Larger particles are also easier to filter out by more common means of filtration such as standard HVAC filters. Superior Air works with other filtration systems to increase the chances of removing these pollutants. **Superior Air system's ionizer is making filtration more efficient**[12]**.**



Source – ResearchGate

Ions can last anywhere from seconds to minutes, so **installing ionizers in HVAC ducting does not provide the same benefit as it does when the ionizer is put into a unit that is closer to the subjects its benefits are provided to**. Additionally, incorrectly engineered ionizers can produce dangerous amounts of ozone. The Superior Air unit uses a **UL 2998 validated zero ozone emissions ionizer that has been tested to UL 867**[11]**.**

Useful Terminology

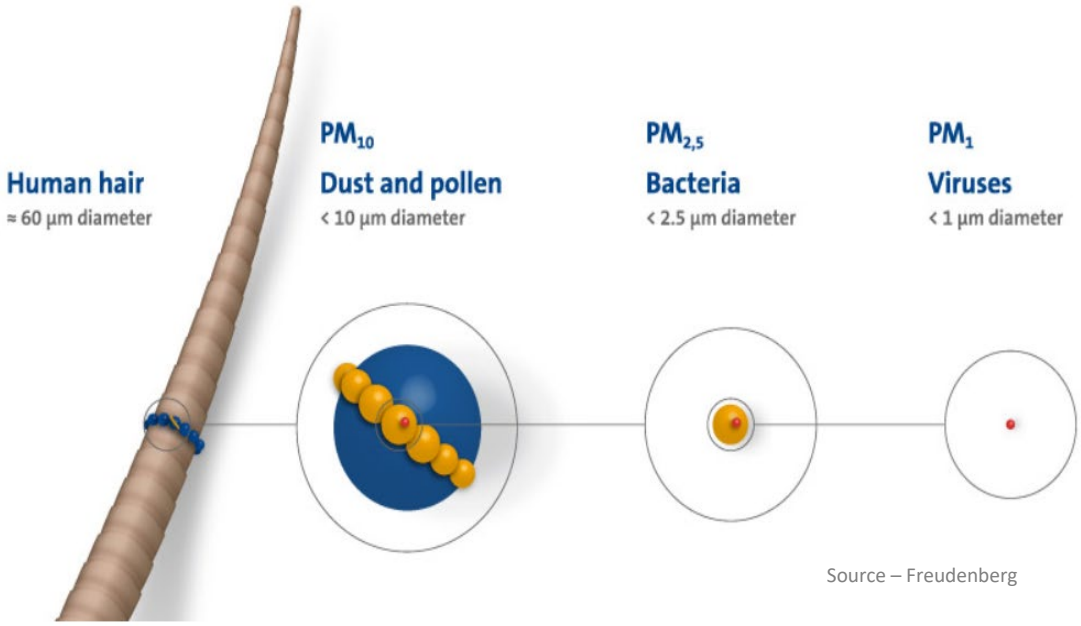
Air Changes Per Hour (ACH)

Air Circulation is measured in changes per hour. This term is used when evaluating complete air purification solutions. If used properly, filtration units are very effective in improving air quality, but the air must go through the filter. The more times it goes through the filter every hour, the better the air quality and the less risk posed by air pollutants. **Most standard HVAC systems only perform 2-3 ACH which means the air only turns over every 20-30 minutes[13]**. ASHRAE recommends a minimum of 6 ACH but suggests an **optimum range of 6-12 ACH to help prevent airborne infections.** No matter how effective an air purification system or HVAC system is set up to be, if it does not turn over the air in the ASHRAE recommended range, then it is not doing the job to the fullest extent. To calculate the ACH in a given area, measure out the length, width, and ceiling height of the space in feet. Then, find the HVAC system's airflow rate measured in CFM (cubic feet per minute). Multiply the length, height, and width of the space to get the total volume. Multiply the airflow rate by 60 and then divide it by total volume. The resulting number is the Air Changes Per Hour:

$$ACH = \frac{Air\ Flow\ Rate\ (CFM) * 60(\frac{min}{hr})}{Length\ (ft) * Width(ft) * Ceiling\ Height(ft)}$$

Micron

A micron or micrometer is **one-millionth of a meter** ($1*10^{-6}$ m or .000001 meters). It is extremely small and useful for measuring tiny particles. Below is a relative size representation of the particles we will be focusing on.



Source – Freudenberg

Purpose

The objective of the testing procedures is to refine, prove, and explore the benefits/results of the Superior Air purification system.

Approach/Set-Up

Key Measurement Metrics

Particle Count

Sizes - 0.3µm, 0.5µm, 0.7µm, 1µm, 2.5µm, 5µm, 10µm

Particle counts of various sizes in the ambient air depict data of the filtration efficiency achieved. A micron-level particle counter will be placed in the same environment the Superior Air unit will be placed. We will get a baseline of the data in the sizes listed above and record that data over 7 days. After the 7-day baseline test, we will then activate the Superior Air unit and record the particle count. Once we have both sets of data, we will compare the two data sets to analyze the results and findings. The principle of the particle count comparison is if we can measure a baseline of the number of particles per size then we have a refined view of the current air quality then comparing the data when the Superior Air unit was activated, we will be able to evaluate to what extent we have increased the air quality. The environment is in a metal manufacturing building with a high amount of indoor air pollutants and human traffic in and out that are working with paints, metals, plastics, and other various manufacturing materials. We chose this environment because it was an extreme indoor air composition to test the results, durability, universality, and functionality of the Superior Air unit.

Air Change Over Rate

Air Change Over as mentioned above is a very important metric to analyze because it determines the frequency at which you completely cycle through the air in the room. The quicker you cycle the air the less time microorganisms spend in the air possibly inflicting harm to people's health.

Single Pass Efficiency

Testing the particle distribution and count at the inlet and then at the outlet will show us the true before and after of the Superior Air Unit's efficiency and performance.

UV-C/UV-GI Intensity

UV-GI is a technology that uses short wave ultraviolet waves to inactivate viruses and other microorganisms by disrupting their DNA/RNA. It is important to make sure the intensity is to a level that is above the incidence energy of the specific microorganism in order to effectively inactive it. We will be measuring this in a multitude of places inside of the unit to simulate the path of a particle.

