HEALTHIER BUILDINGS & COVID-19 DESIGN STRATEGIES

August 27, 2020

Cosentini
A TETRA TECH COMPANY

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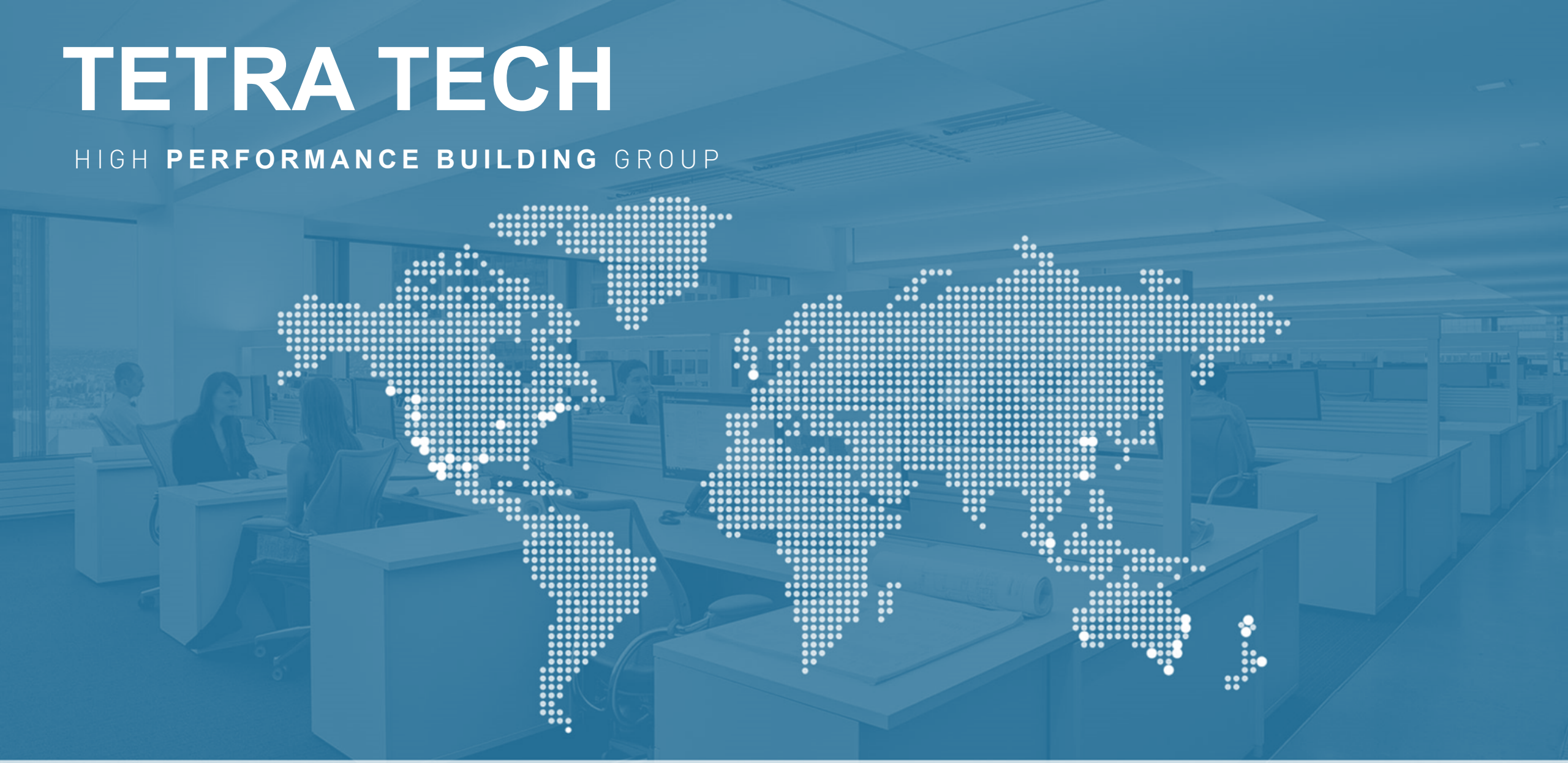
HIGH **PERFORMANCE BUILDING** GROUP



2500
BUILDING DESIGN
EXPERTS

15
SERVICE
LINES

30
OFFICES
WORLDWIDE

4
CONTINENTS
WORLDWIDE

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COURSE ACCREDITATION INFORMATION

Course Title: Healthier Buildings & COVID-19 Design Strategies

Course Code: CAA-MEP501

Course Credits: 1 LU|HSW

Provider Name: Glumac+Cosentini

Provider Number: G188

Course Description: Currently, buildings are designed to protect structures and occupants from smoke, fire, wind, power outages, and flooding. As we navigate the new normal we are facing during the coronavirus pandemic, the expectations of building occupants will change in regards to health and safety. It is clear that our future buildings need to facilitate wellness, but they will more critically need to safeguard public health. This comprehensive presentation addresses the sensible measures we can take in the design and operations of buildings to improve the current situation, as well as make healthy buildings a focus moving forward. This learning program is registered with AIA CES for continuing professional education.

Learning Objectives:

- Look at the awareness of the New Normal and how our raised awareness will impact how occupants view buildings and their role in our health and safety
- Review physical environmental design concepts: what design enhancements we can make to the building systems and architecture to make buildings healthier
- Reviews building operational changes: what the building owners can do to improve cleaning strategies and air quality
- Overview of important social behavioral changes: What building occupants can do and how we can influence those behaviors to improve the health and safety of fellow occupants

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AIA Continuing Education Provider

CURRENT SITUATION

SARS-CoV2 is a contagious virus that causes the illness COVID-19 and is primarily transmitted through respiratory droplets (>5 microns). Other modes of transmission may include aerosols (<5 microns) and touching contaminated surfaces, although this is not thought to be the main way the virus spreads[1].

We need to re-think how we design buildings moving forward with a focus on healthy buildings

1. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-covid-spreads.html

“Companies are going to come back to a different world where their workers have a heightened awareness about the risk of infectious disease transmission and how the building influences that.”

Source: The Harvard Gazette “How Masks and Buildings can be Barriers to the Coronavirus” by Dr. Joe Allen & Colleen Walsh

How do we respond

as design industry professionals that deal with existing and new buildings

+

to the community that will soon be allowed to re-enter buildings?

COVID-19 RESPONSE

Awareness of SARS-CoV2 & COVID-19

Operational Concepts

Physical Environment Design Concepts

Social Behaviors

THE VIRUS

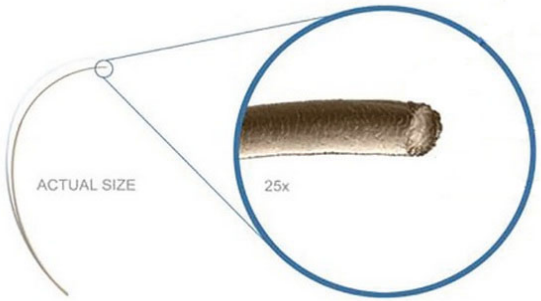
SARS-CoV2: Severe **A**cute **R**espiratory **S**yndrome **C**orona **V**irus **2**

The illness caused by the virus is known as **COVID-19**

	SARS-CoV1	SARS-CoV2
Year of affect	2002-2004	2019-ongoing
Confirmed Cases	8,096	24,271,466*
Mortality Rate	9.50%	3.41%

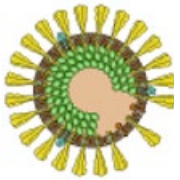
**as of 2020/08/27*

SARS-CoV2 is 60-140 nanometers in diameter



Human Hair
80,000 nm

AEROSOL



SARS-CoV2
60-140 nm

AEROSOL

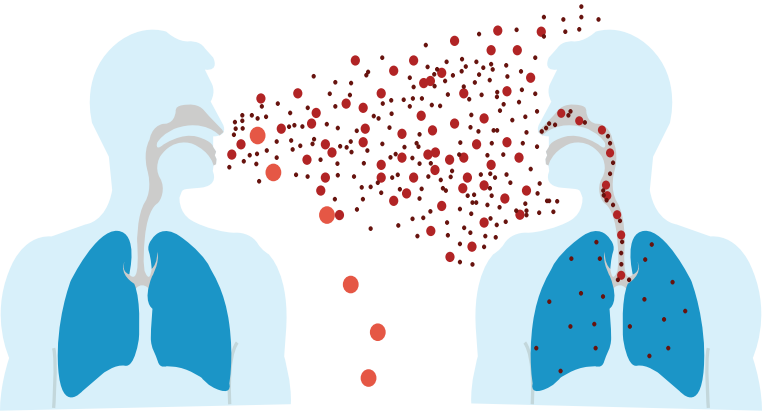
Influenza
100 nm

AIRBORNE

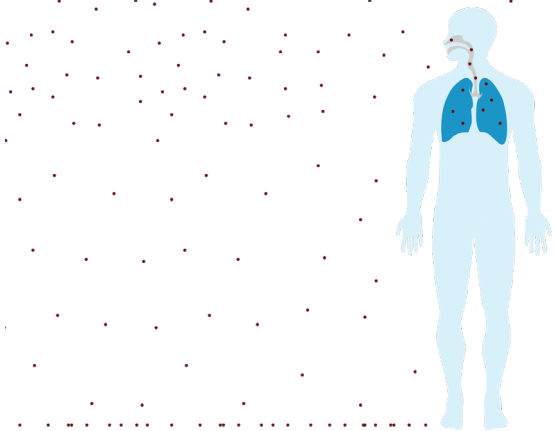
Rhinovirus
30 nm

TRANSMISSION

The primary transmission method is from person-to-person in close contact through respiratory droplets.

