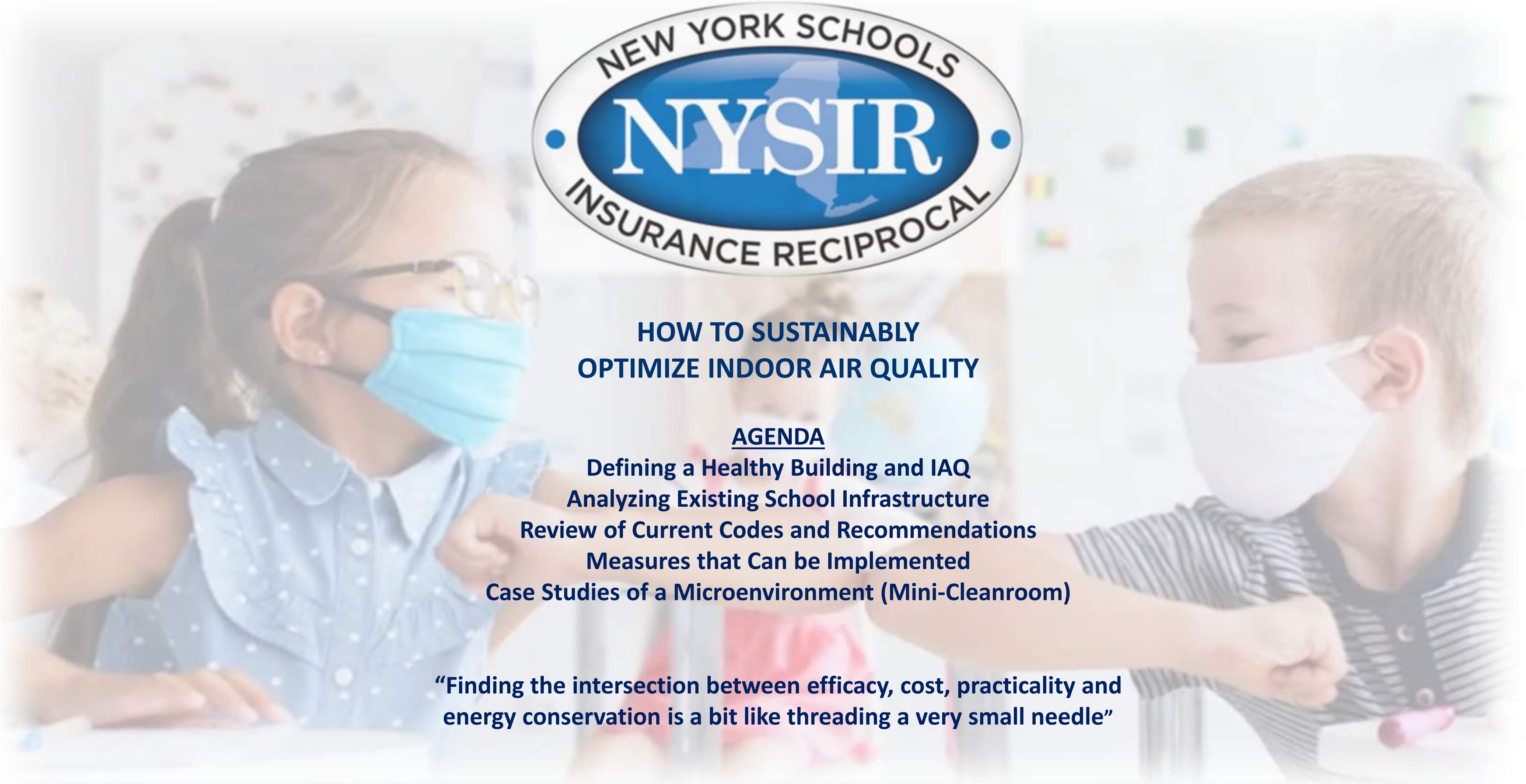


NEW YORK SCHOOLS
NYSIR
INSURANCE RECIPROCAL

HOW TO SUSTAINABLY OPTIMIZE INDOOR AIR QUALITY

<u>AGENDA</u>

Defining a Healthy Building and IAQ
Analyzing Existing School Infrastructure
Review of Current Codes and Recommendations
Measures that Can be Implemented
Case Studies of a Microenvironment (Mini-Cleanroom)

“Finding the intersection between efficacy, cost, practicality and energy conservation is a bit like threading a very small needle”

<u>Speaker Today</u>
Andy Weidert
Vice President of Business Development
Stark Tech

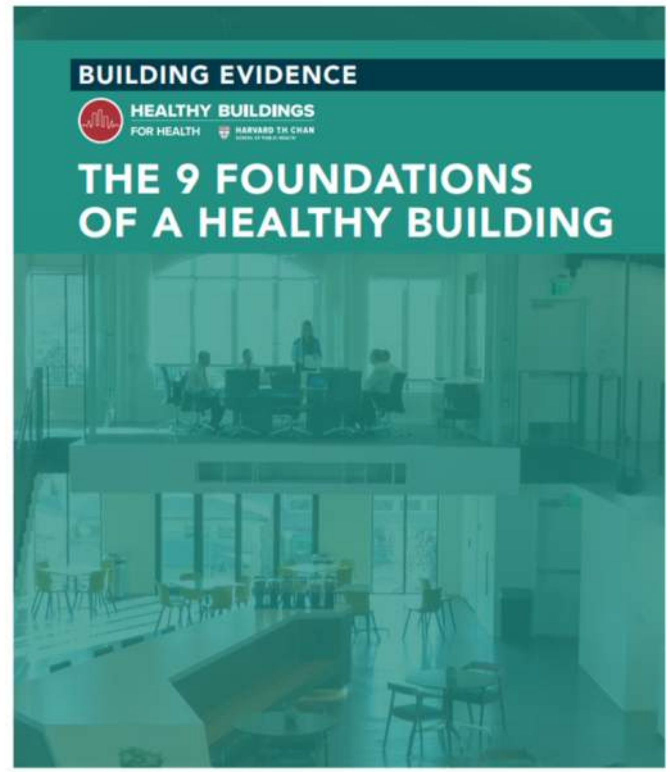
20 Years Designing & Implementing
Mission Critical HVAC Solutions

Idea of a Healthy Building

Harvard School of Public Health
The 9 Foundations of a Healthy Building

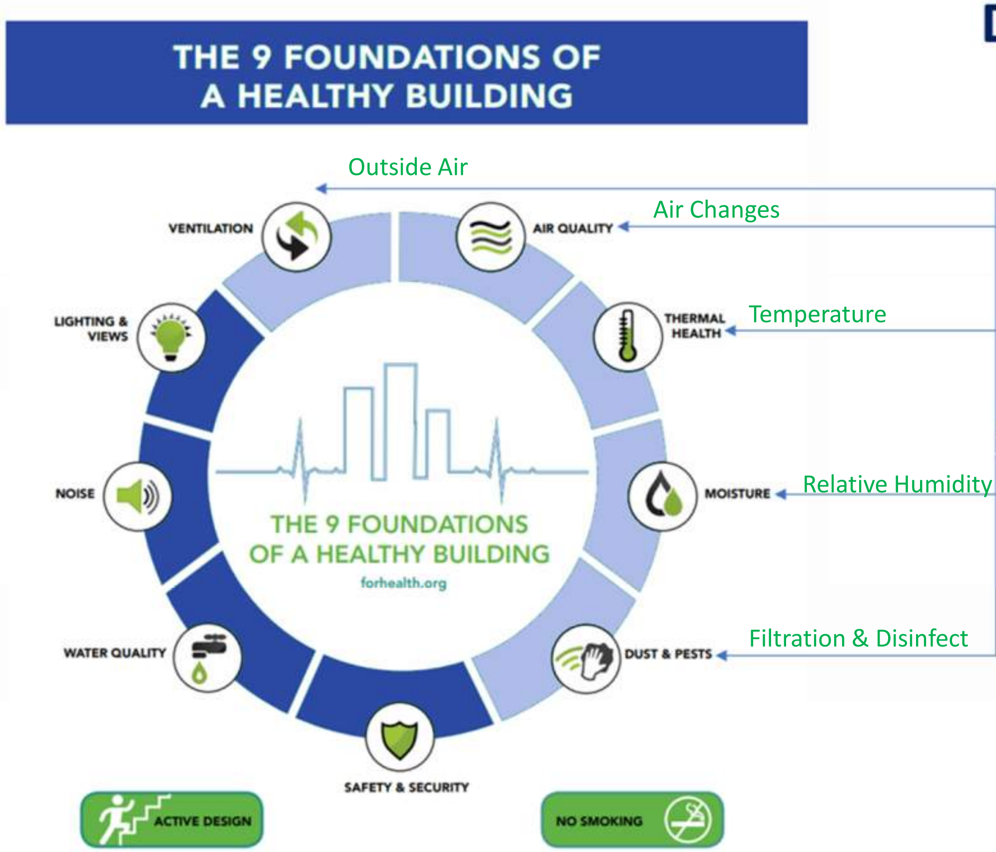
Established in 2017

The idea for the "The 9 Foundations of a Healthy Building" arose from many interactions over the past several years with real estate professionals, building owners, hospital administrators, facilities directors, homeowners, and academic colleagues. Two things stood out. First, during these discussions, we would often say, "The idea of a healthy building has been made too complicated. We know how to make buildings healthy. There are a few simple foundations." This of course led to requests to name the foundations of a healthy building. In the ensuing discussion and debate we realized that we, the public health community, have failed to translate our research into actionable information; the richness of the public health literature was invisible to key decision-makers. Second, in these presentations and meetings we would often hear some variation of the refrain, "Your research is very interesting, but I can't take a scientific paper into my meeting on Monday and convince a building owner or manager to do things differently. I need a short summary." Thus, the 9 Foundations project was born.



Defining a Healthy Building

HEALTHY BUILDINGS FOR HEALTH
HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH



Indoor Air Quality

Is directly Associated with 5 out 9 Foundations of a Healthy Building

*Significantly Improve IAQ
*Increase Attendance
*Greater Productivity
*Better Performance
*Improve Morale
*Boost Collaboration
*Support Mental Health

World Health Organization

Air pollution is the greatest environmental threat to human health

- 7 Million people died prematurely from illnesses attributable to air pollution in 2016
  - 9 out of 10 people worldwide do not breathe safe air
- Head of WHO, Dr. Tedros Adhanm Ghebreyesus, calls air pollution the “new tobacco” (2018)

Why is Indoor Air Quality (IAQ) so Important?

Average Student from Kindergarten to High School Graduation will spend over 15,000 HRS in a classroom

Close to 1/3 of the United States Population resides in an Educational Facility during a school Day.