Thermal Imaging

UV-GI bulbs produce energy, some of which is in the form of heat. Heating and cooling are a large expense to many institutions with large indoor spaces that need to be climate controlled. Due to this, we wanted to make sure we are not adding significant costs to the user's HVAC operation. We will be taking pictures with a thermal imaging camera while the unit is running and will record the temperature change between the intake and discharge of the air stream.

Noise Level

Sound or acoustic attenuation is the process of diminishing the volume and quality of a sound wave. High levels of sound can be distracting and disruptive to various environments. In engineering the Superior Air unit, we kept the user's environment in mind and spent valuable time dampening and blocking much of the sound of the Superior Air unit. We will be taking a high precision decibel meter and measuring the volume in decibels of multiple parts of the unit to ensure it is not a bother to those around it while it promotes a healthier environment.

Particle Count Test

Length of Room: 62 ft

Width of Room: 20 ft

Ceiling Height: 10 ft

Total Volume: 12,400 ft^3

Air Changes per Hour: ~8.7

Suspected Air Composition: High Levels of Metal Dust, Plastic Dust, General Dust, Etc.

Air Flow Rate of Superior Air: 1800 CFM

Conditions of Service: Harsh/Extreme

Duration of Test: 7 Days

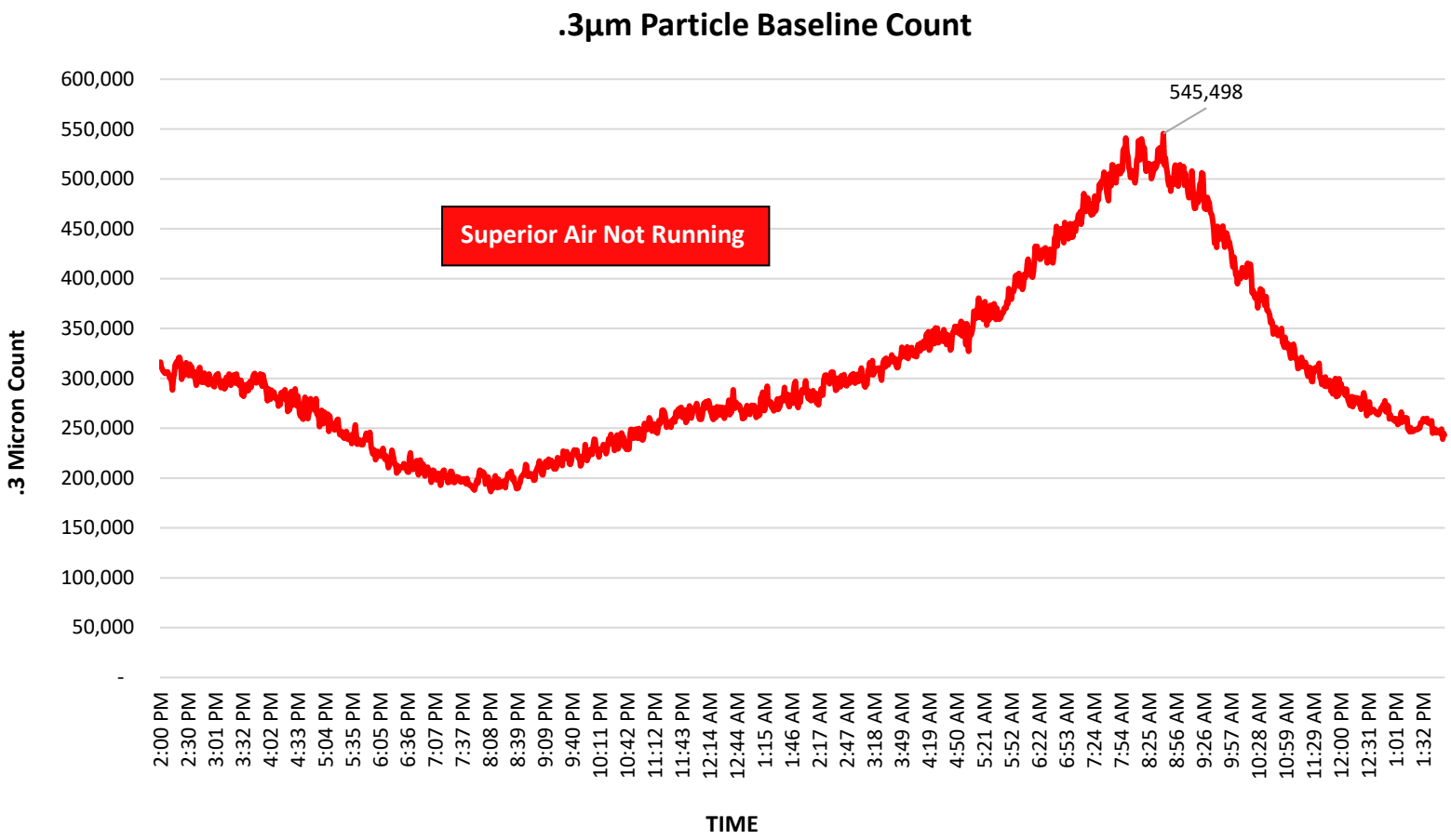
Data Evaluation: Average

Room Function: Training Room

Environment: Metal and Plastic Manufacturing Facility

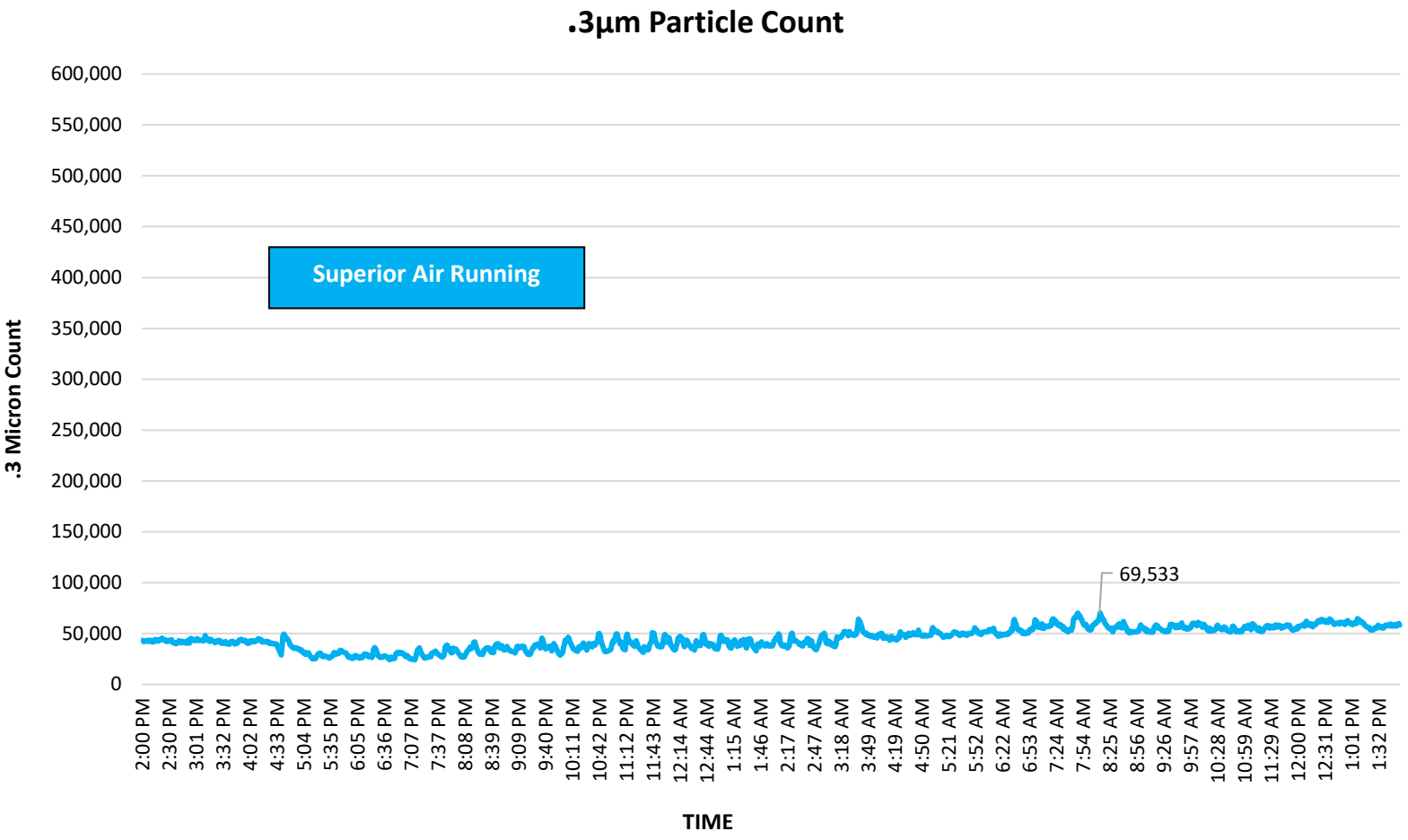
Max. Occupancy: 62 People

The set-up was comprised of a particle counter and the Superior Air unit. We placed a particle counter that measures .3µm to 10µm particles simultaneously in a training room for 7 days, recording in **sixty-second sampling rates** constantly for a **total of 168 hours**. We then took the data and averaged it on the same basis of time to create a more accurate representation of the particle distribution and count. The first time we recorded this data the **Superior Air unit was not in the room or powered on.**



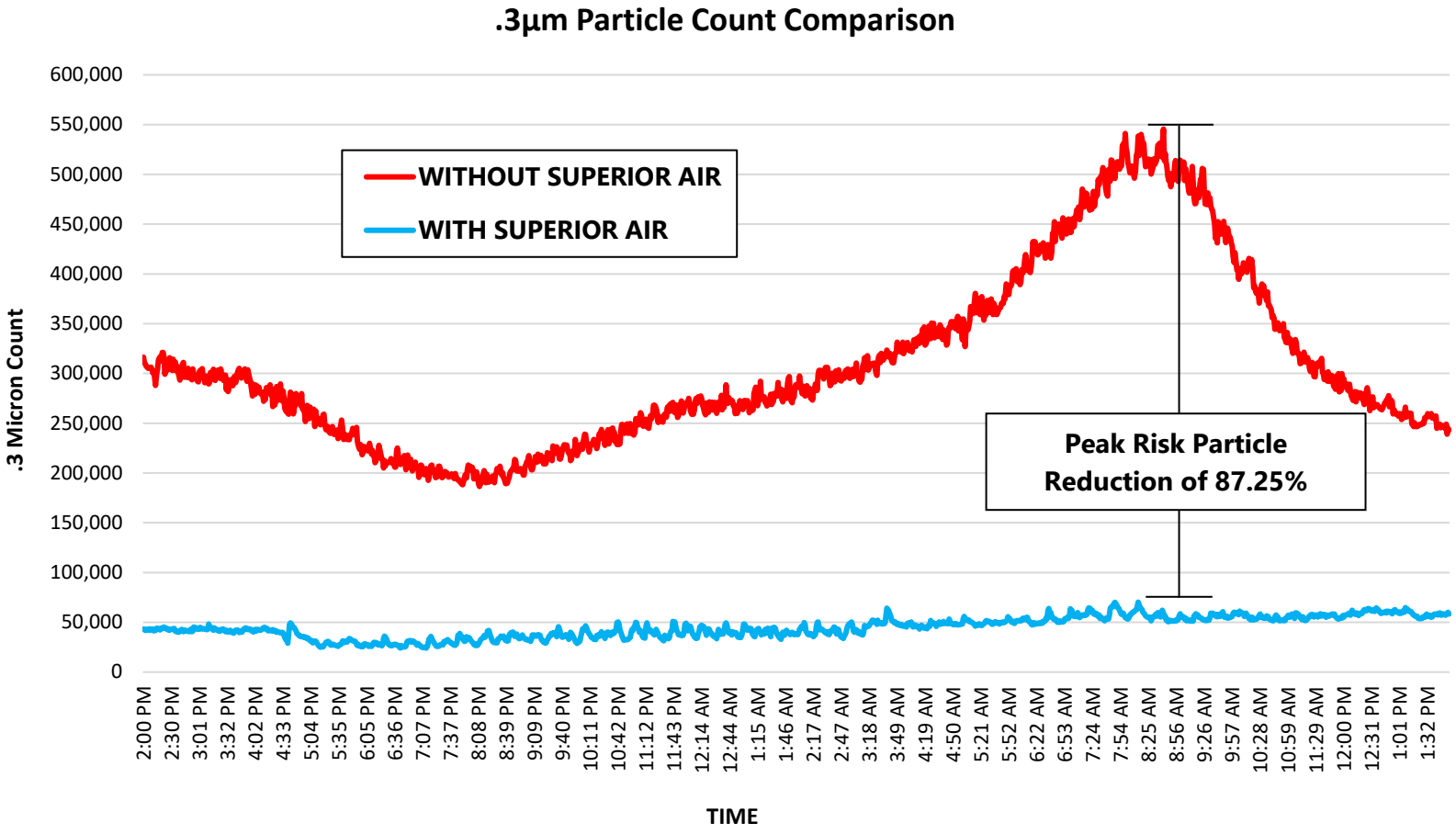
The data shows a **peak value of 545,498 .3µm particles** in the room around 8:30 AM. We also see a **high variability of particle counts** which suggests that **employee traffic in the area has a considerable influence on the indoor air quality of the environment**. Variability in the particle count is a metric we will be looking at because the goal is to reduce the effects higher traffic has on the safety and health of people in the space. The **Standard Deviation of the data is 88,508**, we will be comparing this to the same test with the Superior Air Unit powered on.