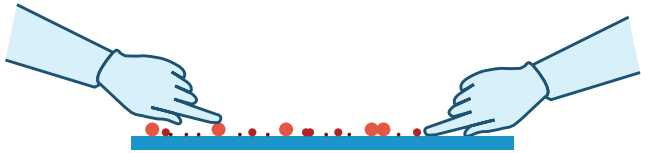


Source: Kimberly A. Prather et al. Science 2020; DOI: 10.1126/science.abc6197



Virus found to live in the air for up to 3 hours

4 hours	1 day	3 days
Copper	Cardboard	Steel/Plastic



Source: N van Doremalen, et al. Aerosol and surface stability of HCoV-19 (SARS-CoV-2) compared to SARS-CoV-1. The New England Journal of Medicine DOI: 10.1056/NEJMc2004973

Respiratory droplets >5 microns

Coughs, sneezes, or exhales release droplets of infected fluid – most fall quickly. If you are standing within 6' of someone you can catch it by breathing in droplets.

Aerosolized Droplets <5 microns

Aerosolized droplets (droplet nuclei) can travel long distances through the air stream and linger, where they can be breathed in before eventually settling on surfaces. Most small particle losses are by exchange with outdoor air.

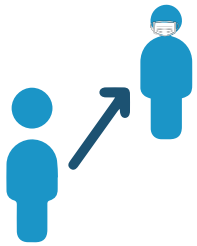
Fomite Transmission

Touching contaminated surfaces or objects and then touching your eyes, nose or mouth.

Sources: WHO: "Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations"
CDC: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-covid-spreads.html
CDC: "Generation and Behavior of Airborne Particles (Aerosols)" https://www.cdc.gov/niosh/topics/aerosols/pdfs/Aerosol_101.pdf
CDC: "Aerosol and surface distribution of severe acute respiratory syndrome coronavirus 2 in hospital wards, Wuhan, China, 2020." https://doi.org/10.3201/eid2607.200885

TRANSMISSION

There are 4 main elements to consider when identifying the risk of transmission.[1]



Distance

The closer you are to others the higher the risk. It is recommended by the CDC to stay at least 6' apart and to wear a mask.

Environment

A majority of infections (outside of nursing homes) occurred indoors, at home, in workplaces, on public transit, and during social gatherings. Reduce risks indoors with good ventilation.[2]

Time

The longer amount of time spent with others increases transmission risk. It is recommended to reduce sustained contact time to less than 15 minutes, especially if you are indoors.

Activity

Singing and yelling produce far more droplets than breathing, leading to an increased risk. Consider the activities happening around you to reduce risk.

1. *https://www.vox.com/science-and-health/2020/5/22/21265180/cdc-coronavirus-surfaces-social-distancing-guidelines-covid-19-risks*
2. *https://www.erinbromage.com/post/the-risks-know-them-avoid-them*

TRANSMISSION

Pre-symptomatic spread: Those infected with the coronavirus are emitting the virus BEFORE they are symptomatic[1].

Asymptomatic spread: Those that are truly asymptomatic (never develop symptoms) appear to be a lower transmission risk[1].

2.5 days

Time an infected individual is estimated to be spreading the virus before first symptoms appear

18 hours

Time before developing first symptoms at which an infected person is estimated to be most contagious

44%

Estimation of transmissions that may occur during the pre-symptomatic period

Symptoms may appear **2-14 days after exposure to the virus**[2].

1. *He, X., Lau, E.H.Y., Wu, P. et al. Temporal dynamics in viral shedding and transmissibility of COVID-19. Nat Med 26, 672–675 (2020). https://doi.org/10.1038/s41591-020-0869-5*
2. *https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html*

TRANSMISSION

The infectious dose (the amount of virus necessary to make someone sick) of SARS-CoV2 is currently unknown. Experts speculate it ranges from a few hundred to thousands of infectious particles[1].

Lower infectivity, Needs more sustained contact time to infect ⟷ **Higher Infectivity, Needs less sustained contact time to infect**

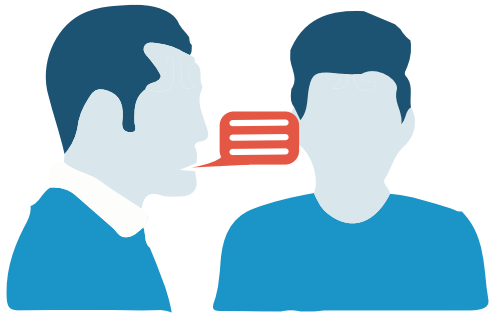
Less droplets
Average droplet size is smaller
Most droplets don't come from lower respiratory area

More Droplets
Average droplet size is larger
Many droplets come from lower respiratory area

Breathing

50-5,000 Droplets[2]

~33 infectious particles per minute for influenza, unknown for SARS-CoV2



Speaking

600-2,600 Droplets[2 3]

~200-1,000 infectious droplets per minute & can stay in the air for 8-14 minutes

Coughing

3,000 Droplets[2]

~millions of infectious particles, travels at 50 mph, and can stay in the air for 30 minutes or more

Sneezing

40,000 Droplets[2]

~millions of infectious particles, travels at 200 mph, and can stay in the air for 30 minutes or more

1. https://www.sciencemediacentre.org/expert-reaction-to-questions-about-covid-19-and-viral-load/
2. https://www.erinbromage.com/post/the-risks-know-them-avoid-them
3. Valentyn Stadnytskyi, Christina E. Bax, Adriaan Bax, and Philip Anfinrud "The airborne lifetime of small speech droplets and their potential importance in SARS-CoV-2 transmission" PNAS first published May 13, 2020 https://doi.org/10.1073/pnas.2006874117

ASHRAE'S POSITION

"Because it is sufficiently likely that SARS-CoV-2 can be transmitted through the air, airborne exposure to the virus should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning systems, can reduce airborne exposures.

Ventilation and filtration provided by heating, ventilating, and air-conditioning systems can reduce the airborne concentration of SARS-CoV-2 and thus the risk of transmission through the air."

Source: ASHRAE's statement on airborne transmission of SARS-CoV-2/COVID-19

PHYSICAL ENVIRONMENT DESIGN CONCEPTS

Recommendations for healthier buildings

HVAC

Improve air quality: Increase air exchange rates & High-efficiency filtration/air treatment

Ensure pressurization between spaces

Humidification

Decentralized Systems

Architectural

Space planning for distancing

Frictionless entryways

Lighting Controls & Automated Shading

Distance Indicator on Floors

Larger workstations

Material

Low-VOC materials

Easy to clean surfaces

Entryway mats

Technology

High-tech connectivity

App-based touch-free systems

Smart Concierge

Thermal Scanning

ENHANCED HVAC SYSTEMS

Air Quality
(Dilution)

Increase outdoor air ventilation

Disable demand-controlled ventilation

Extend hours of operation and consider pre/post occupancy purge ventilation

Provide CO2 sensors in densely occupied spaces

Air Treatment
(Removal/Disabling)

Enhanced Filtration (MERV 14+)

Air Ionization (Bi-Polar Ionization / Photo-Hydro Ionization)

UV Light Sanitizers (Ultraviolet Germicidal Irradiation & Photo Catalytic Oxidation)

Air Exchange
(Containment)

Reduce air recirculation with smaller HVAC zones

Increase bathroom exhaust and elevator ventilation

Control pressurization relationships

Humidification
(Optimization)

Control humidification within optimal bandwidth

INCREASING AIR QUANTITY (ACH)

Increase outdoor air change to dilute contaminants in the air.

Air Changes Per Hour (ACH)

Assuming 9' ceiling and 1 CFM/sf	Typical Modern Building			Typical 1970's Induction Building		
		Outside ACH	Filtered Recirculation ACH		Outside ACH	Filtered Recirculation ACH
Outside air	.15 CFM/sf			.25 CFM/sf		
Time for 100% outside air change	60 minutes	1	6	36 minutes	1.7	6
If % outside air is doubled	30 minutes	2	6	18 minutes	3.3	6
Assuming 12' ceiling and 1 CFM/sf	**Typical Modern Building**			**Typical 1970's Induction Building**		
Time for 100% outside air change	80 minutes	.75	4.5	48 minutes	1.25	4.5
If % outside air is doubled	40 minutes	1.5	4.5	24 minutes	2.5	4.5

Implications of HVAC Energy Usage

Code outside air without demand controlled ventilation **+5% energy usage**

Doubling the ventilation without demand controlled ventilation **+20% energy usage**