1 in 13 Americans suffer from Asthma with an associated annual economic impact of 82 Billion

Studies suggest up to 65% of Asthma cases in school aged children could be prevented with proper IAQ in school and at home

AVERAGE AMERICAN SPENDS CLOSE TO 90% INDOORS

- 68.7% In a Residence
- 12.8% Other Indoor Locations
- 5.4% Office/Factory
- 7.6% Outdoors
- 5.5% In a Vehicle

REVIEW OF EXISTING SCHOOL INFRASTRUCTURE

53% OF PUBLIC-SCHOOL DISTRICTS NEEDED TO "UPDATE OR REPLACE MULTIPLE BUILDING SYSTEMS OR FEATURES" IN THEIR SCHOOLS

45% OF DISTRICTS NEEDED TO RENEW OR UPGRADE HVAC SYSTEMS IN AT LEAST ½ OF THEIR SCHOOLS, REPRESENTING AN ESTIMATED 36,000 SCHOOLS NATIONWIDE

OVER 30% OF BUILDING SYSTEMS FOR HVAC, VENTILATION & FILTRATION SYSTEMS ARE IN FAIR OR POOR CONDITION

The United States allocates 11.6% of public funding toward education, well below the International standard 15.00%

United States Environmental Protection Agency

How well can our Schools HVAC Infrastructure Provide INDOOR AIR QUALITY

BUILDING FOR HEALTH — HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH — HEALTHY BUILDINGS

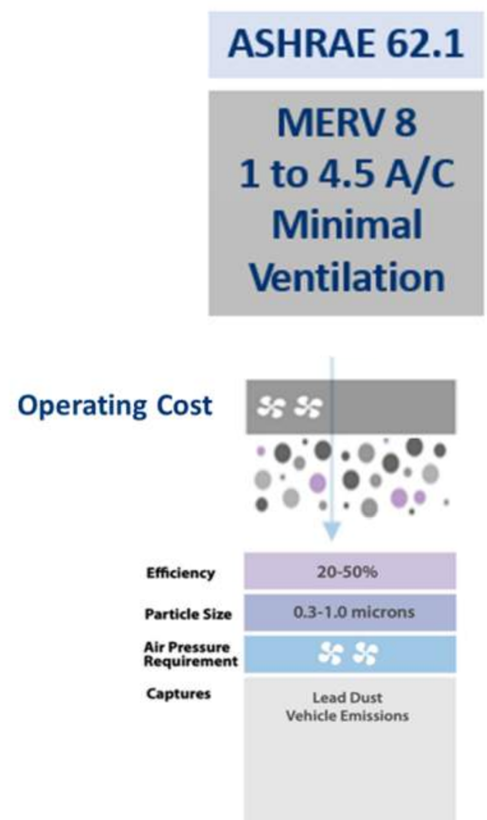
VENTILATION	FILTRATION	AIR QUALITY
OUTSIDE AIR	**FILTRATION**	**AIR CHANGES**
AVERAGE SCHOOL ACHIEVES **1.5 AIR CHANGES PER HOUR** WHICH IS A MINIMUM STANDARD DESIGNED TO PROVIDE MERELY "ACCEPTABLE IAQ"	MAJORITY OF HVAC SYSTEMS WERE DESIGNED TO HAVE **MERV 8 FILTERS**. THIS LEVEL OF FILTRATION IS **NOT** EFFECTIVE FOR CAPTURING BACTERIA OR VIRUS CARRIERS. MINIMAL LEVEL OF FILTRATION IN THE HVAC WORLD	MAJORITY OF CLASSROOMS TOTAL AIR CHANGES PER HOUR FALLS IN THE **LOW TO BARE MINIMUM TARGET**

Ideal (6 ACH)
Excellent (5-6 ACH)
Good (4-5 ACH)
Bare minimum (3-4 ACH)
Low (<3 ACH)

$$\text{Air changes per hour} = \frac{\text{"clean" air rate}}{\text{room volume}} = \frac{\text{cubic feet per minute} * 60 \text{ minutes}}{\text{length} * \text{width} * \text{height (in feet)}}$$

6 Air Changes an Hour is Ideal

SUMMARY OF STANDARDS AND CODES
FOR
ASHRAE PRIOR TO THE EPIDEMIC



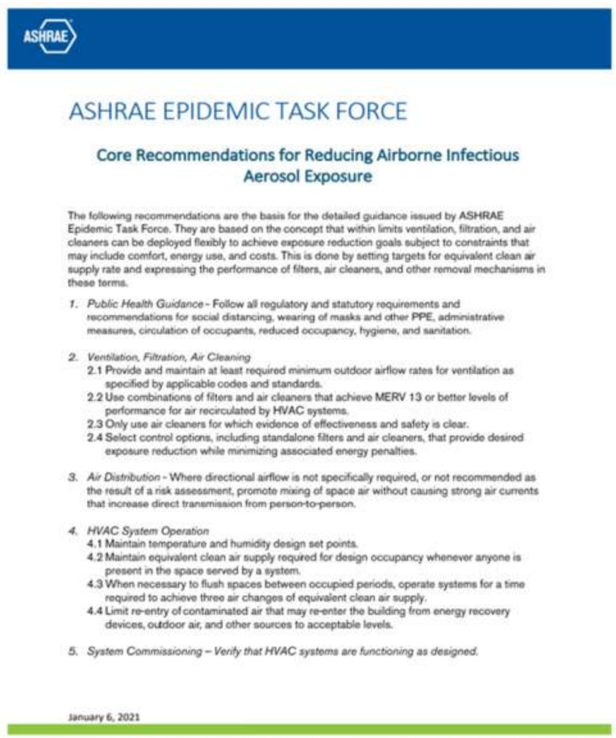
Designer Guidelines – General
Maintain Temperature & Humidity
Winter: 72 F/40-50% RH / Summer: 75 F/50-60% RH

CURRENT SUMMARY OF GUIDANCE AND CODES
ASHRAE, CDC, NYS DOH, NYSED

Health and Safety Guide for the 2021-2022 School Year

New York State Education Department

August 2021



ASHRAE

ASHRAE EPIDEMIC TASK FORCE

Core Recommendations for Reducing Airborne Infectious Aerosol Exposure

The following recommendations are the basis for the detailed guidance issued by ASHRAE Epidemic Task Force. They are based on the concept that within limits ventilation, filtration, and air cleaners can be deployed flexibly to achieve exposure reduction goals subject to constraints that may include comfort, energy use, and costs. This is done by setting targets for equivalent clean air supply rate and expressing the performance of filters, air cleaners, and other removal mechanisms in these terms.

1. *Public Health Guidance* - Follow all regulatory and statutory requirements and recommendations for social distancing, wearing of masks and other PPE, administrative measures, circulation of occupants, reduced occupancy, hygiene, and sanitation.

2. *Ventilation, Filtration, Air Cleaning*
   - 2.1 Provide and maintain at least required minimum outdoor airflow rates for ventilation as specified by applicable codes and standards.
   - 2.2 Use combinations of filters and air cleaners that achieve MERV 13 or better levels of performance for air recirculated by HVAC systems.
   - 2.3 Only use air cleaners for which evidence of effectiveness and safety is clear.
   - 2.4 Select control options, including standalone filters and air cleaners, that provide desired exposure reduction while minimizing associated energy penalties.

3. *Air Distribution* - Where directional airflow is not specifically required, or not recommended as the result of a risk assessment, promote mixing of space air without causing strong air currents that increase direct transmission from person-to-person.

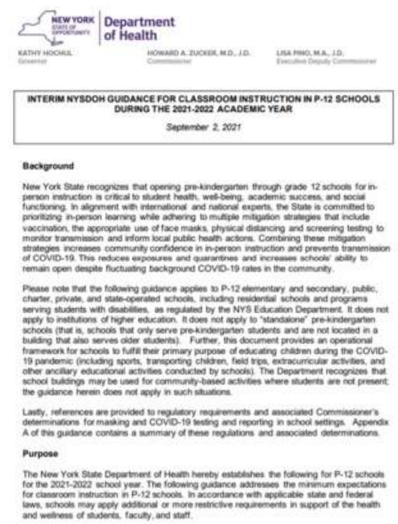
4. *HVAC System Operation*
   - 4.1 Maintain temperature and humidity design set points.
   - 4.2 Maintain equivalent clean air supply required for design occupancy whenever anyone is present in the space served by a system.
   - 4.3 When necessary to flush spaces between occupied periods, operate systems for a time required to achieve three air changes of equivalent clean air supply.
   - 4.4 Limit re-entry of contaminated air that may re-enter the building from energy recovery devices, outdoor air, and other sources to acceptable levels.

5. *System Commissioning – Verify that HVAC systems are functioning as designed.*

January 6, 2021

ASHRAE EPIDEMIC TASK FORCE JAN 6, 2021

CDC GUIDANCE ON REOPENING SCHOOLS



NEW YORK STATE OF OPPORTUNITY | Department of Health

KATHY HOCHUL, Governor — HOWARD A. ZUCKER, M.D., J.D., Commissioner — LISA PINO, M.A., J.D., Executive Deputy Commissioner

INTERIM NYSDOH GUIDANCE FOR CLASSROOM INSTRUCTION IN P-12 SCHOOLS DURING THE 2021-2022 ACADEMIC YEAR

September 2, 2021

Background

New York State recognizes that opening pre-kindergarten through grade 12 schools for in-person instruction is critical to student health, well-being, academic success, and social functioning. In alignment with international and national experts, the State is committed to prioritizing in-person learning while adhering to multiple mitigation strategies that include vaccination, the appropriate use of face masks, physical distancing and screening testing to monitor transmission and inform local public health actions. Combining these mitigation strategies increases community confidence in in-person instruction and prevents transmission of COVID-19. This reduces exposures and quarantines and increases schools' ability to remain open despite fluctuating background COVID-19 rates in the community.

Please note that the following guidance applies to P-12 elementary and secondary, public, charter, private, and state-operated schools, including residential schools and programs serving students with disabilities, as regulated by the NYS Education Department. It does not apply to institutions of higher education. It does not apply to "standalone" pre-kindergarten schools (that is, schools that only serve pre-kindergarten students and are not located in a building that also serves older students). Further, this document provides an operational framework for schools to fulfill their primary purpose of educating children during the COVID-19 pandemic (including sports, transporting children, field trips, extracurricular activities, and other ancillary educational activities conducted by schools). The Department recognizes that school buildings may be used for community-based activities where students are not present; the guidance herein does not apply in such situations.

Lastly, references are provided to regulatory requirements and associated Commissioner's determinations for masking and COVID-19 testing and reporting in school settings. Appendix A of this guidance contains a summary of these regulations and associated determinations.

Purpose

The New York State Department of Health hereby establishes the following for P-12 schools for the 2021-2022 school year. The following guidance addresses the minimum expectations for classroom instruction in P-12 schools. In accordance with applicable state and federal laws, schools may apply additional or more restrictive requirements in support of the health and wellness of students, faculty, and staff.