After establishing our base conditions, we turned the Superior Air unit on and observed the benefits. The conditions of the test were established the same way they were before. The only variable was powering on the Superior Air unit.



The data shows a **peak value of 69,533 .3µm particles** in the room around 8:20 AM. **The Standard Deviation of the data is 10,379. With the Superior Air unit on we have produced a flatter more stable particle count implying a low variability in risk influenced by employee traffic.**

Overlaying the datasets shows us a straightforward way to compare the two.



In analyzing the two data sets the standard deviation of the data was reduced immensely. This corresponds to a **reduction of risk volatility by 88.27%.** Additionally, the data reveals that the overall **average reduction of particles by 85.41%. During peak times the maximum particle count was cut by 87.25%.**

Even Under Extreme Conditions Superior Air Provides Undeniable Results

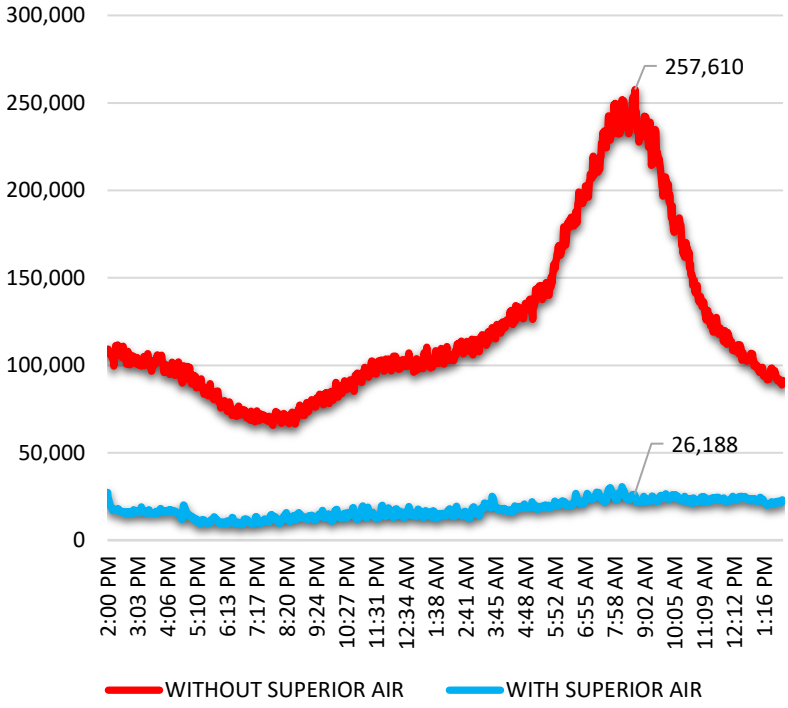
85.41% Average Reduction of .3µm Particles

87.25% Average Peak Risk .3µm Particle Reduction of

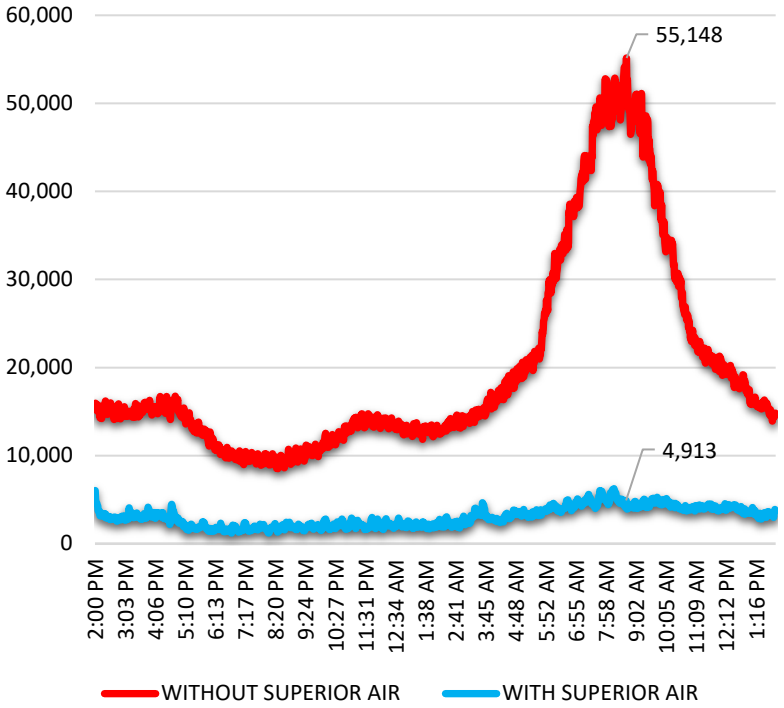
88.27% .3µm Drop in Risk Volatility

Our focus has been on .3µm up to this point because .3µm is the hardest particle diameter to filter out. **Now we will look at the data on the remaining sizes of particle diameters (0.5µm, 0.7µm, 1µm, 2.5µm, 5µm, 10µm).**