**These numbers are for a floor by floor VAV system.*

AIR TREATMENT SYSTEMS

HEPA Filters

Bi-Polar Ionization

UV Light Sanitizers

Carbon Filters

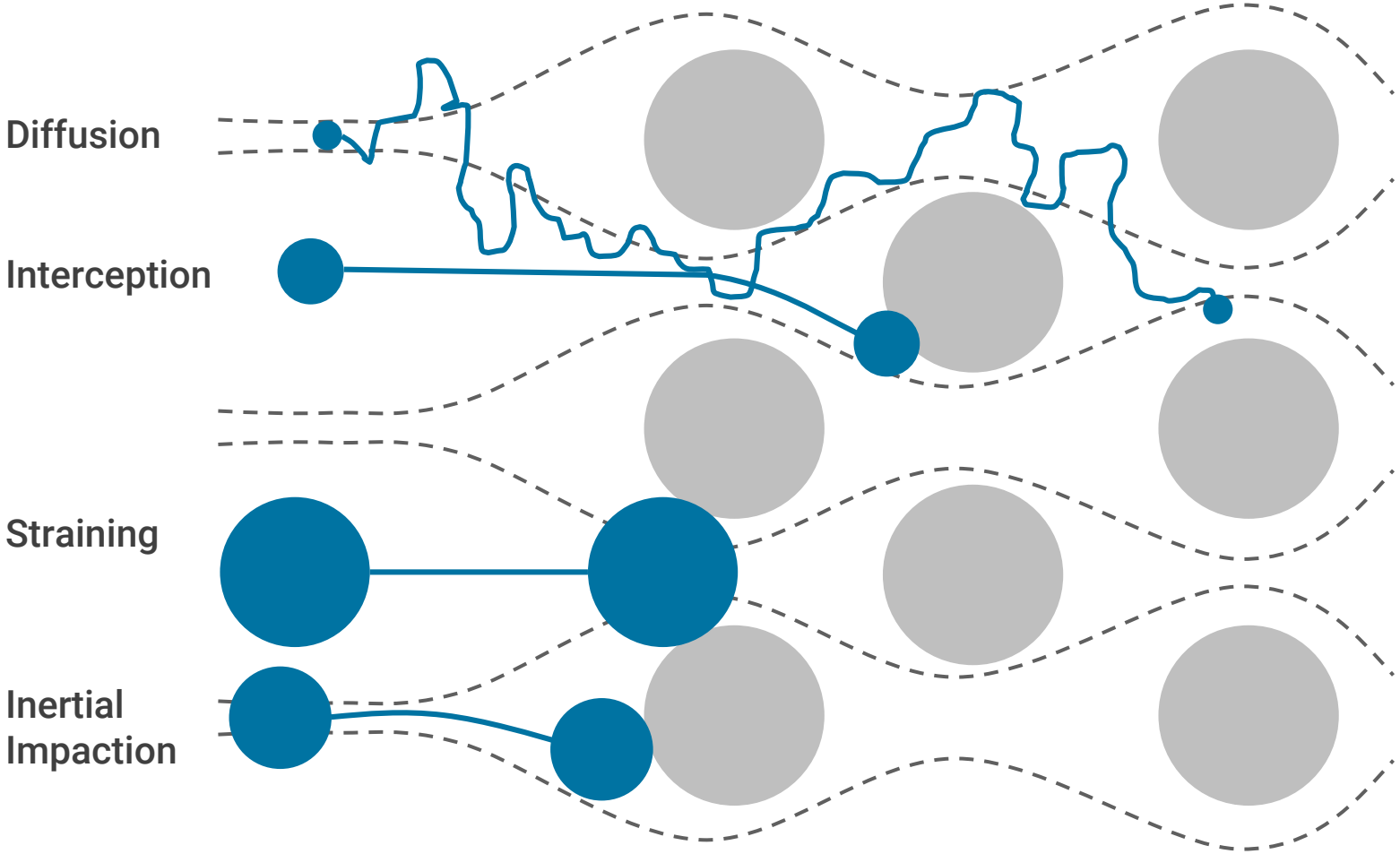
Due to the nature of the SARS-CoV2 virus, **HVAC solutions are not effective in preventing the spread of contamination person to person or eliminating airborne transmission risk**, however the following technologies are presented because they provide benefit in bacterial and virus reduction within their path of effect. The highest performance treatment systems can remove up to 99.99% of viruses.

AIR TREATMENT – HEPA FILTERS

HEPA filters consist of interlaced glass fibers that create a fibrous maze that takes particles out of circulation through diffusion, interception, straining, and inertial impaction.

HEPA Filters*

When selecting a filter, careful consideration must be given due to the pressure drop from a high filter



**In large central stations consider electronic filter (performs at MERV 15 level)*

AIR TREATMENT – FILTRATION

MERV - Minimum Efficiency Reporting Value

HEPA - High Efficiency Particulate Air filter

SARS-CoV2 is 0.06 microns to 0.14 microns

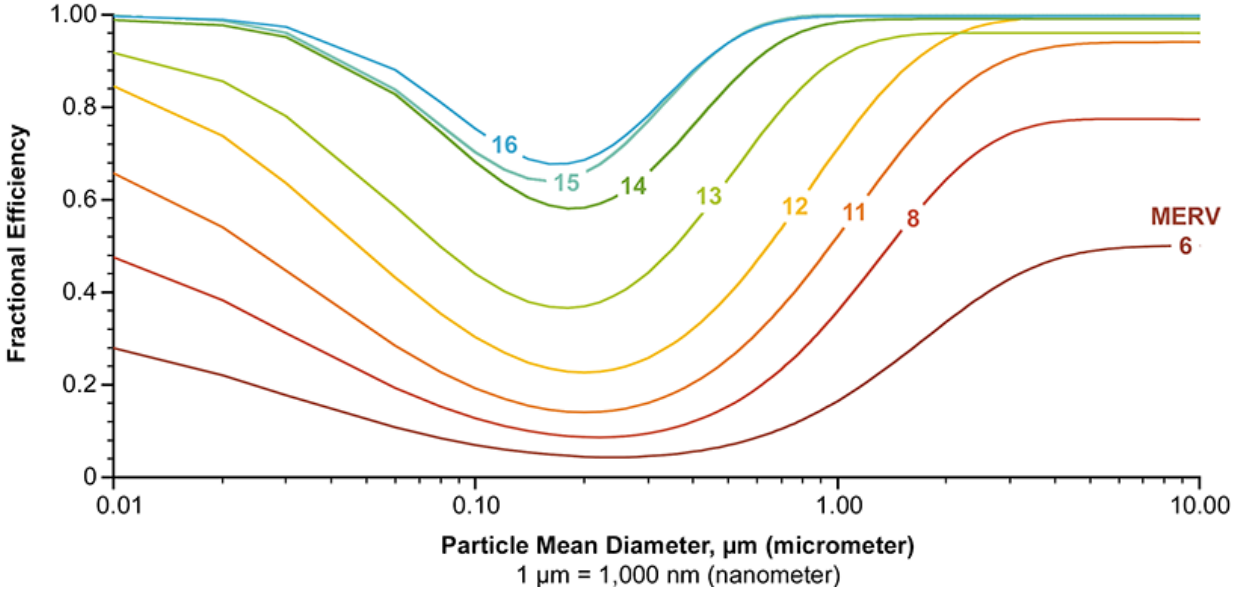
Ratings	0.3-1 microns*	1-3 microns	3-10 microns	Filter Type	Controlled Particles
MERV 8	-	-	70-85%	Low Quality MERV Filter	Mold spores, pollen, dust
MERV 9	-	<50%	85-90%	Standard MERV Filter	Fine dust
MERV 11	-	65-79%	85-90%		
MERV 13	**<75%**	<90%	<90%	Superior MERV Filter	Bacteria, viruses, smoke
MERV 14	**75-84%**	<90%	<90%		
MERV 15	**85-94%**	<90%	<90%		
MERV 16	**<95%**	<95%	<95%		
MERV 17	**99.97%**	<99%	<99%	HEPA / ULPA Filter	Small bacteria and viruses, fumes
MERV 18	**99.997%**	<99%	<99%		
MERV 19	**99.9997%**	<99%	<99%		
MERV 20	**99.99997%**	<99%	<99%		

Filters must be changed regularly. Consider monitoring air quality as well.

AIR TREATMENT – FILTRATION

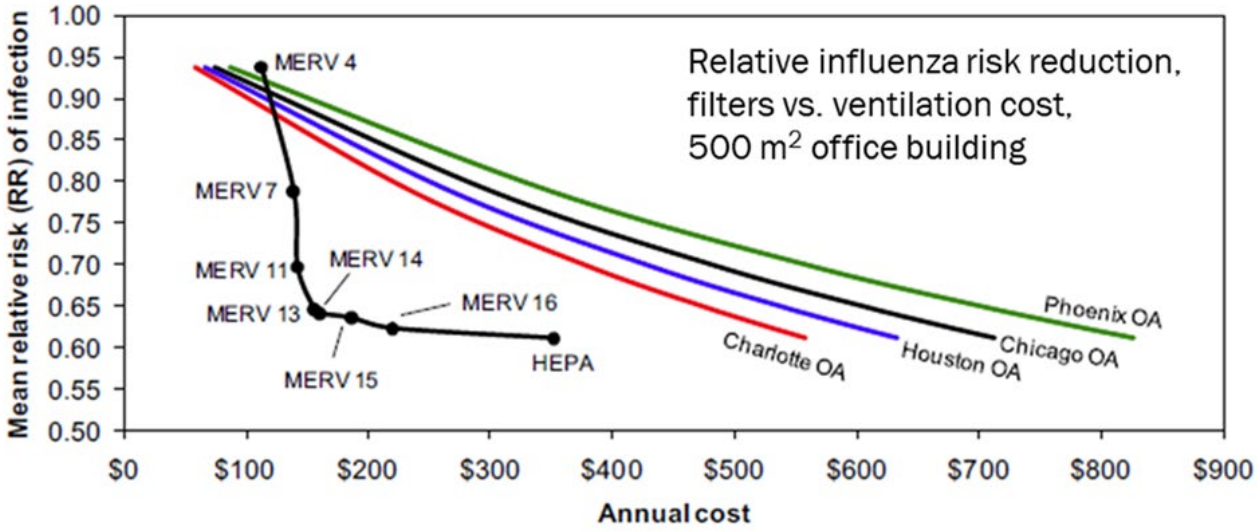
Composite model of how filters perform for influenza virus filtration versus MERV

Fractional Efficiency of MERV Rate



Source: Kowalski and Bahnfleth (2002), MERV Filter Models for Aerobiological Applications.

Filtration vs Ventilation: Cost & Risk Reduction



Source: Azimi and Stephens, Building and Environment 70 (2013).

AIR TREATMENT – FILTRATION

How filters perform for influenza virus and cost of filtration versus MERV

Infections Versus Filtration Rate

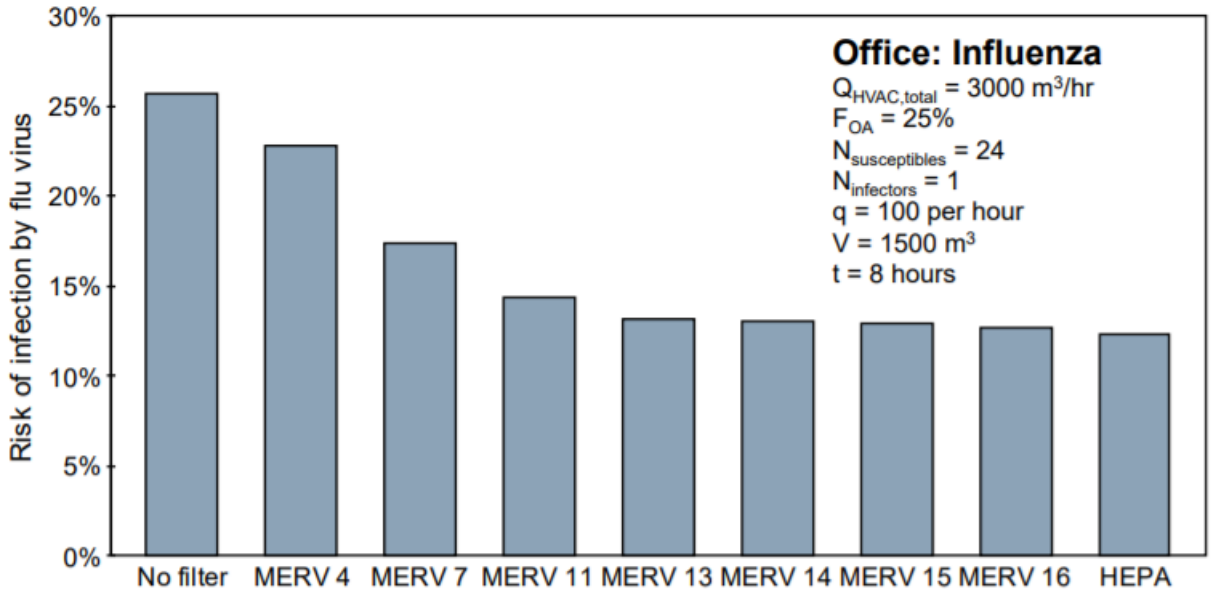


Figure 6. Projected risk of infection by influenza virus during an 8-hour workday in a hypothetical office building with 25 occupants and 25% outdoor air supply using a range of HVAC filters installed in a system with a recirculation rate of 1.5 per hour