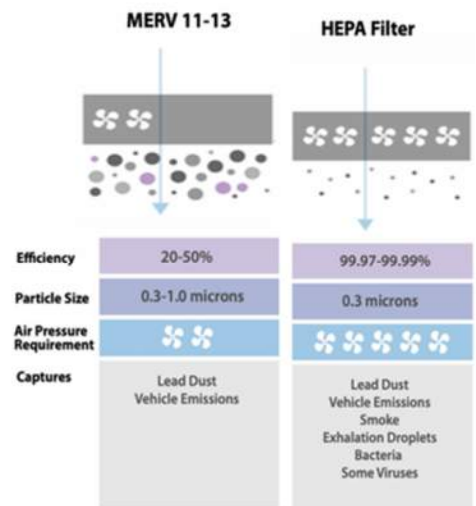
INTERIM NYSDOH GUIDANCE FOR CLASSROOM
SEPTEMBER 2, 2021

CURRENT SUMMARY OF GUIDANCE AND CODES ASHRAE, CDC, NYS DOH, NYSED

- Use Combination of Filters and Air Cleaners that achieve MERV 13 or Better
- Maximize Ventilation / Disable any demand control ventilation
- Increase Air Changes and Keep systems running longer on school days, 24/7 if possible
- Designer Guidelines – General
  Maintain Temperature & Humidity
  Winter: 72 F/40-50% RH / Summer: 75 F/50-60% RH
- Recommended "Flush Cycle"
  Between Occupied Periods
  3 A/C of Clean Air Supply
- Units that feature ionizers, precipitators, or ozone generators do not help and can generate harmful byproducts.
- 3rd Party Validated data on removal efficacy and safety. Documentation and Testing to CARB and UL is essential.

CURRENT

MERV 13 or Better
+ Portable HEPA
Optimize A/C
Maximize Ventilation
Flush Period



IMPLEMENTED INDOOR AIR QUALITY SCORECARD

Preparation in the Pandemic:
How Schools Implemented Air Quality Measures to Protect Occupants from COVID-19

ANNIE HOANG
Research Associate, The Center for Green Schools
MPH Candidate, Harvard TH Chan School of Public Health
MD Candidate, University of California – San Francisco School of Medicine (UCSF)

ANISA HEMING
Director, The Center for Green Schools

ASHRAE THE CENTER FOR GREEN SCHOOLS

Executive Summary

Upgrade to higher grade MERV filters
- Schools not designed to support this strategy
- High cost
- Lack of availability of filters

Air cleaners with HEPA Filters
- High Cost

Increase outdoor air system via HVAC system
- Schools not designed to support this strategy

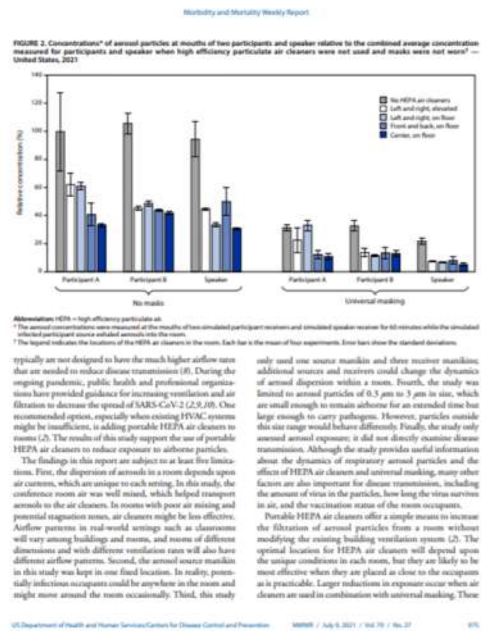
Open windows
- Climate and weather challenges
- Schools not designed to support this strategy

Use fans in doors and windows to increase exhaust
- Climate and weather challenges
- Not a priority of school district leaders
- School not designed to support this strategy

Pre/post-occupancy flushing
- School not designed to support this strategy

We found that school districts relied heavily on their mechanical systems to implement air quality measures. Using mechanical ventilation to increase fresh air was most commonly adopted by schools, followed by filtration measures to remove airborne contaminants from recirculated air. The most frequently cited challenge to implementing protective air quality measures at schools was that school buildings were not designed to support the strategies that were being recommended.

CDC RESPONSE



July 9 2021, CDC Document Efficacy of Portable Air Cleaners and Masking

July 15 2021, CDC Webinar on Returning to Schools

Ventilation

- Improving ventilation reduces the number of virus particles in the air.
- Bringing fresh outdoor air into a building helps keep virus particles from concentrating inside:
  - Open multiple doors and windows.
  - Use child-safe fans to increase the effectiveness of open windows.
  - Make changes to the HVAC or air filtration systems.
- Funds provided through the Elementary and Secondary Schools Emergency Relief Programs and the Governors Emergency Education Relief Programs can support improvements to ventilation.

https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/ventilation.html

SERIES: Indoor Air Quality Fact Sheets

This overview introduces the series and provides important background information.

Series Overview

What is airborne transmission?

Strong evidence tells us that the dominant way that diseases like COVID-19 spread is through droplets and respiratory aerosols, which can float and travel, infecting people who inhale them at short and long distances from the infected person.

Indoor air quality and COVID-19:

To protect against COVID-19, schools have implemented many measures recommended by public health professionals: distancing, cohorts, masking, hand-washing, and vaccination. These are effective actions to reduce the spread of the virus, but they rely on human behavior and choice.

After studying viral transmission pathways, scientists are confident that people are less likely to get sick from COVID-19 and other respiratory pathogens when the air around them is refreshed continuously with clean air that is free from the virus. Investing in indoor air quality (IAQ) is a straightforward and non-controversial way to stop the spread of COVID-19.

Know your buildings: What systems do you have?

- **Window unit, radiator, or no space conditioning:** If a mechanical system is present, it is for temperature only and not ventilation (window unit or radiator). Where no mechanical system is present, windows and/or fans may be in use.
- **Unit ventilator or univent:** Located on an outside wall with a filter, fan, and coil capable of mixing outdoor air with recirculated air. Air is heated/cooled as it passes the coil.
- **Decentralized heating/cooling systems:** Heats or cools recirculated air and, in some but not all systems, outdoor air. Typically, it has a 1" filter rack. Includes heat pumps and fan coil units.
- **Central system (100% recirculation):** Serves multiple rooms and heats and cools recirculated air. Typically has a filter. Examples: AHU and RTU units.
- **Central system (recirculation + ventilation):** Serves multiple rooms and mixes outside air with recirculated air while heating and cooling. Typically has a filter. Examples: AHU and RTU units.

The right strategy for your classrooms?

Mechanical systems can include heating, ventilation, and/or air-conditioning, but they do not always provide all three. Strategies that can be considered will depend on the capabilities of your system.

Fact Sheet Topic	Building System Type: Window unit, radiator, or no space conditioning	Unit ventilator or univent	Decentralized heating/cooling systems	Central System serving one or multiple rooms/zones: 100% recirculation	Recirculation + ventilation
Ventilation: Mechanical		✓	Depending on system		✓
Ventilation: Natural (operable windows)	✓		✓	✓	
HVAC Filtration		Depending on pressure drop might need to increase filter rack from 1" to 2"	Depending on pressure drop might need to increase filter rack from 1" to 2"	Depending on pressure drop	Depending on pressure drop
In-Room HEPA Air Cleaners	✓	✓	✓	✓	✓
Upper-room Germicidal UV	✓	✓	✓	✓	✓
In-duct Germicidal UV				✓	✓

THE CENTER FOR GREEN SCHOOLS

The IAQ Fact Sheet Series was authored in collaboration with Marwa Zaatari, with technical assistance from Sarah Gudeman. The fact sheet series is intended for informational purposes only. See disclaimer on USGBC's web site.

Released October 26, 2021
LATEST INFORMATION

ASHRAE

THE CENTER FOR GREEN SCHOOLS

Recommendations for schools from ASHRAE's COVID Epidemic Task Force

ASHRAE is an organization known for establishing standards for building design, including strategies that impact air quality.

- Ventilate spaces per minimum standards (ASHRAE 62.1)
- Clean recirculated air using MERV 13 filtration or equivalent
- Use only air cleaners for which evidence of safety is clear
- Use air cleaners (HEPA, UVGI) where needed to minimize exposure while considering energy impacts

Proven strategies include "subtractive" technologies like filters, sorbent media, and UVGI, which remove targeted contaminants from the air.

Unproven strategies include "additive" technologies like electronic air cleaners, ionizers, and fumigation that add things to the air to remove particles, inactivate microorganisms, or react with chemical contaminants.

NEW YORK SCHOOLS NYSIR INSURANCE RECIPROCAL

Reaching your air change rate goal:

eACH is equivalent air change rate. It is calculated by adding all ventilation and air cleaning strategies. A reasonable target for air change rate in a classroom is at least 6 eACH.

Example eACH for a typical 1,000 ft² classroom

This eACH calculation may vary based on factors such as the amount of air supplied from an HVAC system. The graph is provided as a general comparison between strategies and as an example of how strategies can be combined for infection control.

Imagine measuring contaminants in a space and then starting a stopwatch. At 6 eACH, at the end of 30 minutes, 95% of the original contaminants would have been removed. At a lower eACH, it would take longer to get the same result. At a higher eACH, it would take less time.