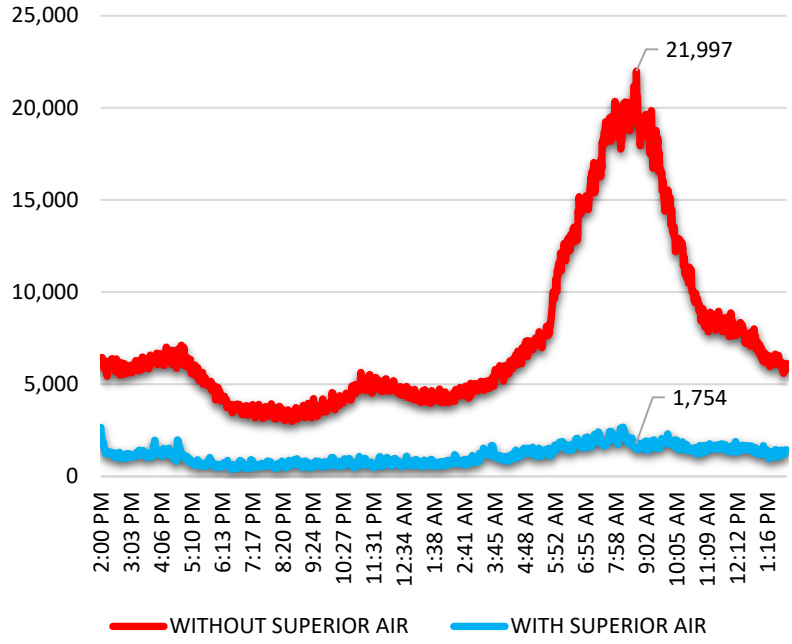
.5 MICRON



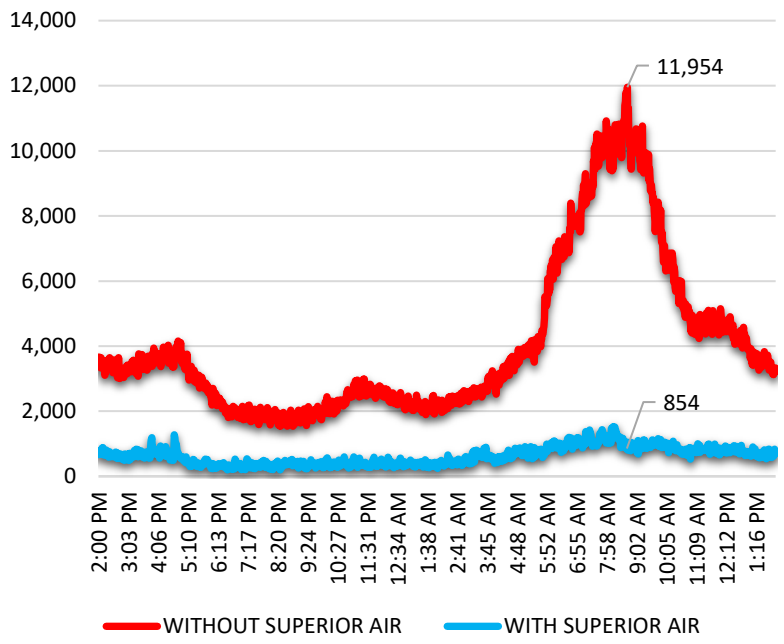
.7 MICRON

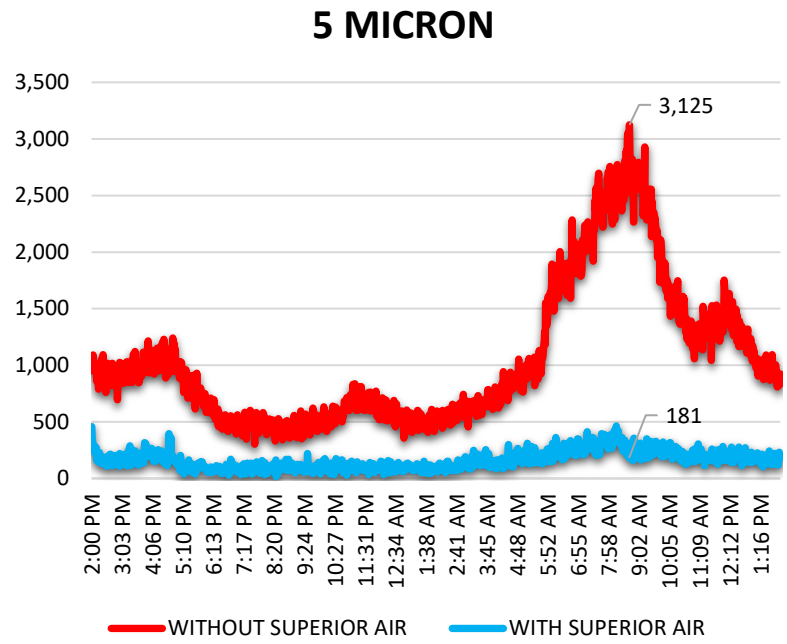


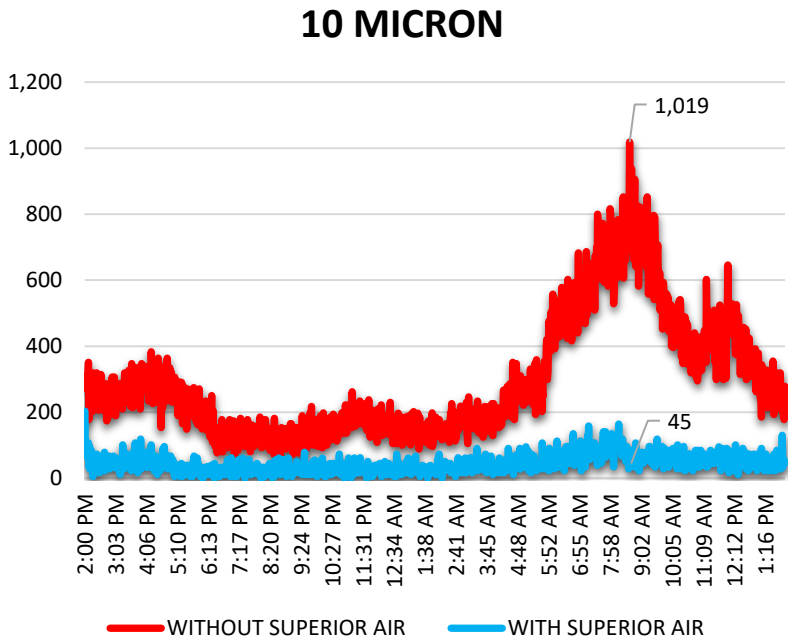
1 MICRON



2.5 MICRON







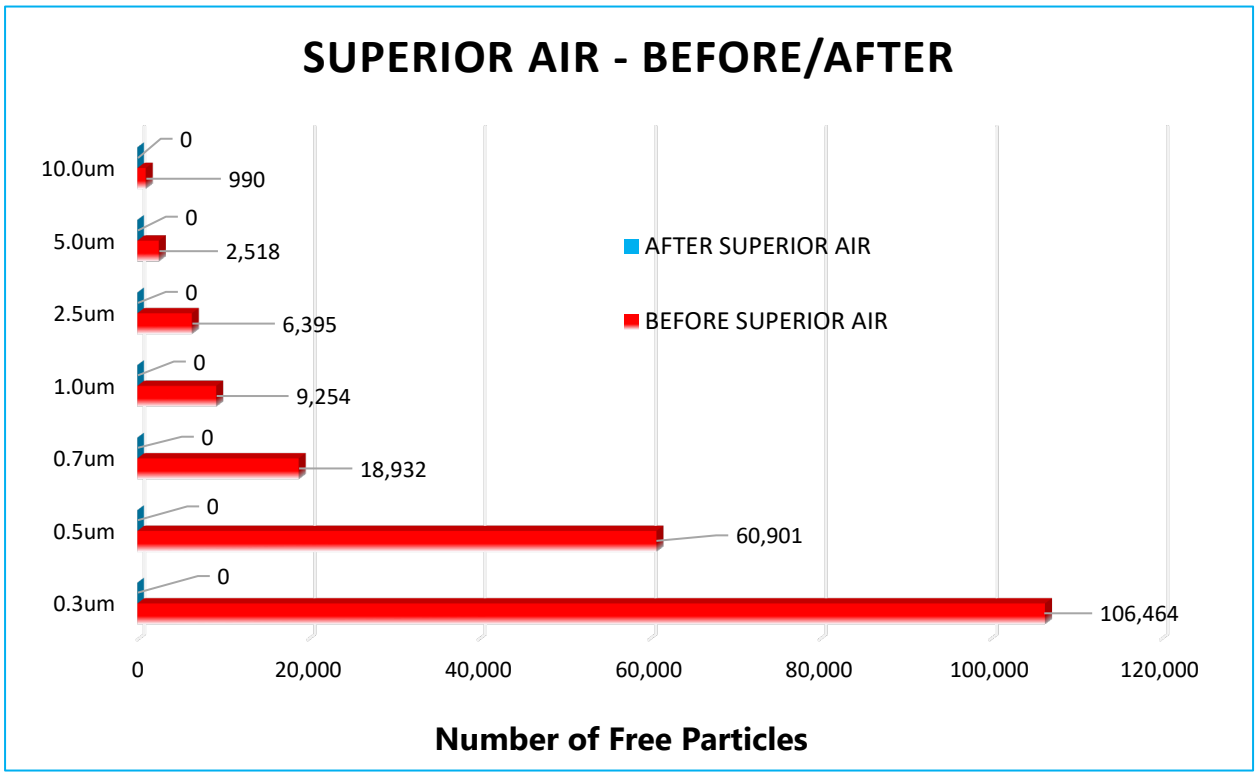
The data clearly shows a large reduction in particles, regardless of size. Additionally, we can see in our particle distribution data that the **Bi-Polar ionizer is utilizing its agglomeration benefit to create larger less harmful pollutants in the air**. The agglomerated pollutants are **easier to filter out and are less effective in entering the lungs**. Particles **over 10µm can not be generally inhalable**[15], which points to why an ionizer is a crucial piece to making sure we are producing larger and larger particles to **reduce their impact on our health**.