Cost of Filtration Versus MERV

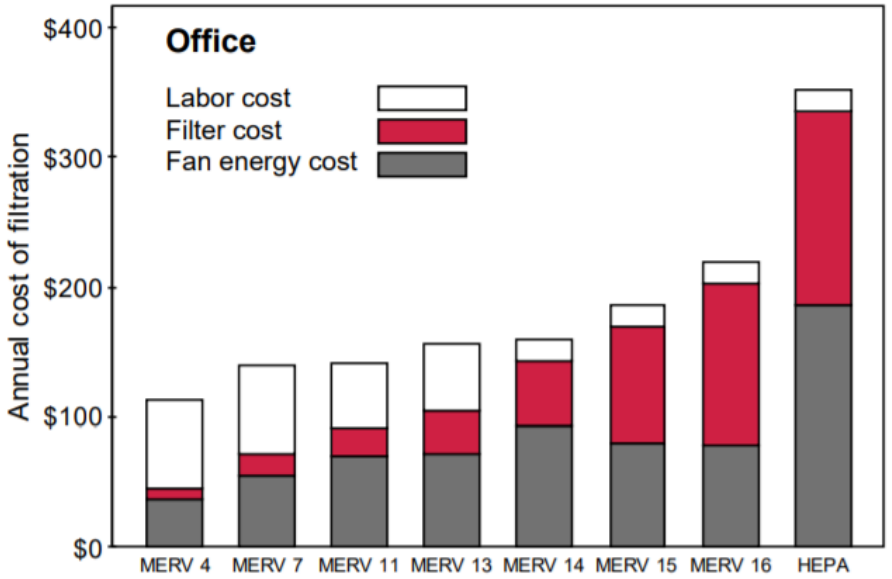
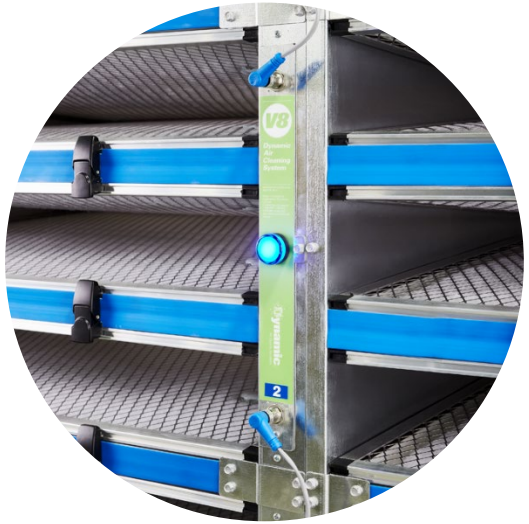


Figure 17. Estimated annual cost of filtration in the hypothetical office environment

Source: Stephens, B. HVAC Filtration & Wells Riley Approach. *Built Environment.* 3/1/12.

AIR TREATMENT – ELECTRONICALLY CHARGED FILTERS

Electronically charged filters use active-field polarized media to remove particles from the air. Another inherent mechanism of polarization uses particle agglomeration whereby ultra fine particles become polarized after passing through the air cleaner and as a result of polarization are attracted to each other, in addition to other chemical contaminants, to form bigger particles that are subsequently captured.



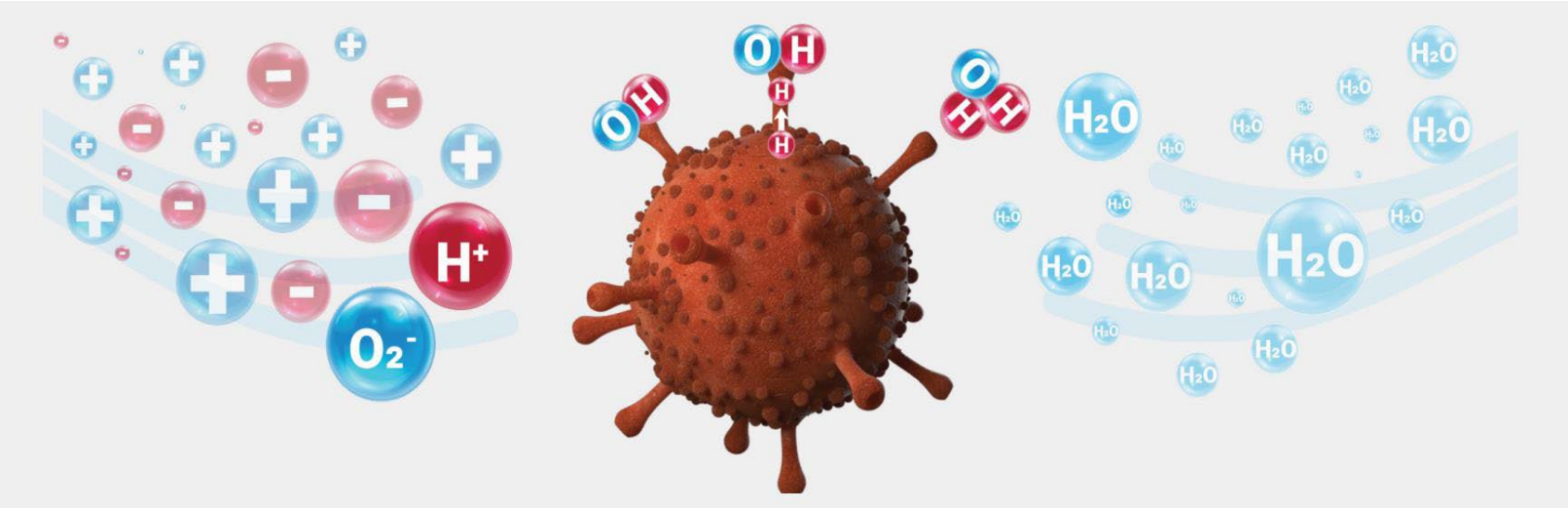
Does not require frequent filter changes and is a good option for large plant retrofits

Equivalent to a MERV 15 filter

AIR TREATMENT – BI-POLAR IONIZATION

Bi-Polar Ionization works by introducing positive and negative ions into the air via the supply side of ducts. The ionization causes production of clusters of hydroxyl (OH) radicals which are formed on the surface of microbes, removing hydrogen from the microbes cell wall, thereby inactivating the virus.

Bi-Polar Ionization



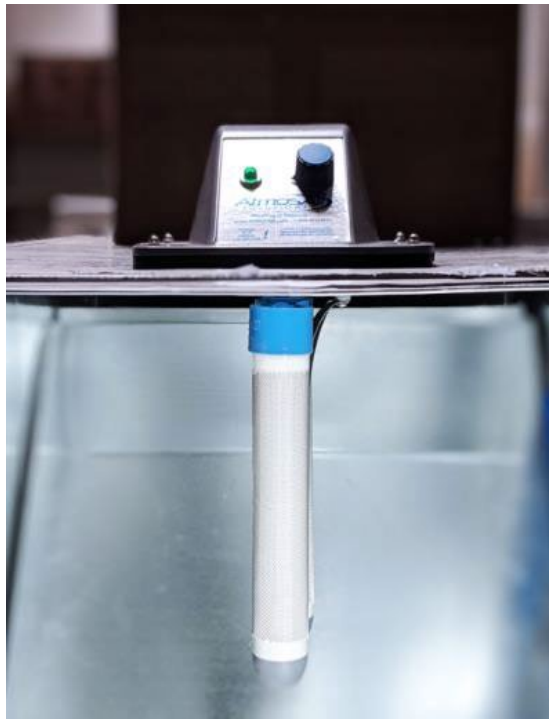
ASHRAE Position: Systems are reported to range from ineffective to very effective in reducing airborne particulates and acute health symptoms. Convincing scientifically-rigorous, peer-reviewed studies do not currently exist on this emerging technology; manufacturer data should be carefully considered.

AIR TREATMENT – BI-POLAR IONIZATION

Installation is most often in supply ducts, but can also be rack-mounted in plenums, in air handling units, or smaller units can be installed within fan coil unit plenums.

Bi-Polar Ionization

The unit has negligible air pressure drop, and can be easily retrofitted to an existing HVAC system.