Introduction to eACH Equivalent Air Changes an Hour

Healthy Buildings
With Quality Indoor Air

MEASURES

- Ventilation
- UV-C
- Bipolar Ionization
- Humidification
- Filtration/Portable Air Cleaners
- Create a Microenvironment

VENTILATION

MOST COMMONLY RECOMMENDED MEASURE

-EXISTING HVAC INFRASTRUCTURE IS NOT DESIGNED TO BRING IN MORE OUTSIDE AIR

-THIS APPROACH HAS SIGNIFICANT IMPACT ON OPERATIONAL EXPENSE

-ALL VENTILATION AIR ALL HAS TO BE FILTERED, HEATED AND DISTRIBUTED

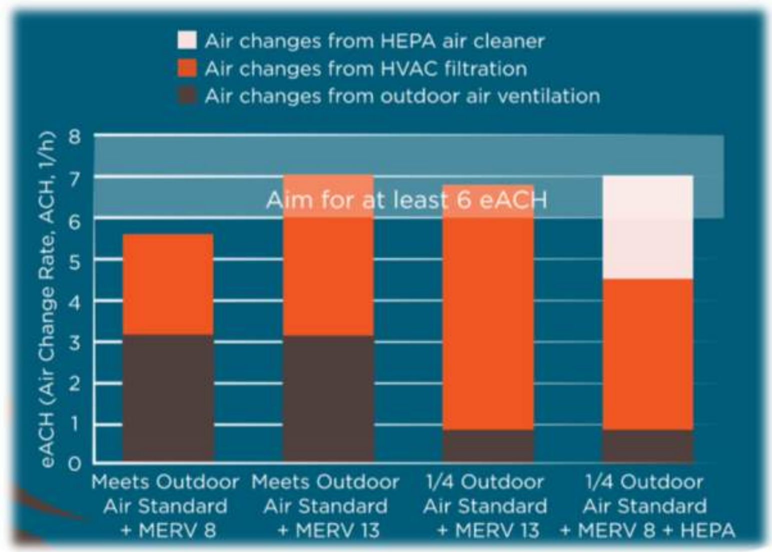
-EXISTING CRITICAL INFRASTRUCTURE (BOILER, CHILLERS, FANS) ARE
NOT DESIGNED TO MOVE OR CONDITION MORE AIR

-NEW EQUIPMENT (DOAS, MUA, AHU'S OR ROOM LEVEL VENTILATION)
USUALLY REQUIRE HEAVY COST AND MODIFICATIONS

-OPENING WINDOWS IS NOT A SUSTAINABLE APPROACH

-VENTILATION DOES NOT ADDRESS THE NEED FOR MORE TOTAL AIR CHANGES,
PROPER AIR DISTRIBUTION AND BETTER FILTRATION

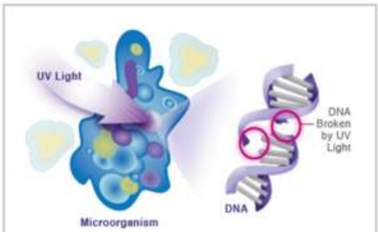
-CONTROL UPGRADES CAN MODIFY SOME EXISTING SYSTEMS TO ASSIST



UV-C TECHNOLOGY

How UV-C Kills Viruses, Bacteria & Other Pathogens

- UV-C attacks at the genetic level
- Breaks DNA Strands and Mutates the Microorganism
- Microorganisms can instantly no longer replicate
- Cellular functions are disrupted to the point where microorganisms will eventually die



UltraViolet C (UVC) light shatters microbes at the genetic level. It breaks DNA strands, disarming and destroying microorganism in just moments.

UV-C SUMMARY

-PROVEN TECHNOLOGY FOR REDUCING SPREAD OF HARMFUL BACTERIA AND PATHOGENS

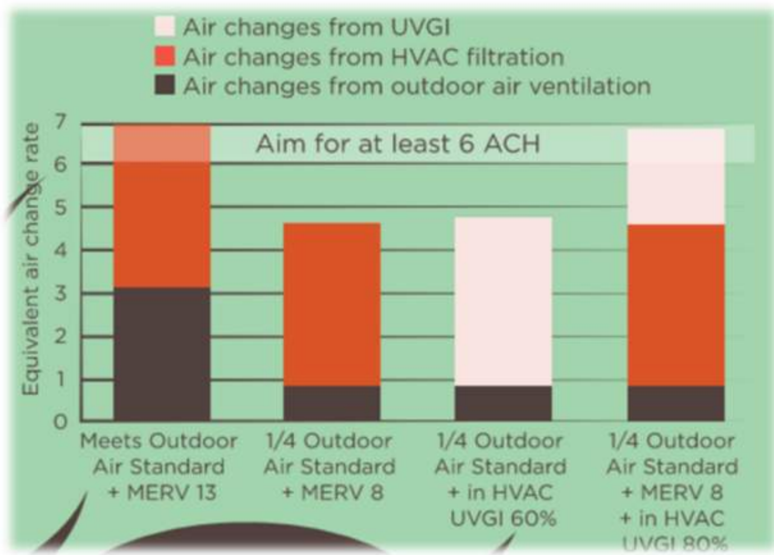
-EFFECTIVE AT SURFACE AND AIR CLEANING

-AVAILABLE IN PORTABLE, FIXED (ROOM, DUCT, AHU)

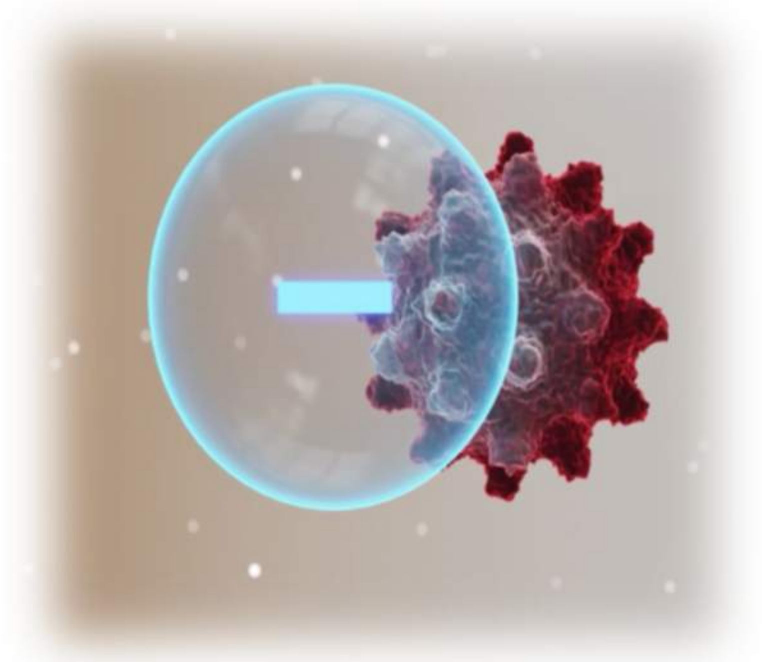
-EFFICIENT FOR DISINFECTING AREAS DIFFICULT FOR MANUAL CLEANING

-CAN ONLY INACTIVE A VIRUS IF DIRECTLY EXPOSED TO RADIATION WITH PROPER INTENSITY

-RELIES ON EXISTING HVAC INFRASTRUCTURE TO MOVE PARTICULATE

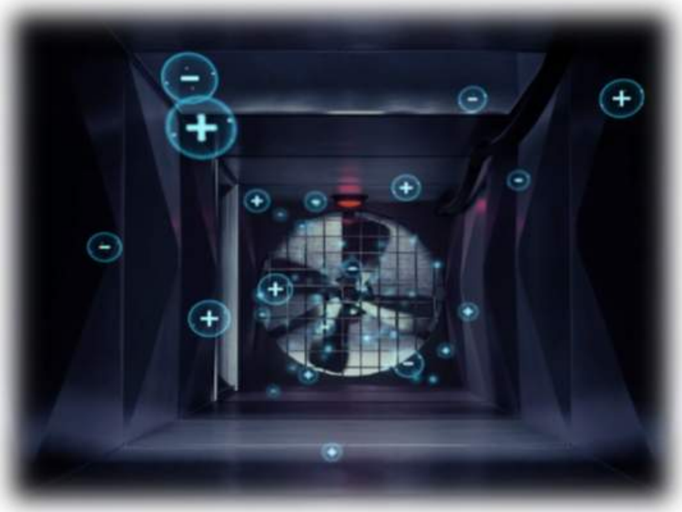


BIPOLAR IONIZATION



Bipolar ionization technology creates and releases ions into the airstream using your existing HVAC system as the delivery method. When these ions disperse throughout a space, they seek out and form bonds with particles in the air through a process called agglomeration. This creates a snowball effect in which particles begin to cluster together. The larger a cluster of particles becomes, the easier it is for your system to filter it out of the air.

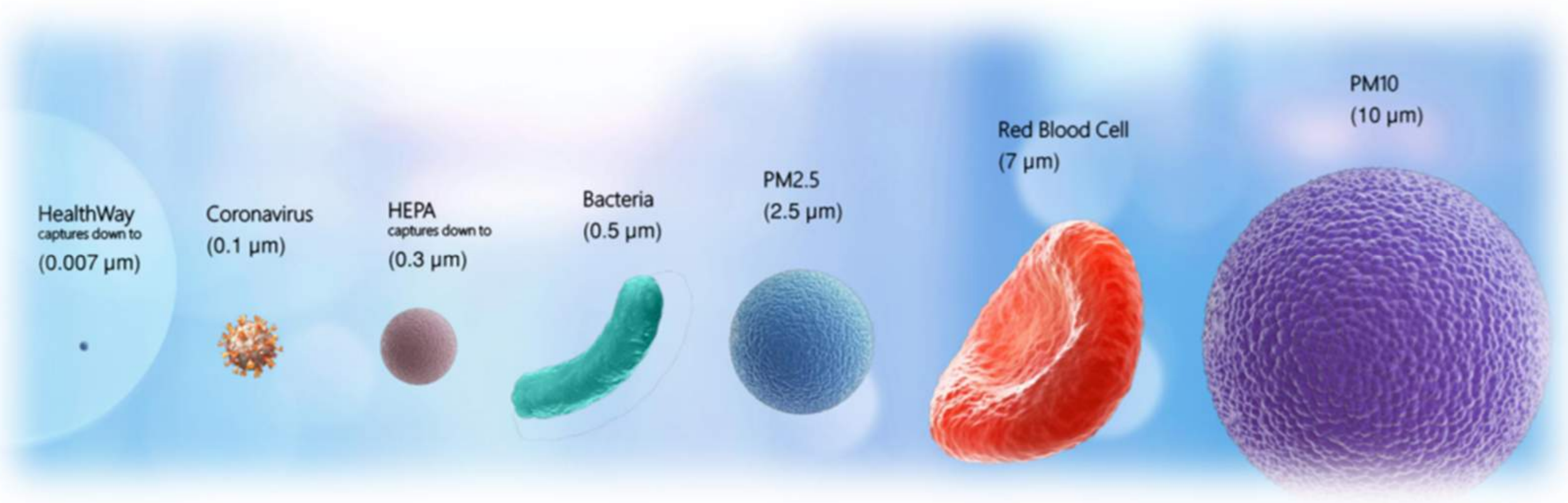
As a complement to air filtration and modern HVAC installations.