Particle Count Test – Data Summary

Particle Diameter (Microns)	*AVG REDUCTION %*	*REDUCTION % @ PEAK*
0.3	**85.41%**	**87.25%**
0.5	**85.41%**	**89.83%**
0.7	**84.70%**	**91.09%**
1	**84.61%**	**92.03%**
2.5	**84.47%**	**92.86%**
5	**84.56%**	**94.21%**
10	**84.72%**	**95.58%**

Single Pass Efficiency Test

The single-pass efficiency test is a verification of the performance of how well the Superior Air unit removes particles that pass through the unit. We tested the air at the inlet before the Superior Air filtration process occurs and then tested the air particle distribution afterward.



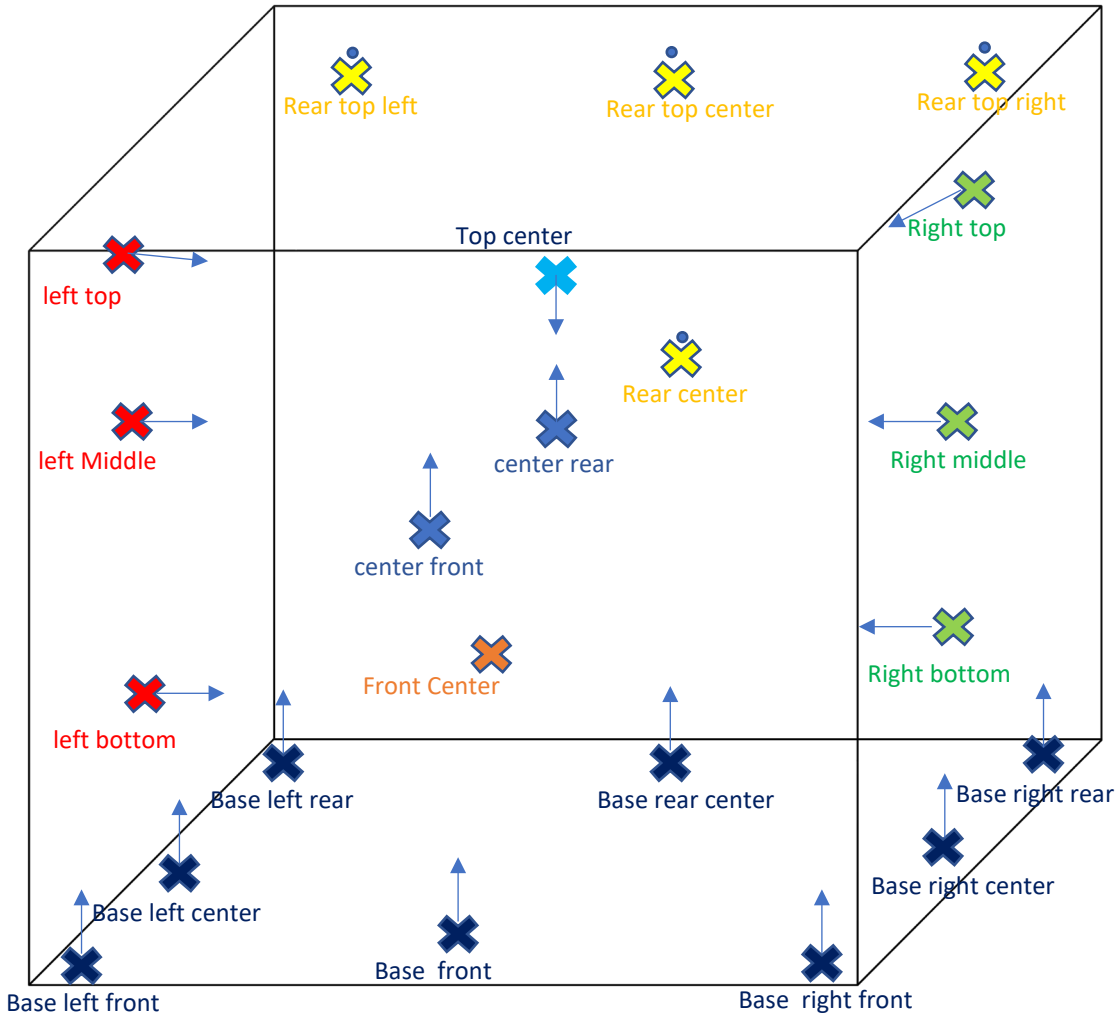
As you can see the results were astonishing! The **Superior Air system removed all traces of .3 µm - 10 µm particles that the particle counter can measure.**