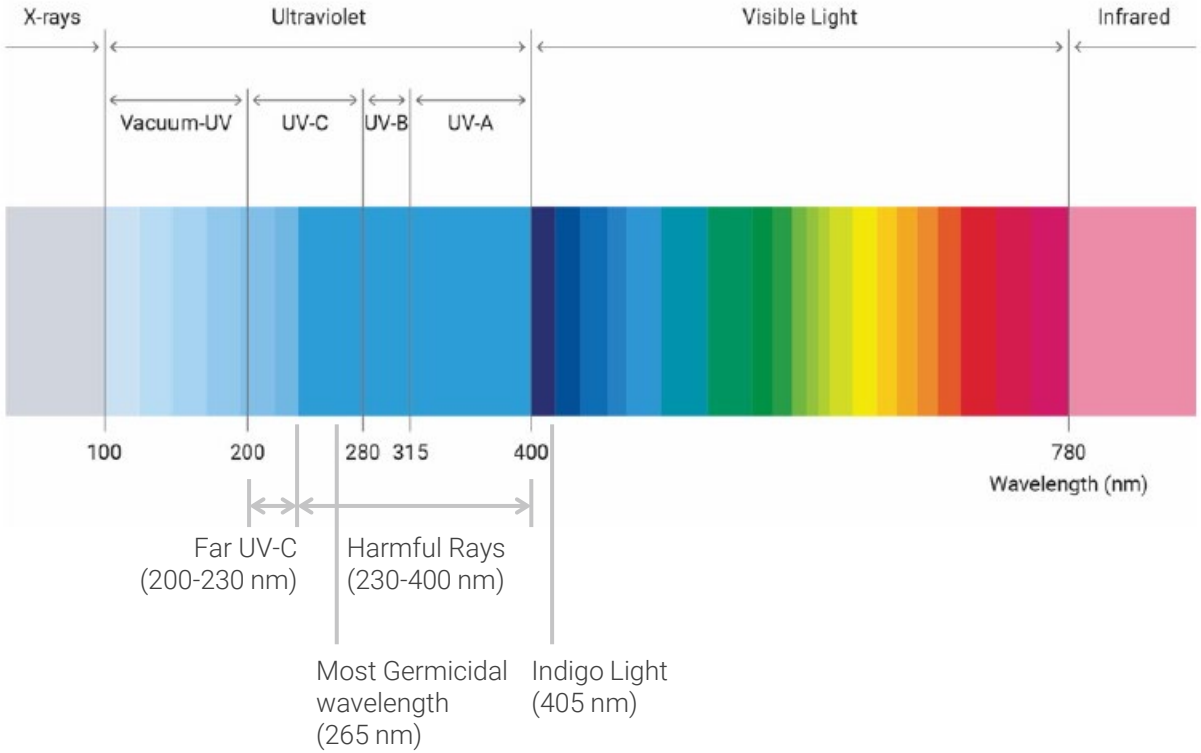
AIR TREATMENT – UV LIGHT SANITIZERS

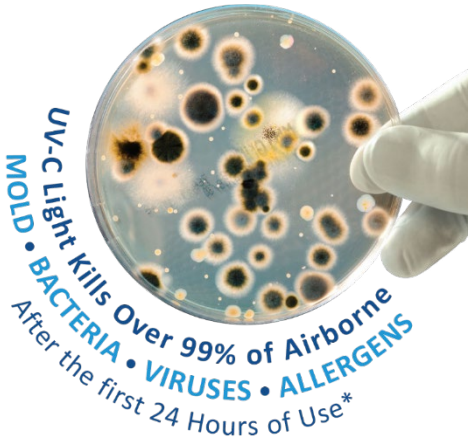
Ultraviolet light kills bacteria and viruses by destroying bonds that hold their DNA together as particles pass under the UV light they are destroyed. UV-C energy in the wavelengths from 200 to 280 nm provides the most germicidal effect, with 265 nm being the optimum wavelength. Exposure to UV-C rays is harmful to occupants.

UV Light Sanitizers

Effectiveness is based on how long air is exposed to UV (resonance time)

ELECTROMAGNETIC SPECTRUM





AIR TREATMENT – UV LIGHT SANITIZERS

Installation can be in-duct or on AHUs. Lamps installed inside HVAC can also clean cooling coils & drain pans.

The majority of modern UVGI lamps create UV-C energy at a near optimum 254 nm wavelength

Works by installing banks of UV-Lamps inside HVAC systems or associated ductwork. Consider adding to return air plenums or downstream of cooling coils.

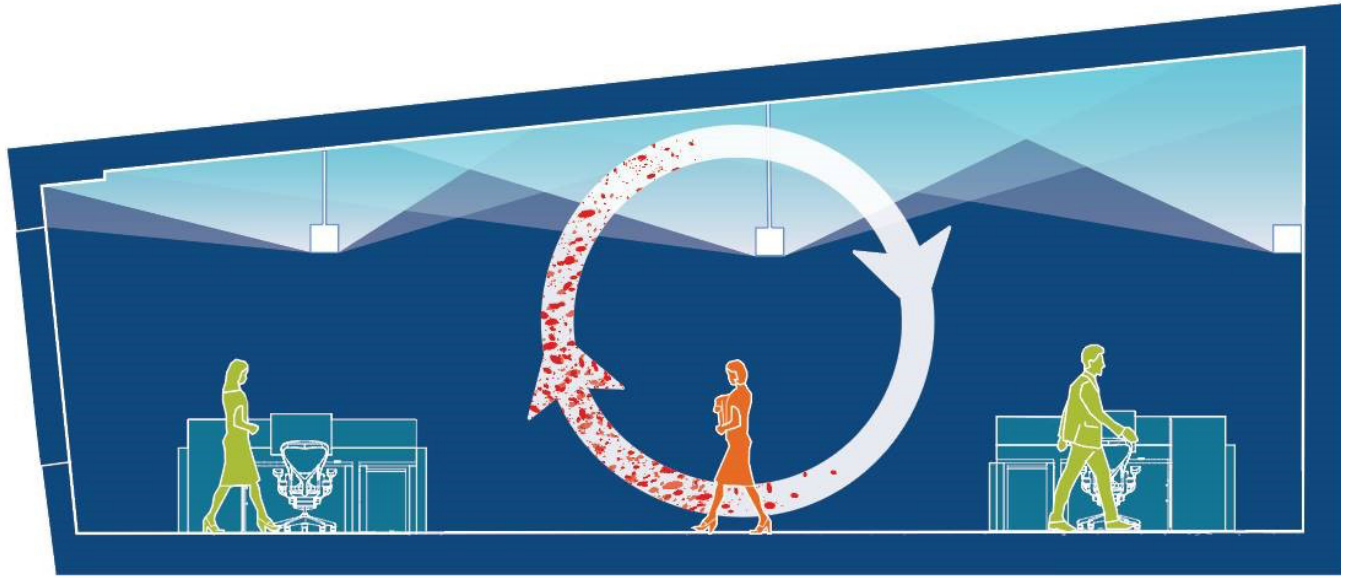
Requires high UV doses to inactivate microorganisms on-the-fly as they pass through the irradiated zone due to limited exposure time.

- 99.9% Coronavirus deactivation in 0.25 seconds (first pass) is commercially available.
- Systems typically designed for 500 fpm (at AHU) moving airstream.
- Installation in ductwork at higher velocities is possible, with exponentially higher lamp power

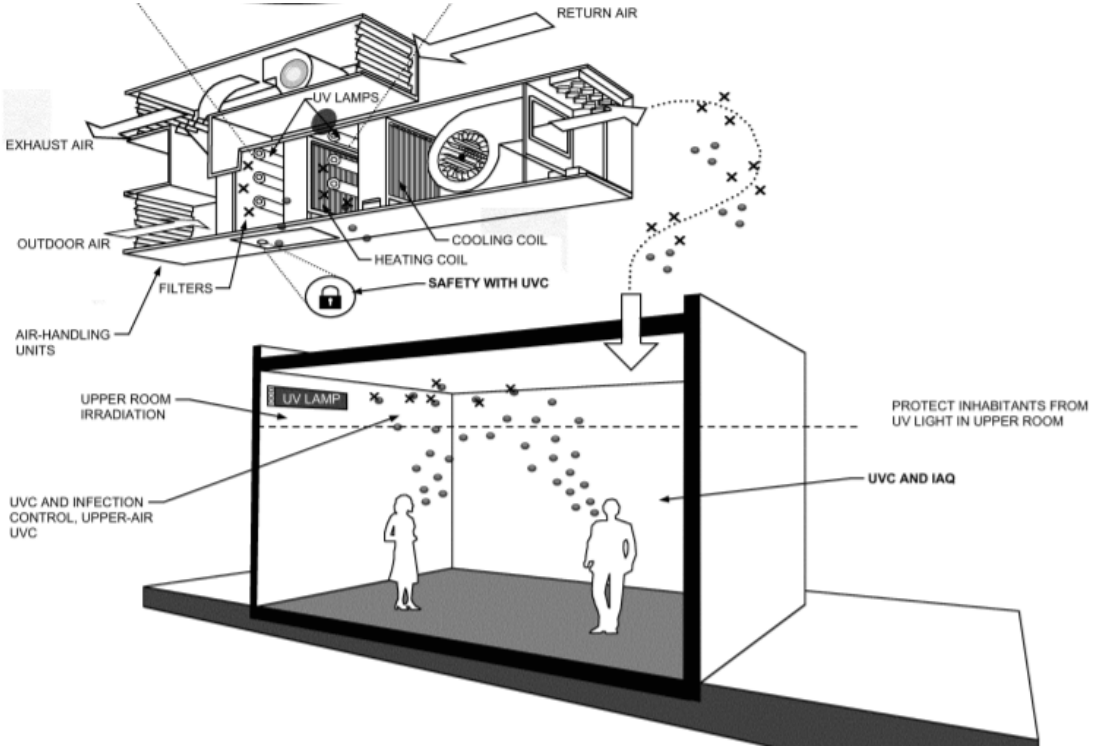
Should always be coupled with mechanical filtration.

AIR TREATMENT – UV LIGHT SANITIZERS

Upper room UV disinfection involves mounting lights from the ceilings or on the walls and pointing them upwards to disinfect the upper room air. It can be used in combination with in-duct UV for maximum effect. The UV-C lamps must be mounted 7’ in the air to protect inhabitants from the harmful UV rays. Requires low UV-reflectivity of walls and ceilings and ventilation should maximize air mixing (supplemental fans needed where ventilation is insufficient).



Upper Room Air UV Light Disinfection



AIR TREATMENT – UV LIGHT SANITIZERS

Portable, fully automated units that can be controlled remotely. Effective on air and surfaces where the light can penetrate (not in shadowed areas).

Units have settings for specific pathogens such as MRSA, C. difficile, both of which are harder to inactivate than coronaviruses.