INTERIM NYSDOH GUIDANCE FOR CLASSROOM INSTRUCTION IN
P-12 SCHOOLS DURING THE 2021-2022 ACADEMIC YEAR

Units that feature ionizers, precipitators, or ozone generators **do not** provide additional benefit and can generate **harmful byproducts**

FILTRATION


HealthWay
captures down to
(0.007 µm)
Coronavirus
(0.1 µm)
HEPA
captures down to
(0.3 µm)
Bacteria
(0.5 µm)
PM2.5
(2.5 µm)
Red Blood Cell
(7 µm)
PM10
(10 µm)

COMMERCIAL FILTRATION

MOST COMMON HVAC FILTER

-MERV 8 FILTERS ARE COMMONLY USED AS A PREFILTER IN OTHER HVAC APPLICATIONS

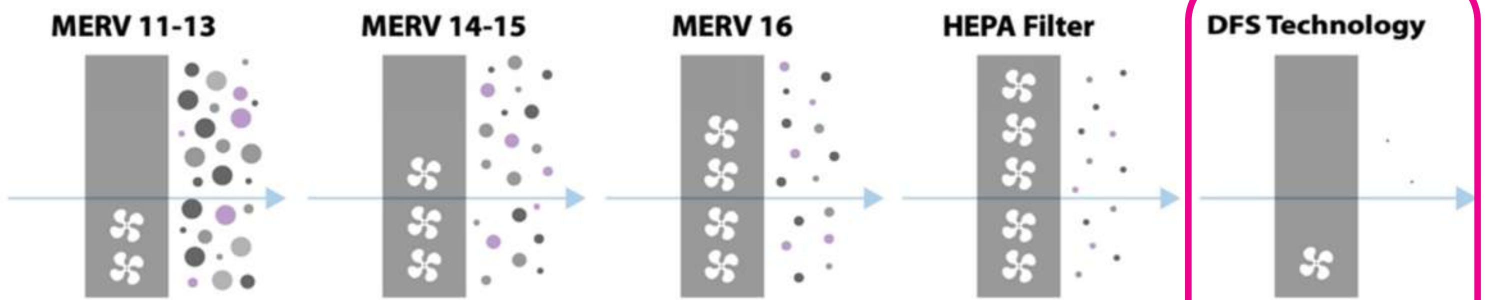
-85% CAPTURE OF PARTICLES FROM 3 TO 10 MICRONS

-EFFECTIVE AT CAPTURING DUST COMMONLY ASSOCIATED WITH ASTHMA

-MOST CURRENT HVAC SYSTEMS ARE NOT DESIGNED TO HANDLE BETTER THAN MERV 8 – INCREASE IN FILTER RESULTS IN DECREASE OF TOTAL AIRFLOW IN MOST CASES (LOWER AIR CHANGES)

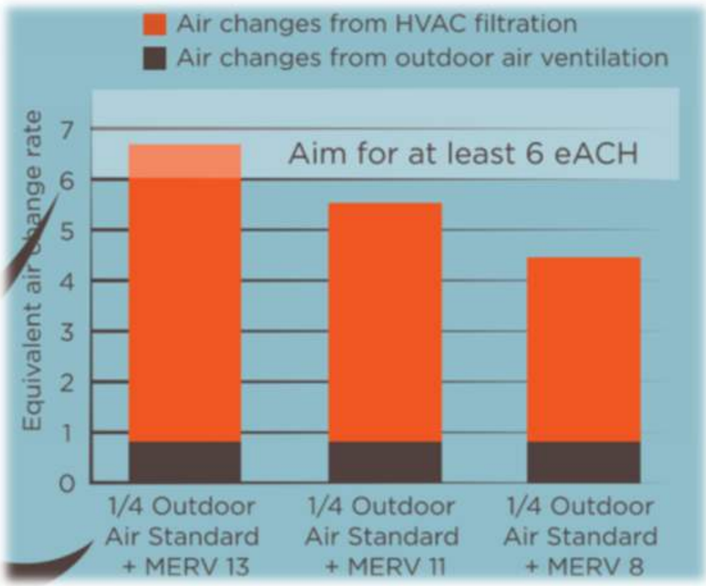
FILTRATION

Filtration Efficiency / Particle Size

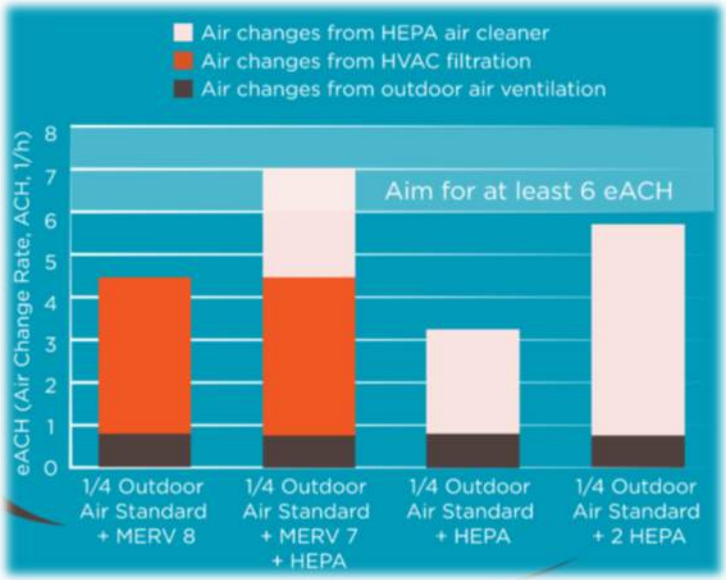


	MERV 11-13	MERV 14-15	MERV 16	HEPA Filter	DFS Technology
Efficiency	20-50%	50-85%	95%	99.97-99.99%	> 99%
Particle Size	0.3-1.0 microns	0.3-1.0 microns	0.3-1.0 microns	0.3 microns	0.007 microns
Air Pressure Requirement					
Captures	Lead Dust Vehicle Emissions	Lead Dust Vehicle Emissions Smoke Exhalation Droplets	Lead Dust Vehicle Emissions Smoke Exhalation Droplets	Lead Dust Vehicle Emissions Smoke Exhalation Droplets Bacteria Some Viruses	Lead Dust Vehicle Emissions Smoke Exhalation Droplets Bacteria Viruses **Ultrafine Particles**

FILTRATION



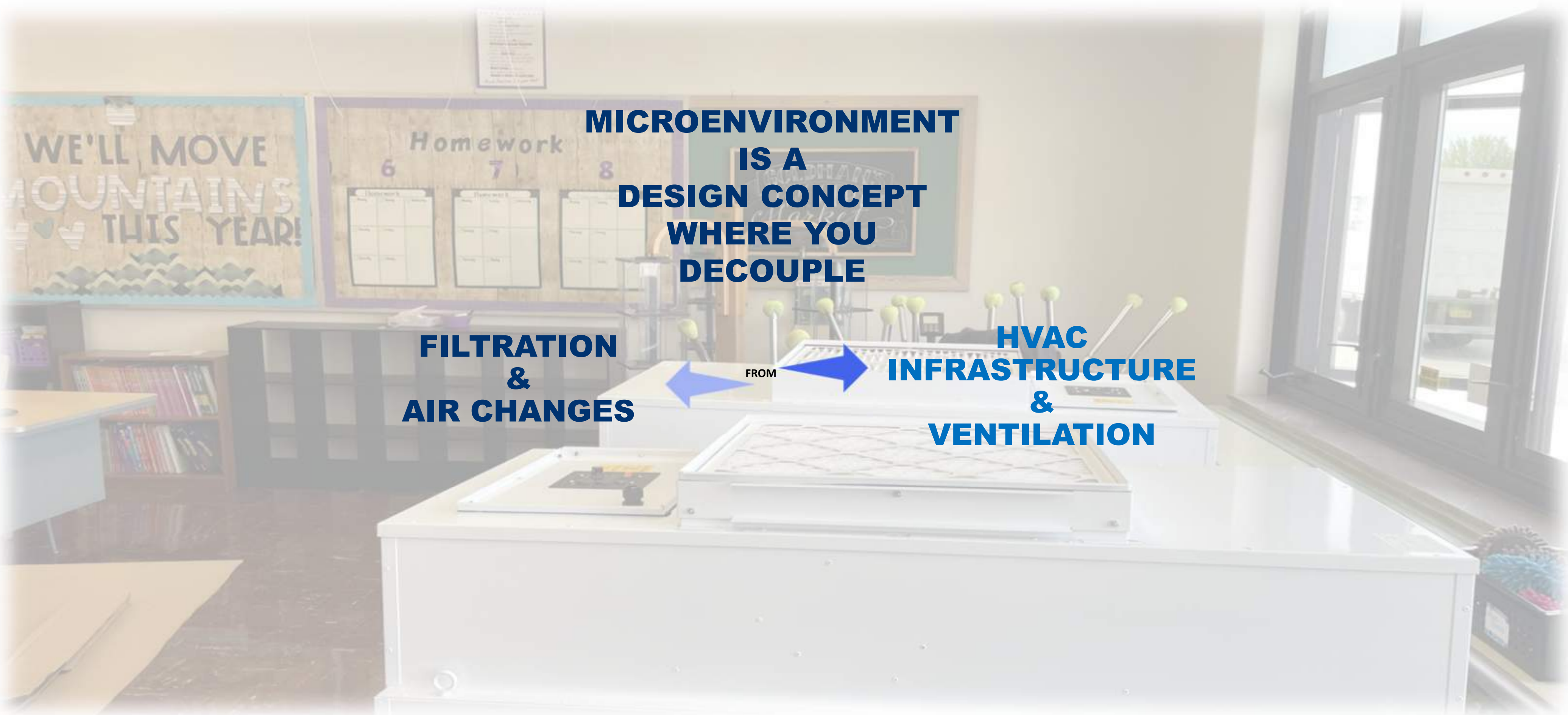
PORTABLE AIR CLEANERS



What is CADR?

An in-room air cleaner should be chosen so that its clean air delivery rate (CADR) meets the needs of the room. The CADR is usually given for the highest fan speed, so if the unit runs at lower speeds, the CADR will be lower. Look for a unit with a CADR at least 2/3 your room's area. For example, a 20' x 30' room (600 ft^2) would require CADR of at least 400. Multiple air cleaners can be added to get the total required CADR (e.g., two units with 200 CADR would meet the 400 CADR requirement).