100% Single Pass Removal of .3-10 µm Particles

Particle Diameter (Microns)	*SINGLE-PASS REDUCTION %*
0.3	*100.00%*
0.5	*100.00%*
0.7	*100.00%*
1	*100.00%*
2.5	*100.00%*
5	*100.00%*
10	*100.00%*

UV-GI/UV-C Test

To measure the effectiveness and the average amount of Ultraviolet Germicidal Irradiation a particle could see on average, we took measurements all over the inactivation compartment in the following spots:



After we obtained the measurements of Ultraviolet Irradiation (254nm) at each location, we needed to determine the contact time to estimate the dose of UVGI the pathogen/virus/microorganism would receive. The results are below, which shows that **one pass** of air through the Superior Air unit will **not only satisfy but exceed ASHRAE's recommendation of 1500 µJ/cm² to inactivate 99% of SARS-CoV-2[5].**

Anticipated Path	***Est. UVGI Dose (µW/cm^2)***
Lowest Exposure Path	2,374.32
Medium Exposure Path	2,644.43
Highest Exposure Path	2,916.77
Average	**2,645.18**

Thermal Imaging

Using a **high-precision advanced thermal imaging camera**, we were able to capture pictures of the Superior Air unit while in operation to prove there is not a significant amount of heat added to the ambient air to cause perceivable added cooling costs.

Ambient Air Intake

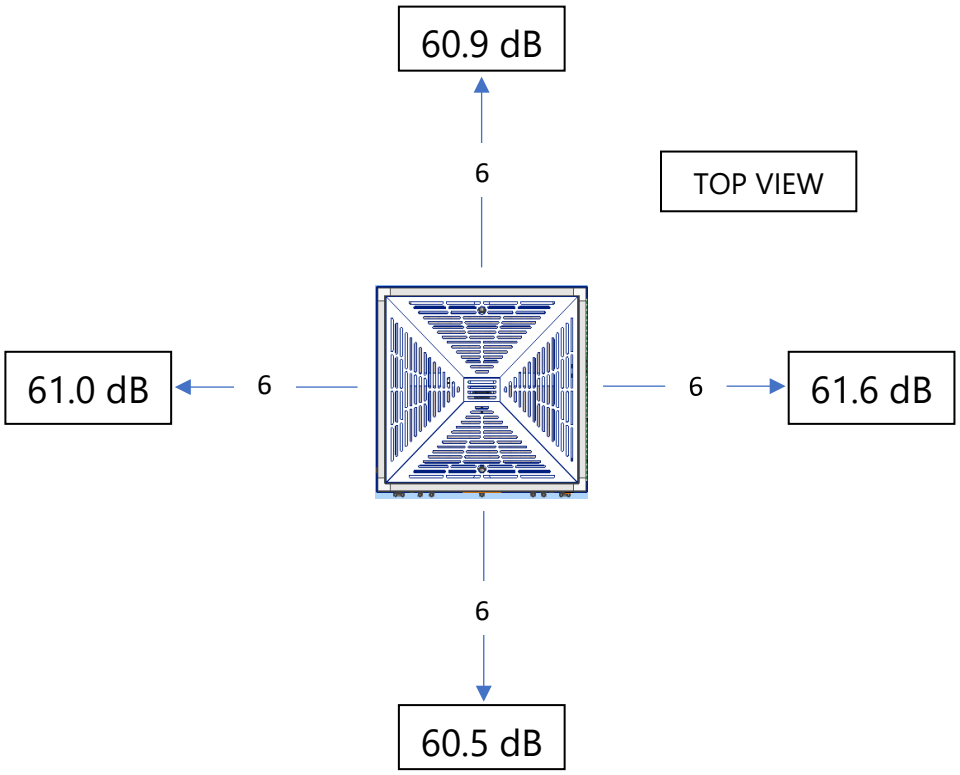
Clean Air Outlet

The thermal imaging pictures show that there was **only a .6 °F difference between the intake and outlet.**, The picture also shows the comparison between a TV and the Superior Air unit and found that the **TV imparts a higher amount of heat to the environment than the Superior Air system.**