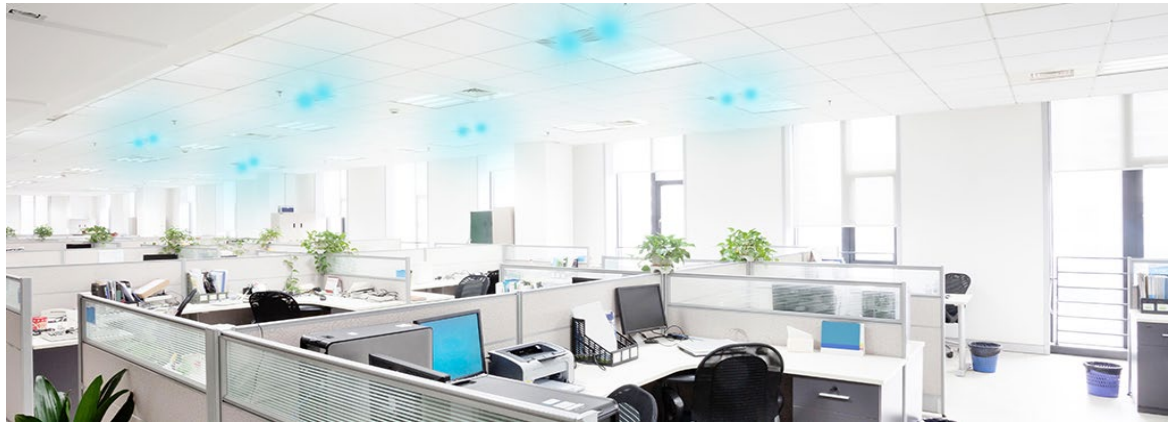
- >99.9% reduction of vegetative bacteria within 15 minutes[1]
- 99.8% for C. difficile spores within 50 minutes[1]

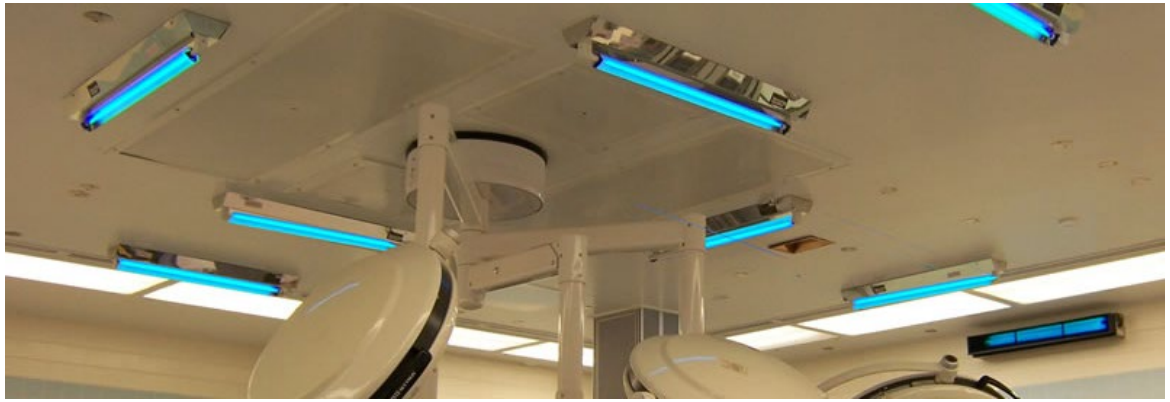
Pulsed Xenon lamps: High-powered UV lamps (generally containing xenon gas) used in rapid pulses of intense energy. Emits a broad brand of visible and ultraviolet wavelengths, with a significant fraction in the UV-C band. Uses significantly higher power outputs than usual UV-C techniques.

1. Weber DJ1, Rutala WA, Miller MB, Huslage K, Sickbert-Bennett E. Role of hospital surfaces in the transmission of emerging health care-associated pathogens: norovirus, Clostridium difficile, and Acinetobacter species. American Journal of Infection Control 2010..

AIR TREATMENT – UV LIGHT SANITIZERS

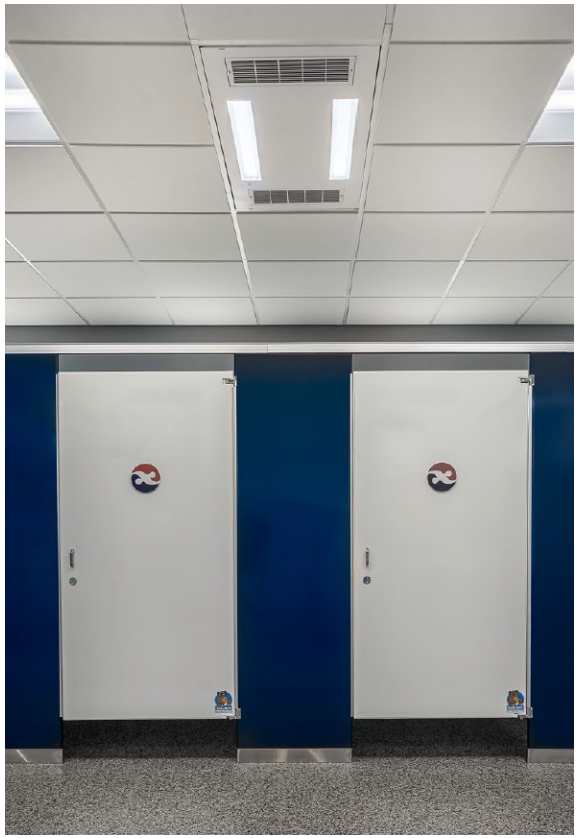
UV-C lights on occupancy sensors so they can sanitize spaces when unoccupied.



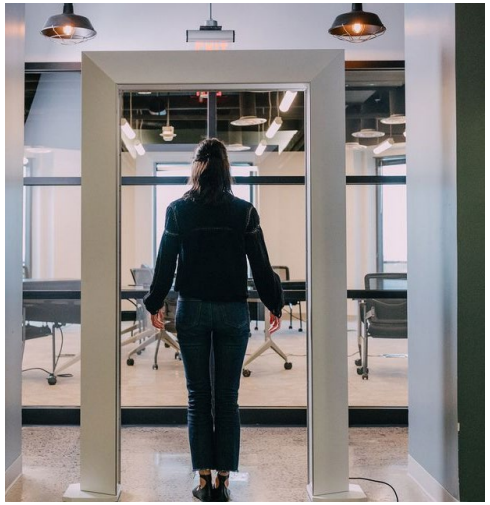


More UV-C lights in various shapes and styles are currently in development, including UV-C LED's which are emerging for use.

Far UV-C lights (200-230 nm spectrum) can sanitize without harming occupants[1]. Awaiting more testing.



One cleanse per 800ft3 achieves 4 air exchanges per hour (50cfm) and also includes a HEPA & Carbon filter



Individual downlights and doorway disinfection technology currently in development

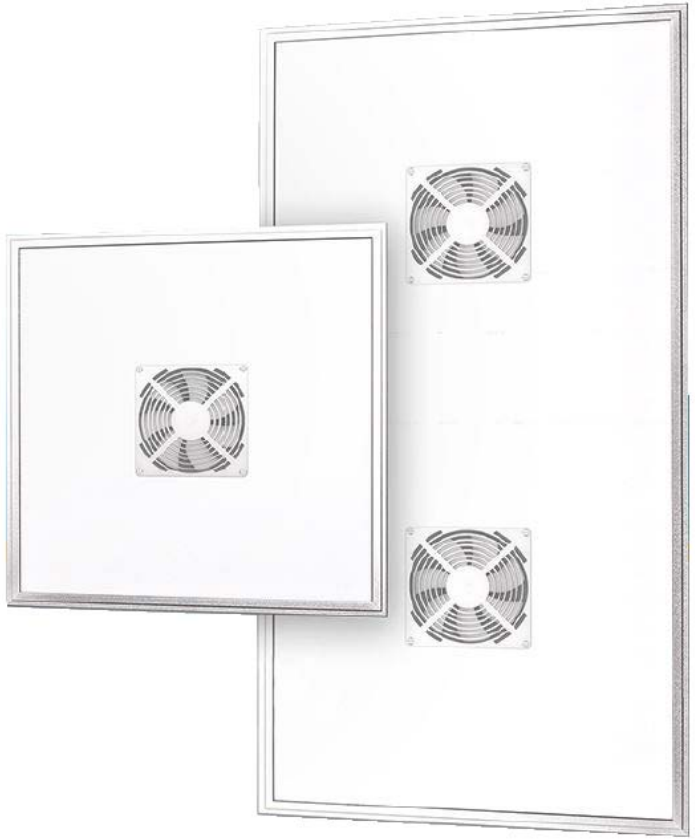
1. Rich M. Simons, Far UV-C in the 200 – 225 nm range, and its potential for disinfection applications. IUVA July 2020. https://bit.ly/2B5rYaa