CADR (Clean Air Delivery Rate)
Important to know at desired operating condition
Noise at operating condition
Central location is best for Airflow



**MICROENVIRONMENT
IS A
DESIGN CONCEPT
WHERE YOU
DECOUPLE**

**FILTRATION
&
AIR CHANGES**

FROM

**HVAC
INFRASTRUCTURE
&
VENTILATION**

CREATE A MICROENVIRONMENT

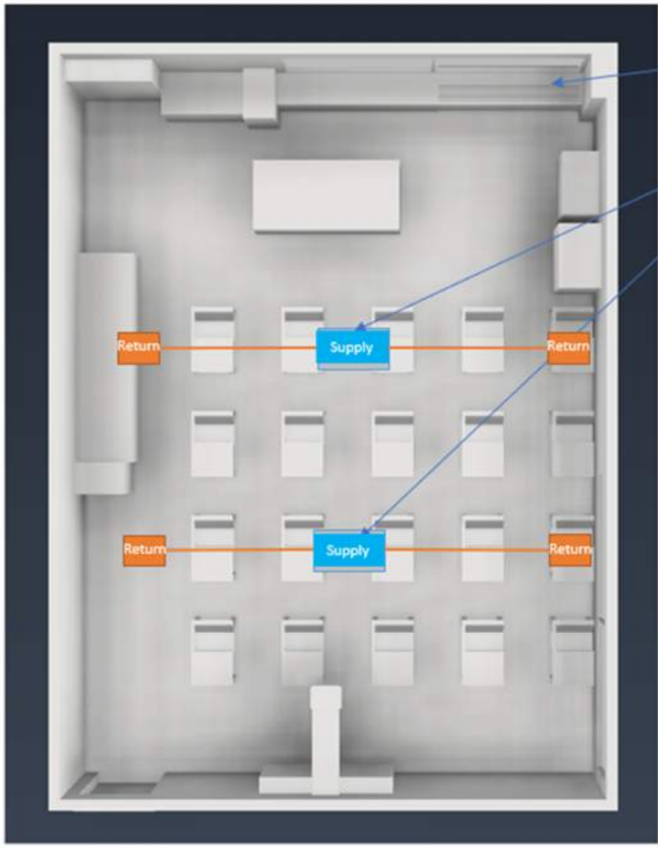
* Provide Locally a High Amount of Air Changes an Hour *
* Create Optimal Airflow at Room Level *
* Implement Best in Class Disinfecting & Filtration *

EACH ROOM

- Provides an additional 4-10 Air Changes an Hour at Room
- Sub Micron Filtration able to capture Particles and individually tested to meet and exceed the HEPA standard of 99.97% @.3 Micron
- Energy Efficient Solution Typical Room requires less than 3 AMPS of Power at 115 Volt / 1 Ph
- Certified Testing and Proven Technology UL867 Tested and CARB. Guaranteed Performance
- Disinfect the Air
- Quiet Operation and Compliant with NC35
- Designed to work in conjunction with any existing HVAC system
- Compatible with Drop or Hard Ceilings
- Provide optimal Airflow Patterns
- Sustainable for Operation and Maintenance

BEST IN CLASS eACH and CADR

Microenvironment Classroom Layout



Unit Ventilator

Fan Filter Units (FFU)

Fan Filter Units (FFU)

Example of FFU Install

A fan filter unit is a motorized unit which supplies clean, filtered air to a cleanroom. Air is drawn via the fan, through a pre-filter and then through a HEPA or better filter which filters the sub-micron particles ensuring a clean and processed air supply. Using FFUs to provide localized clean air is a more energy efficient route than using a traditional Air Handling Unit (AHU) and is a more frequently adopted approach in modern cleanroom design.

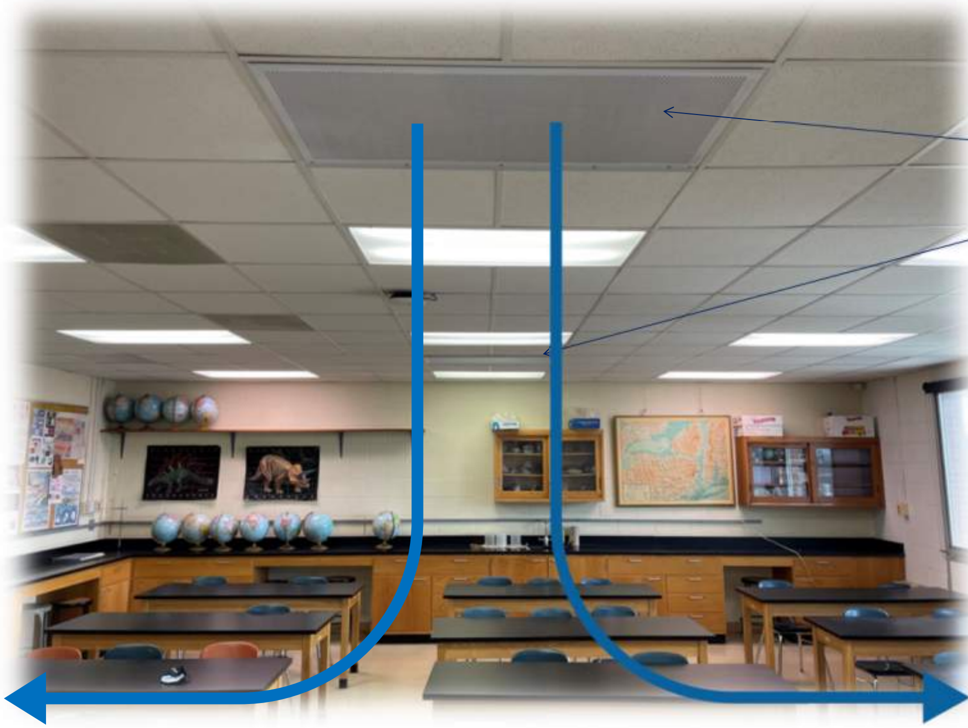
Each Room

Depending on Cubic Feet of Space and Existing HVAC Quantity of Fan Filter Units can Vary

MICROENVIRONMENT DIFFERENCE

* Vertical streamlines *
* High supply and low returns *
* No streamlines flowing across many desks *
* Short streamlines *
* Avoid Horizontal Streamlines
* No dead spots *
* Middle Central Location *