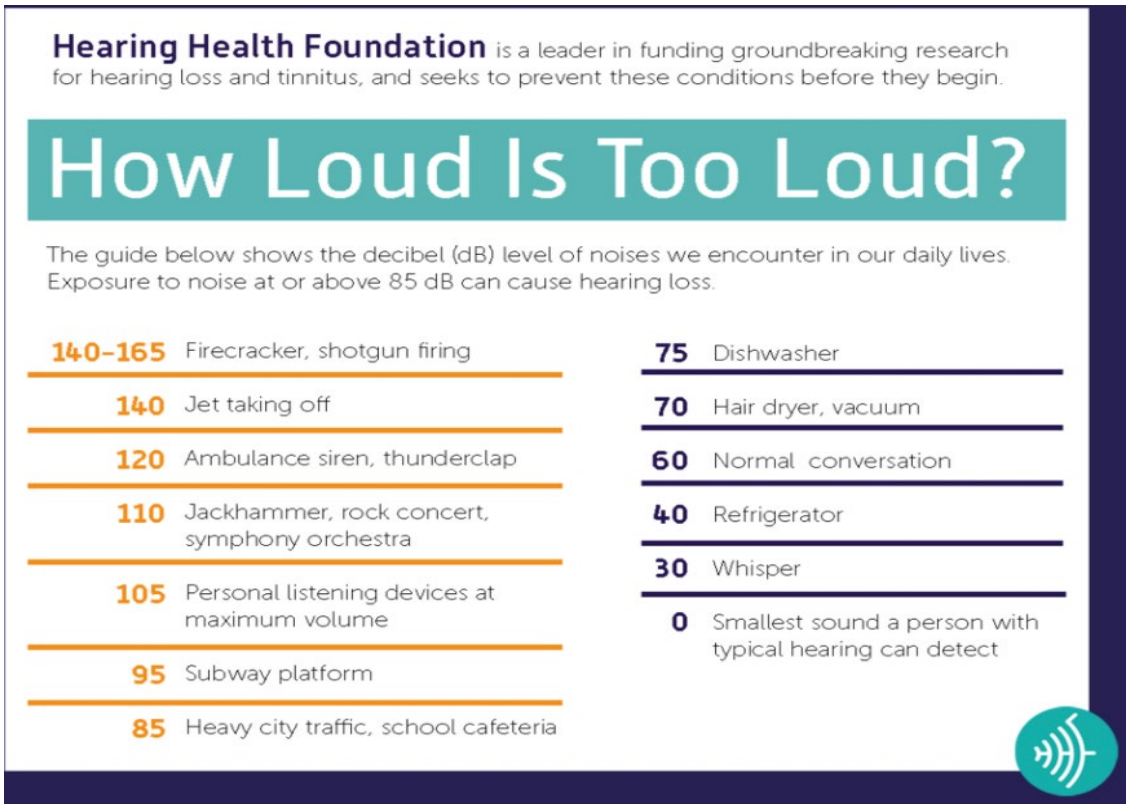
Only a .6 °F difference
between the intake and outlet

Noise Test

We moved 6' away from the purifier in all directions and took an average decibel reading of 5 minutes at each location to produce a noise profile. Our findings are below:



*As the data shows, the Superior Air unit is **equivalent to normal conversation volume** which will **not be disruptive** in office, school, or hospital settings.*



To find additional information about the Superior Air unit, its benefits to your air quality, engineering approach, application guidance, or general questions please reach out to:

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Jim Carter

Works Cited

1. CDC. (2020, March 28). *COVID Data Tracker*. Centers for Disease Control and Prevention. https://covid.cdc.gov/covid-data-tracker/#trends_totaldeaths
2. CEMBALEST, M. C. (2021, October 20). *Help Wanted | J.P. Morgan Private Bank*. JP Morgan. Retrieved November 20, 2021, from https://privatebank.jpmorgan.com/gl/en/insights/investing/eotm/help-wanted
3. *FRED Economic Data*. (2021, November 16). Federal Reserve Economic Data. https://fred.stlouisfed.org/series/MRTSSM7225USN#0
4. *CDC. (2020). COVID-19 employer information for office buildings. Centers for Disease Control and Prevention. Retrieved from cdc.gov/coronavirus/2019-ncov/community/office-buildings.html*
5. *Details on the UV Dose Recommendation for SARS-CoV-2*. (n.d.). Details on the UV Dose Recommendation for SARS-CoV-2. Retrieved November 24, 2021, from https://www.ashrae.org/technical-resources/filtration-disinfection
6. National Air Filtration Association. (2021, January 28). *Understanding MERV | NAFA User's Guide to ANSI/ASHRAE 52.2*. https://www.nafahq.org/understanding-merv-nafa-users-guide-to-ansi-ashrae-52-2/
7. *HEPA DETAILS*. (n.d.). Wikiwand. Retrieved November 24, 2021, from https://www.wikiwand.com/en/HEPA
8. *Debunking Myths About MERV, Air Filtration | ashrae.org*. (n.d.). Web Starter Kit. Retrieved November 24, 2021, from https://www.ashrae.org/news/ashraejournal/debunking-myths-about-merv-air-filtration

9. Robertson, P. (2021, March 10). *What Are HEPA Filters and How Do They Work?* Smart Air. https://smartairfilters.com/en/blog/what-is-hepa-filter-how-hepa-air-filter-work/
10. Dr. Philip M. Tierno Jr., Professor of Microbiology and Pathology, New York University School of Medicine. (2017, April). *Cleaning Indoor Air Using Bi-Polar Ionization Technology*. Ciright.Com. Retrieved November 24, 2021, from https://ciright.com/wp-content/uploads/2020/06/Cleaning-Indoor-Air-Using-Bi-Polar-Ionization-Technology_Dr.-PhilTierno_NYU-SchoolMedicine_2017.pdf
11. *Plasma Air: Technology*. (n.d.). PlasmaAir. Retrieved November 24, 2021, from https://www.plasma-air.com/how-it-works
12. Saif-Aldin, Khaled. (2020). Re: What is the difference between aggregation and agglomeration?. Retrieved from: https://www.researchgate.net/post/What_is_the_difference_between_aggregation_and_agglomeration/5e695e34ad0e8953e1590b81/citation/download.
13. Robertson, P. (2021b, November 16). *ASHRAE Recommended Air Changes Per Hour*. Smart Air. https://smartairfilters.com/en/blog/ashrae-air-changes-per-hour-office-residential/
14. Utrup, Linda J, and Allan Frey. "Table 1 . Characteristics of Aerosols and Particle Settling Time in..." ResearchGate, 10 Dec. 2020, https://www.researchgate.net/figure/Characteristics-of-Aerosols-and-Particle-Settling-Time-in-Still-Air_tbl1_8655608.
15. *How Do Particulates Enter the Respiratory System? : OSH Answers*. (n.d.). Canadian Center of Occupational Health and Safety. Retrieved December 7, 2021, from https://www.ccohs.ca/oshanswers/chemicals/how_do.html