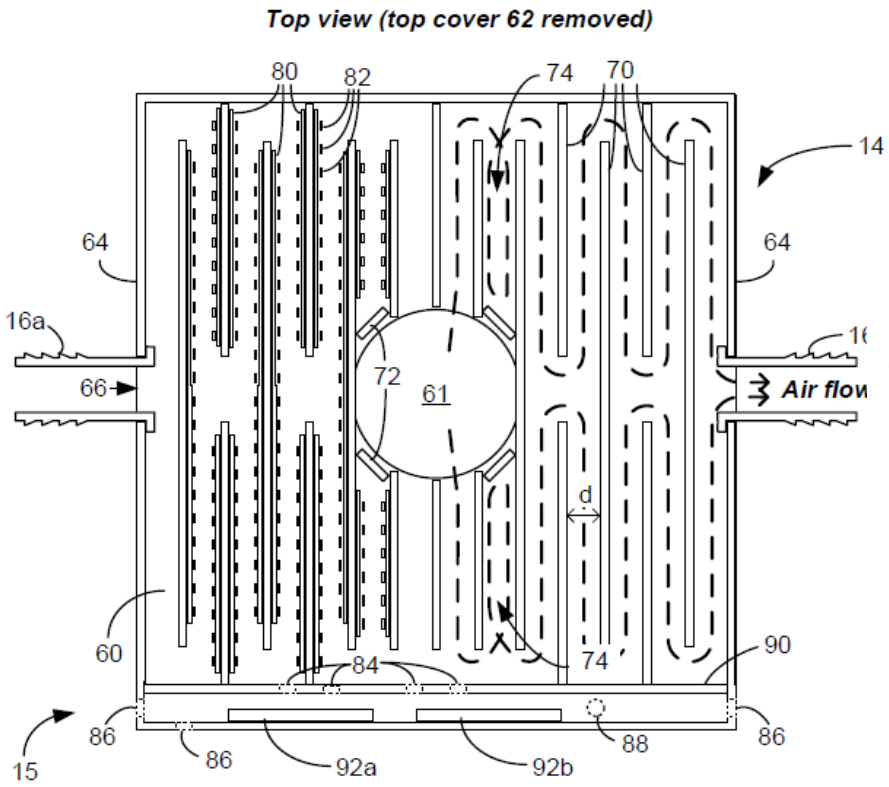
AIR TREATMENT – INDIGO CLEAN

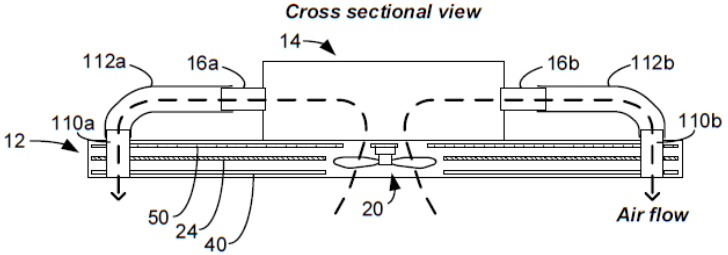
A dual-mode disinfecting light system that remains in the visible light spectrum, operating at 405nm. It is safe for human occupancy while on and has the ability to be on 24/7. The number of studies documenting its performance are very limited and the required exposure times required are relatively long.

AIR TREATMENT – UV LIGHT SANITIZERS (IN DEVELOPMENT)

Air filtering UV light disinfection system includes a 405 nm downlight and a 260-265 UV-C uplight. A fan brings the air into the unit and the maze of UV lights gives the required dosage for disinfection.







EMERGING TECHNOLOGIES – DFS SYSTEM

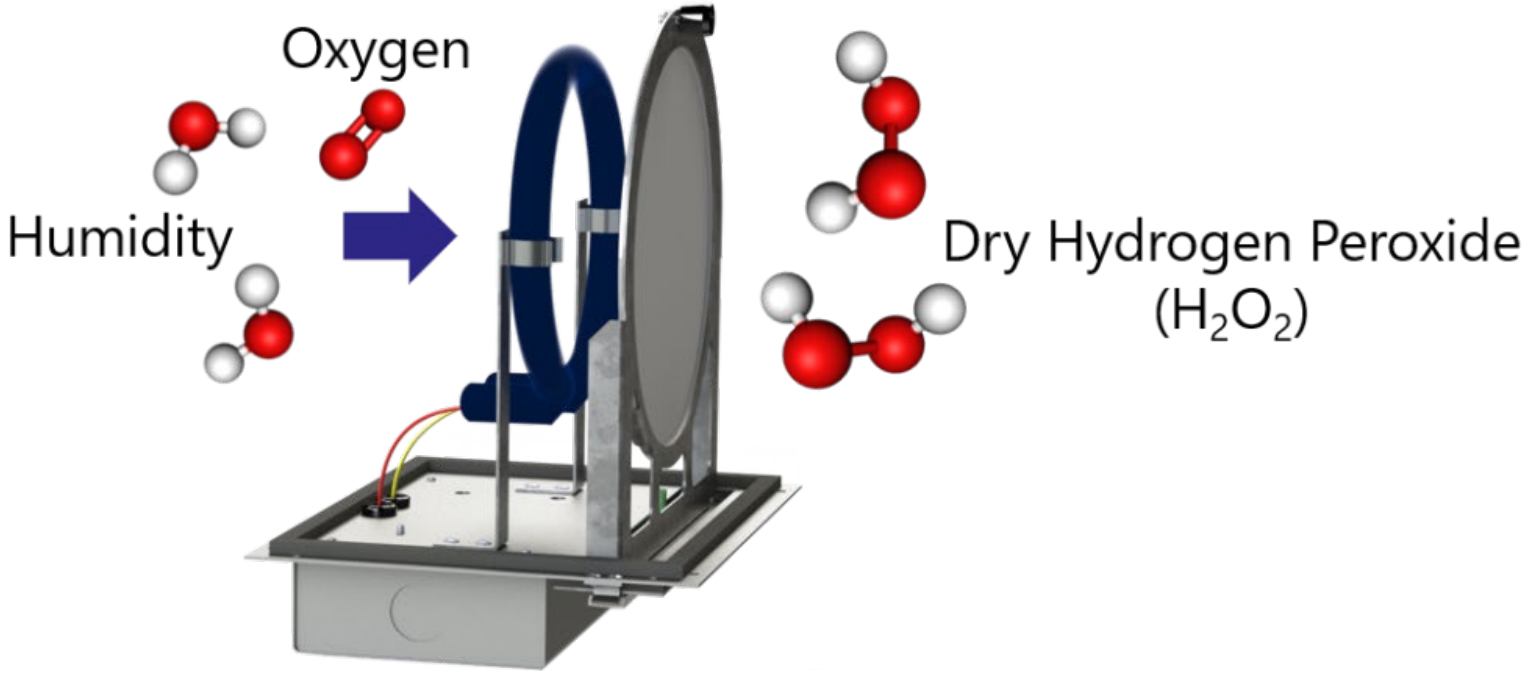
A Disinfecting Filtration System (DFS) traps microorganisms such as bacteria, mold and viruses, reduces bioburden and inhibits microorganism's growth through Microbiostatic condition. The system captures 99.99% of all particles down to .0007 micron in size. System consists of a constant energy field, particle agglomeration and a MERV 15 filter. The filters estimated life expectancy is 1 year.

Self contained independent blower that can be retrofitted to HVAC system or installed as a standalone unit above ceiling space to treat targeted areas. Has zero pressure drop.

Portable Unit

EMERGING TECHNOLOGIES – DHP System

The Dry Hydrogen Peroxide (DHP) system uses ambient oxygen and humidity to create a safe amount of H_2O_2 (5-25 parts per billion) in the air. The molecules attach itself to a microbe's access points and naturally breaks down the microbe. The technology works on odors and insects as well. Works on both air and surfaces. Non-Ozone producing system and regulated by the EPA.



Device fits in-line with existing HVAC ductwork

Portable Systems, duct mounted, and unitary systems

Fogging System

AIR TREATMENT OPTIONS SUMMARY

Due to the nature of the SARS-CoV2 virus, **HVAC solutions are not effective in preventing the spread of contamination person to person or eliminating airborne transmission risk**, however the following technologies are presented because they provide benefit in bacterial and virus reduction within their path of effect.

	High Efficiency/ HEPA Filters	Ionization	UV Light	Activated Carbon
Effectiveness against Viruses	**Very Good**	**Not Effective** (Good on surfaces)	**Good** (Depending on contact time)	**Poor**
Effectiveness against Bacteria	**Excellent**	**Not Effective** (Good on surfaces)	**Good** (Depending on contact time)	**Poor**
Removes Gasses (Radon, Formaldehyde, etc.)	Not Effective	Not Effective	Not Effective	Excellent
Eliminates Odors	Not Effective	Good	Not Effective	Excellent
Effectiveness against pet dander/pollen	Excellent	Excellent	Not Effective	Not Effective
Effectiveness against mold spores	Excellent	Excellent	Good	Not Effective
Effectiveness against dust mite excreta	Excellent	Excellent	Poor	Poor
Cost per cartridge	Moderate	Moderate	Moderate	Inexpensive
Cartridge life expectancy	1 Year	2 years	1 year	3-12 Months

Ineffective  Very Effective

HUMIDIFICATION

"maintaining a RH between 40% and 60% indoors may help to limit the spread and survival of SARS-CoV-2"[1]