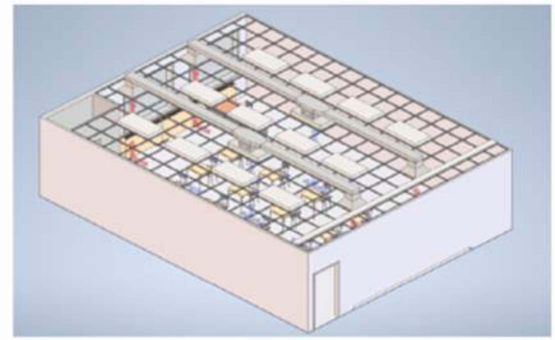
Spencerport CSD



-Top Central Supply
-Vertical Streamlines

Microenvironment
Classroom Layout Installation

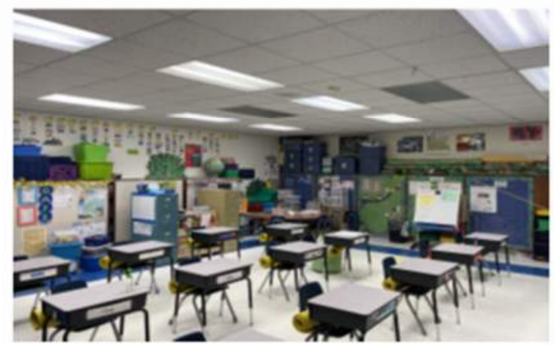
Microenvironment Proof of Concept



Amherst CSD – 1,035 Sq. Ft.
Special Education Room MS

Southwestern CSD – 660 Sq. Ft.
HS AP History Room

Fairport CSD – 780 Sq. Ft.
HS AP History Room



CFD ANALYSIS
LOCATION IS CRITICAL TO AIRFLOW

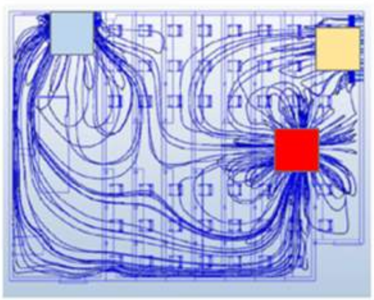


Figure 70: Preliminary Configuration 3 Top View

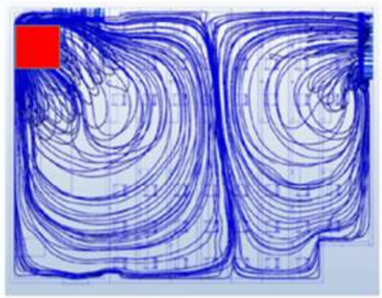


Figure 74: Preliminary Configuration 5 Top View

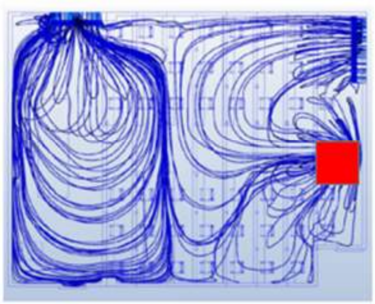


Figure 72: Preliminary Configuration 4 Top View

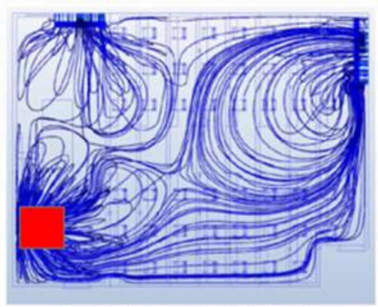


Figure 76: Preliminary Configuration 6 Top View

Air Purifier

Unit Ventilator

Doorway

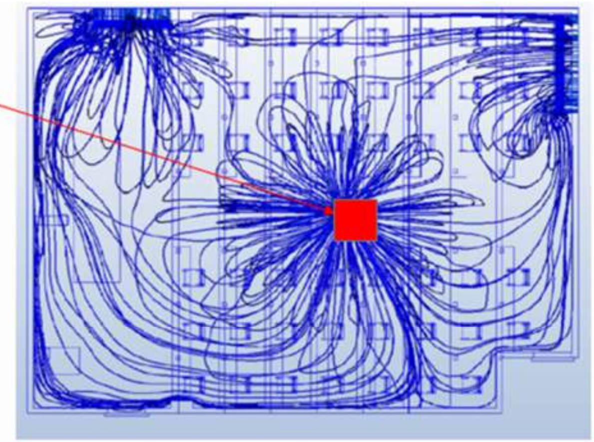


Figure 66: Preliminary Configuration 1 Top View

Optimal Central Location

Promotes Vertical Streamlines

Limits Horizontal Streamlines

No Dead Spots

High Supply

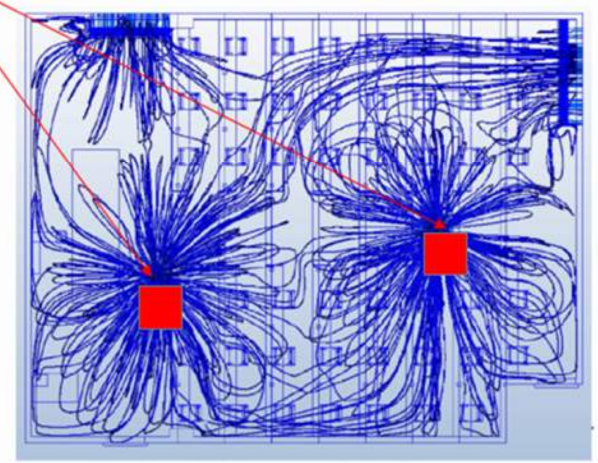
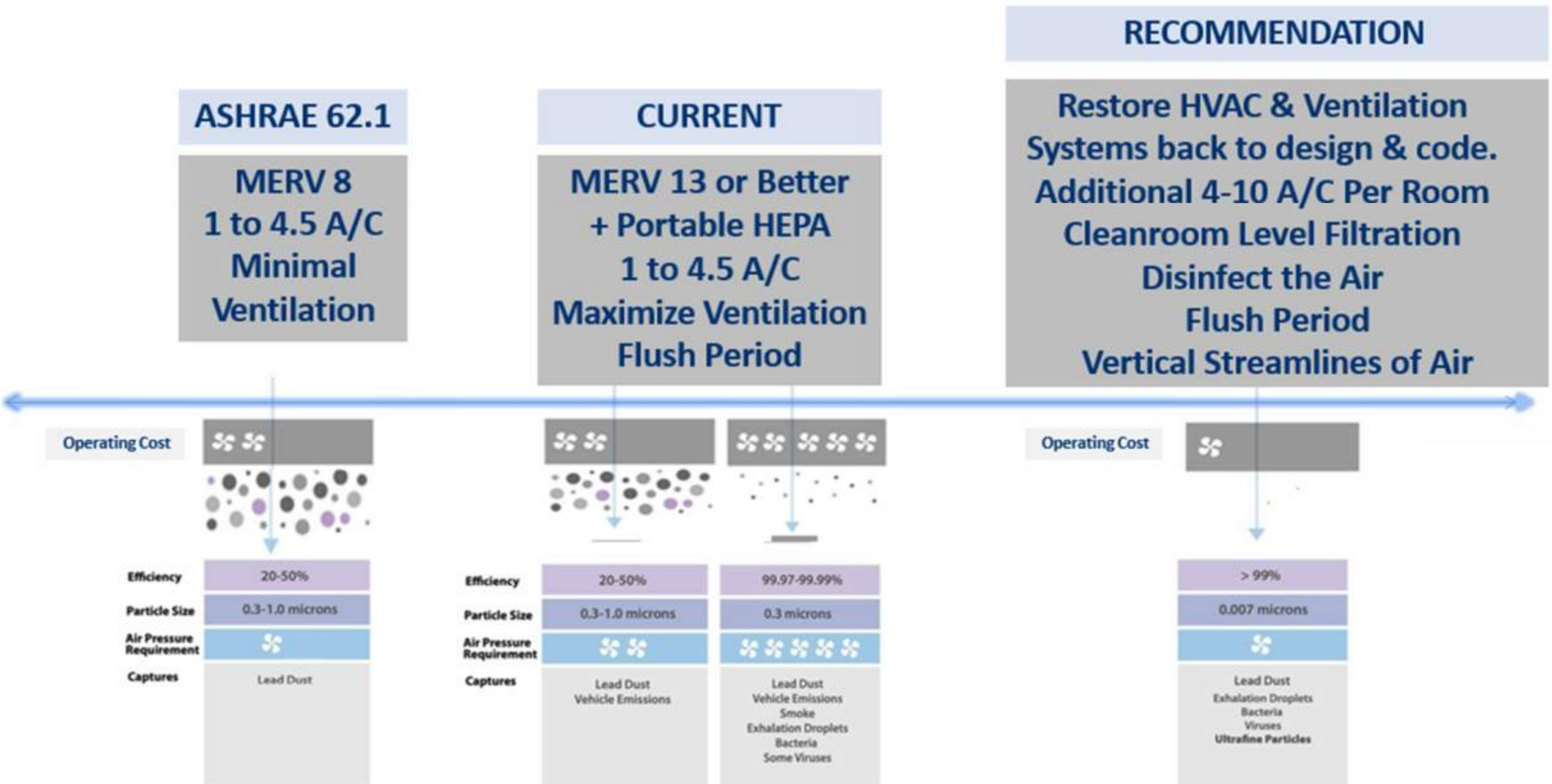
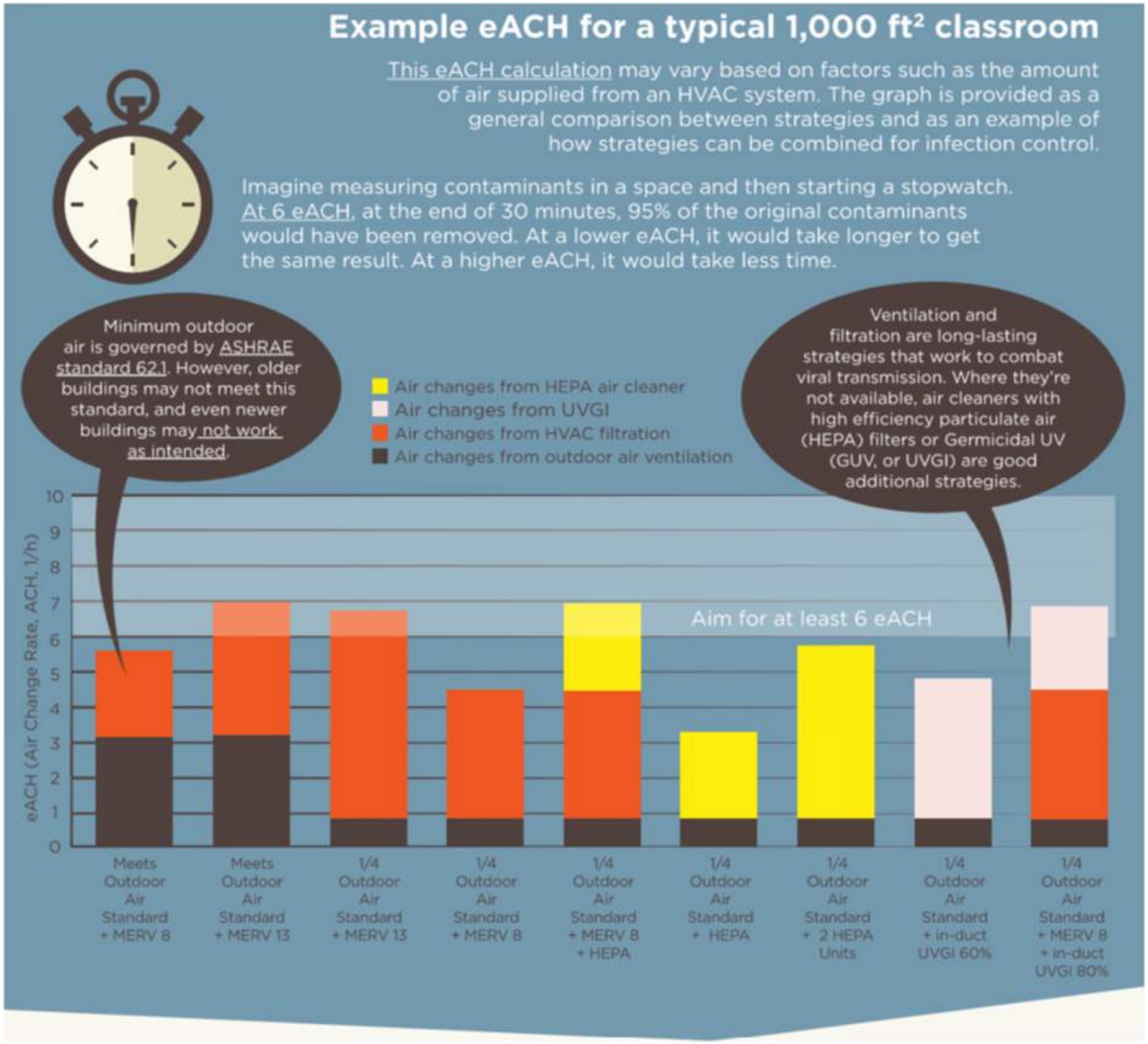


Figure 79: Effect of Two Air Purifiers Top View

Microenvironment Difference

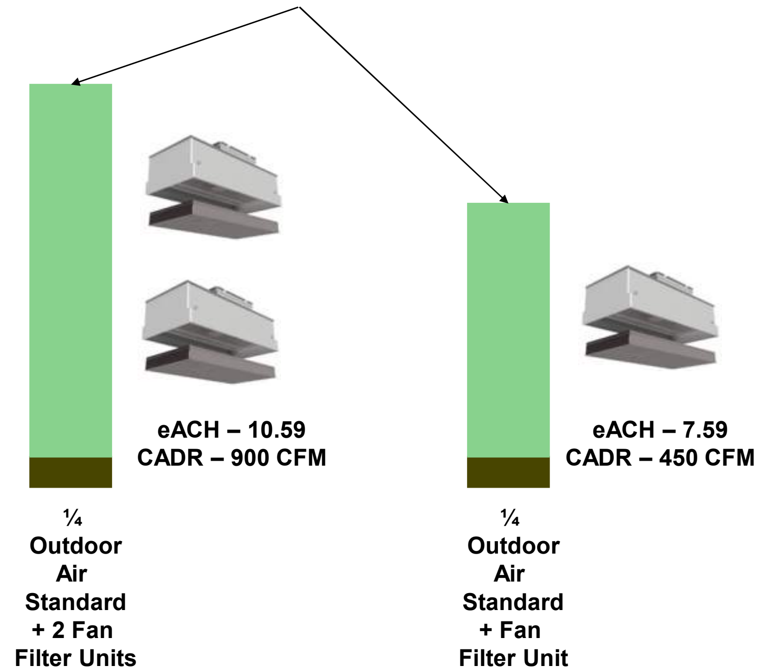


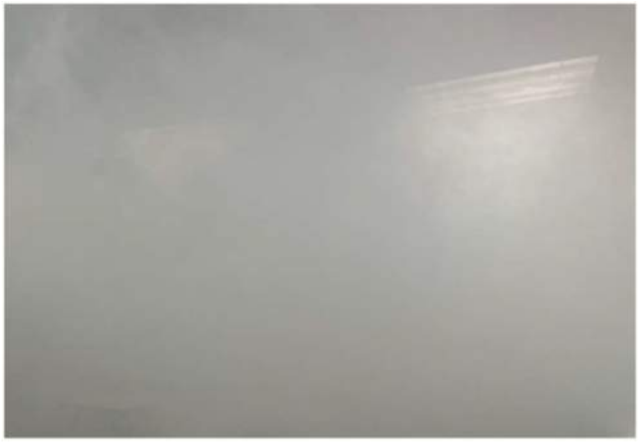


MICROENVIRONMENT

1,000 ft² Classroom
9' Ceilings

Power Requirements
2 AMPS @ 115 Volt
(Power Equivalent to 1 Laptop)





TEST #1

Challenge Test

Baseline Smoke Test

Filled Room with Smoke 1 to 5 Micron

(2) Tests Run

Test 1: Unit Ventilator Only

Test 2: Unit Ventilator and FFU's

(Simulating Concept of 6.5 Air Changes)

Below Pictures are Results after 12 Minutes of Both Tests

EVERY ROOM SHOWED THE SAME TEST DATA

Certified Technician: Chris Sanger

TEST #2

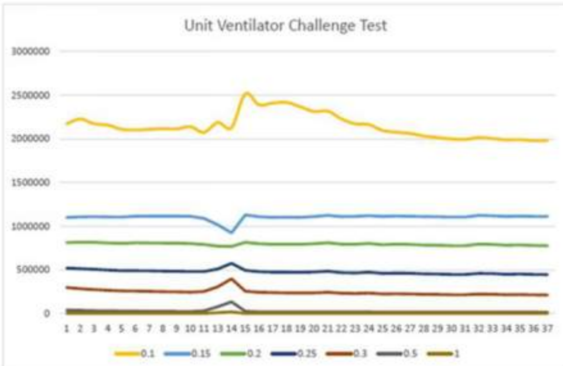
EACH SMOKE TEST SHOWED SIMILAR RESULTS

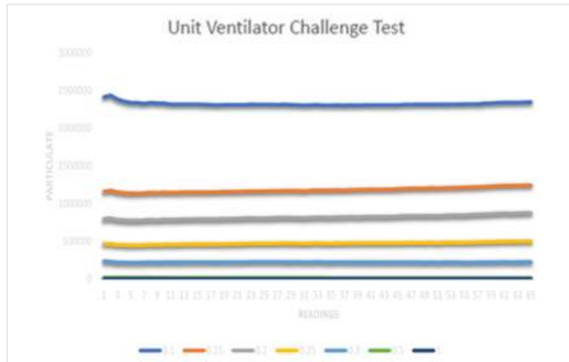
Smoke Challenge Test

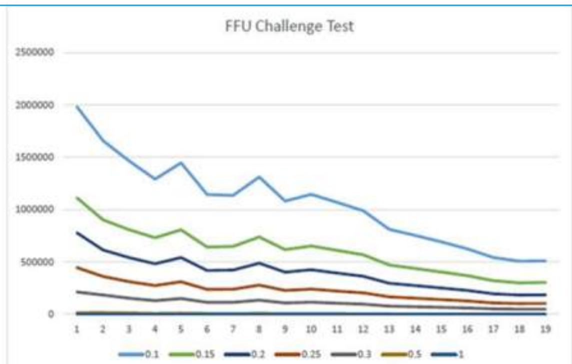
Certified Technician: Chris Sanger

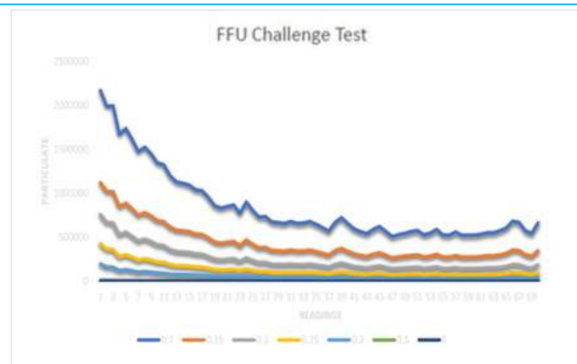
Case Study Data

School A | **School B**









Filtration Effectiveness Test

Testing Procedure

Cleanroom testing agency to take baseline particle counts in classroom.

Introduce aerosol challenge into room to simulate an active classroom. Measure and record how fast and effective the existing infrastructure can remove particulate. Repeat with Microenvironment approach and measure and record.

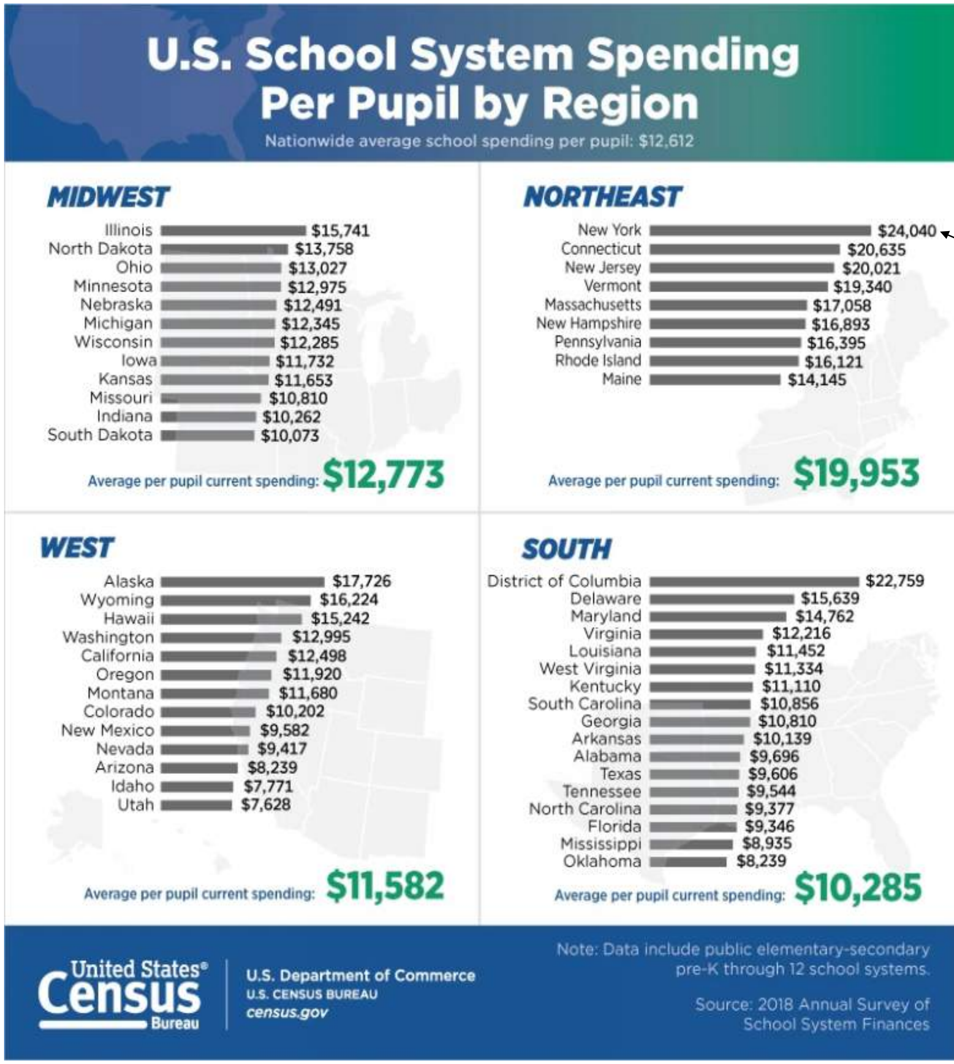
Test 1: Unit Ventilator Only

Test 2: Unit Ventilator and FFU's

(Simulating Concept of 6.5 Air Changes)

5 Classrooms
EVERY ROOM SHOWED SIMILAR TEST DATA

Certified Technician: Chris Sanger



AVERAGE COST PER CLASSROOM TO IMPLEMENT A MICROENVIRONMENT

TYPICAL 600 TO 1,000 SQ.FT CLASSROOM CAN IMPLEMENT A MICROENVIRONMENT FOR LESS THAN

½ THE COST OF 1 STUDENT

Per Classroom Facts:

-Typical Install Completed from Start to Finish in ½ Day

-Estimated Room Cost including Equipment, Controls, Electrical, Ductwork, and Installation

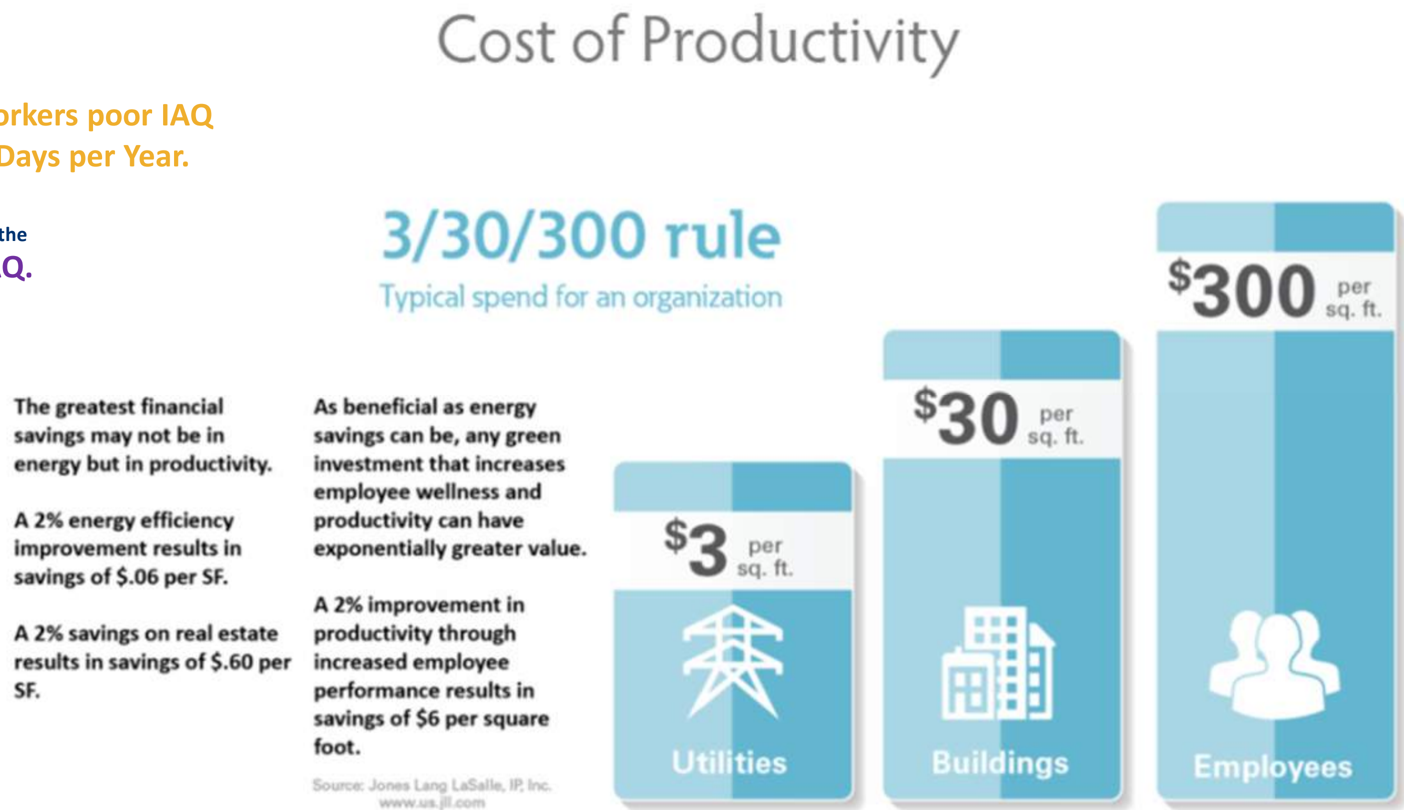
Commercial Buildings

Absenteeism

-For Every 1,000 Workers poor IAQ Results in 600 Sick Days per Year.

Lack of Proper Air Filtration is the

#1 Cause of Poor IAQ.



WHAT IF EFFICIENCY IMPROVEMENT COULD BE BOTH UTILITY AND EMPLOYEES

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Total Facilities Optimization

Stark TECH