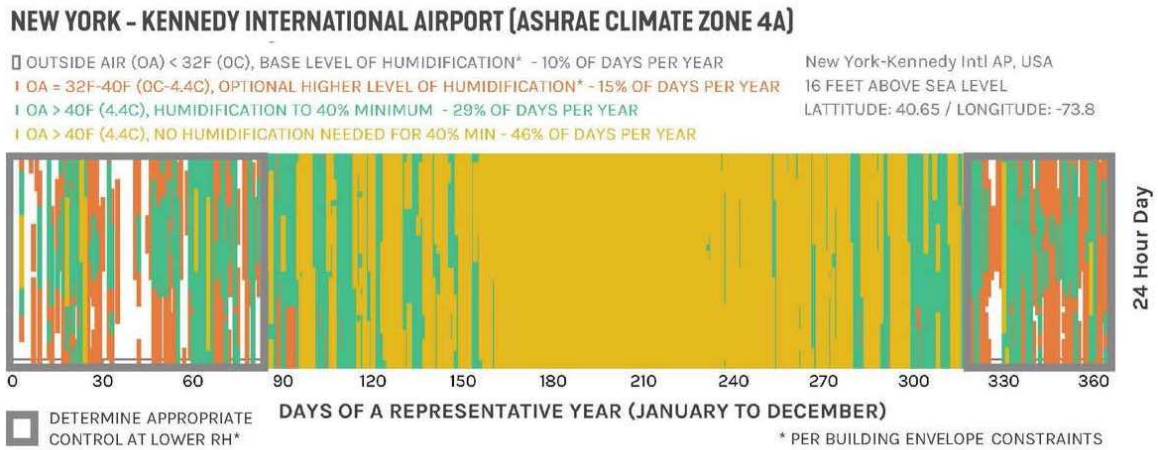


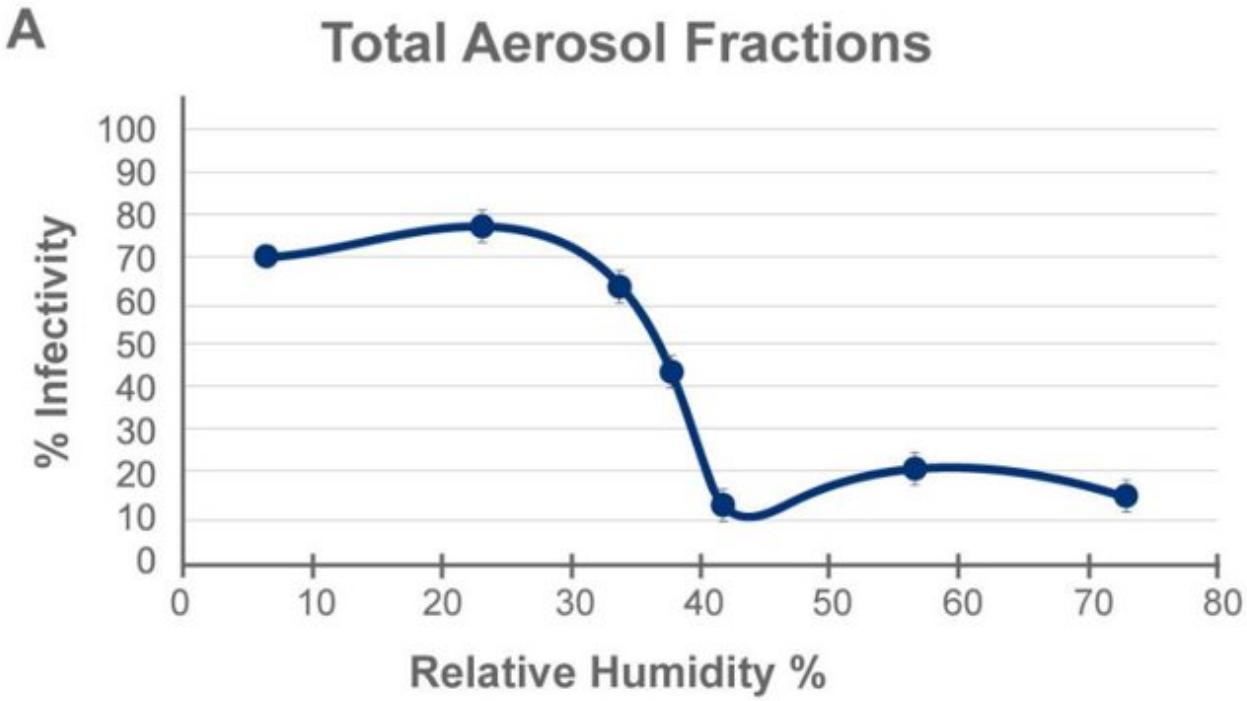
Chart courtesy of Smith group from CSE Magazine "Climate-informed HVAC increases in relative humidity may fight COVID-19 and other pandemics" by George Karidis & Rob Thompson

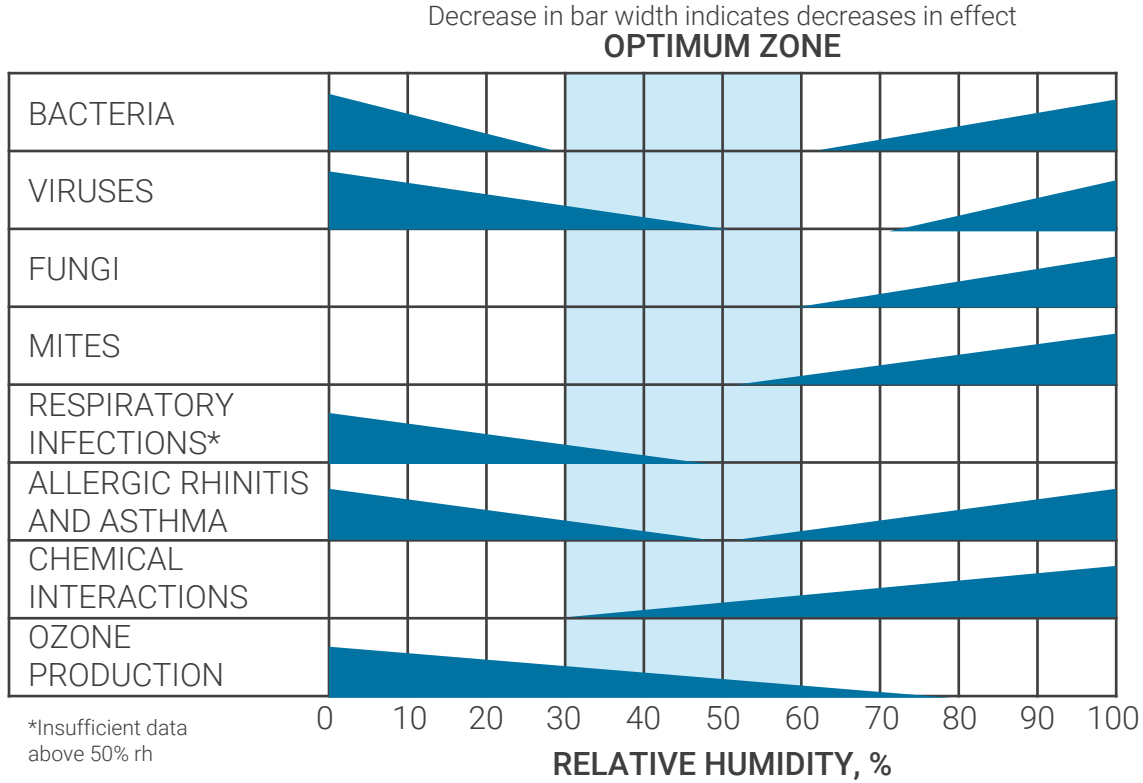
- Higher indoor RH has been shown to reduce infectious influenza[2]
- Higher RH decreases airborne dispersal by maintaining larger droplets that contain viral particles, thus causing them to deposit onto room surfaces more quickly[3]
- Higher humidity likely negatively impacts lipid-enveloped viruses, like CoVs, through interactions with the polar membrane heads that lead to conformational changes of the membrane, causing disruption and inactivation of the virus[4]
- Low ambient humidity hurts the ability of the immune system to fight respiratory viral infection[5]

1. *American Society for Microbiology "2019 Novel Coronavirus (COVID-19) Pandemic: Built Environment Considerations To Reduce Transmission" by Leslie Dietz, Patrick F. Horve, David A. Coil, Mark Fretz, Jonathan A. Eisen, Kevin Van Den Wymelenberg, Jack A. Gilbert, Editor*
2. *Noti JD, Blachere FM, McMillen CM, Lindsley WG, Kashon ML, Slaughter DR, Beezhold DH. 2013. High humidity leads to loss of infectious influenza virus from simulated coughs. PLoS One*
3. *Kim SW, Ramakrishnan MA, Raynor PC, Goyal SM. 2007. Effects of humidity and other factors on the generation and sampling of a coronavirus aerosol. Aerobiologia*
4. *Yang W, Marr LC. 2012. Mechanisms by which ambient humidity may affect viruses in aerosols. Appl Environ Microbiol*
5. *Kudo E, Song E, Yockey LJ, Rakib T, Wong PW, Homer RJ, Iwasaki A. 2019. Low ambient humidity impairs barrier function and innate resistance against influenza infection. Proc Natl Acad Sci U S A*

HUMIDIFICATION

- Higher humidity reduces infectivity of influenza[1]
- Membranes in the respiratory track/nose dry out quicker in low humidity[2]
- Low humidity results in breathing smaller particles[3]



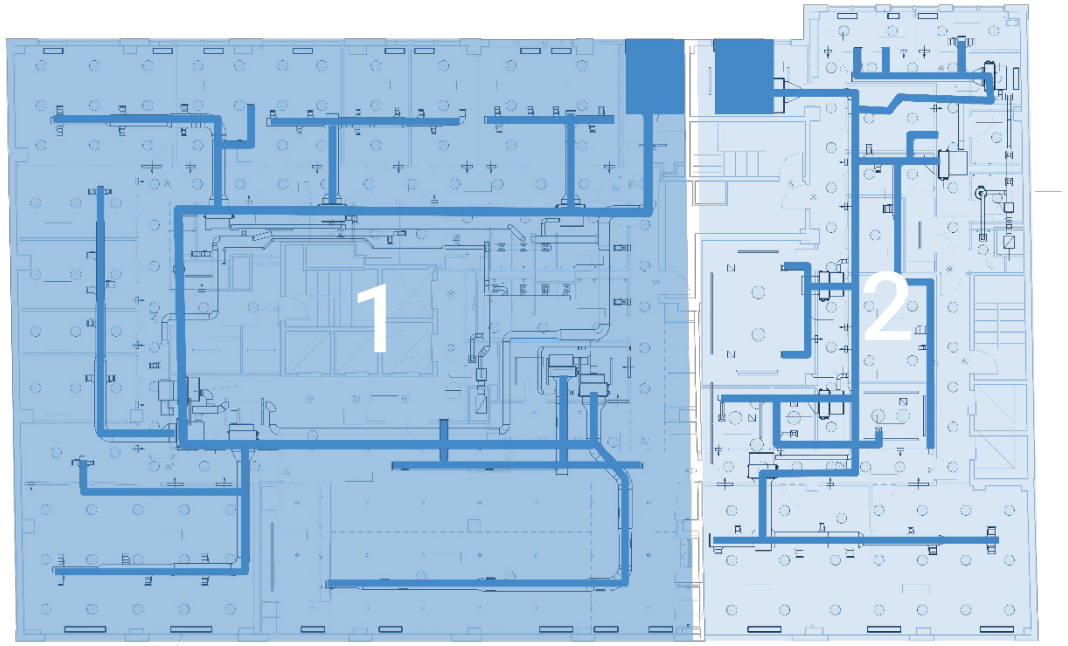


*Insufficient data above 50% rh

1. *John Noti, et al, Humidity Leads to Loss of Infectious Influenza Virus from Simulated Coughs (February 27, 2013)*
2. *J.P. Guggenbichler, R. Huster and S. Geiger, Luftfeuchtigkeit und Immunabwehr Die Rolle der Schleimhaut und Auswirkungen auf die Klimatechnik (2007) Tab Technik AM, Vol. 38 No. 9*
3. *ASHRAE Guidelline 10-2016, Interactions Affecting the Achievement of Acceptable Indoor Environments*

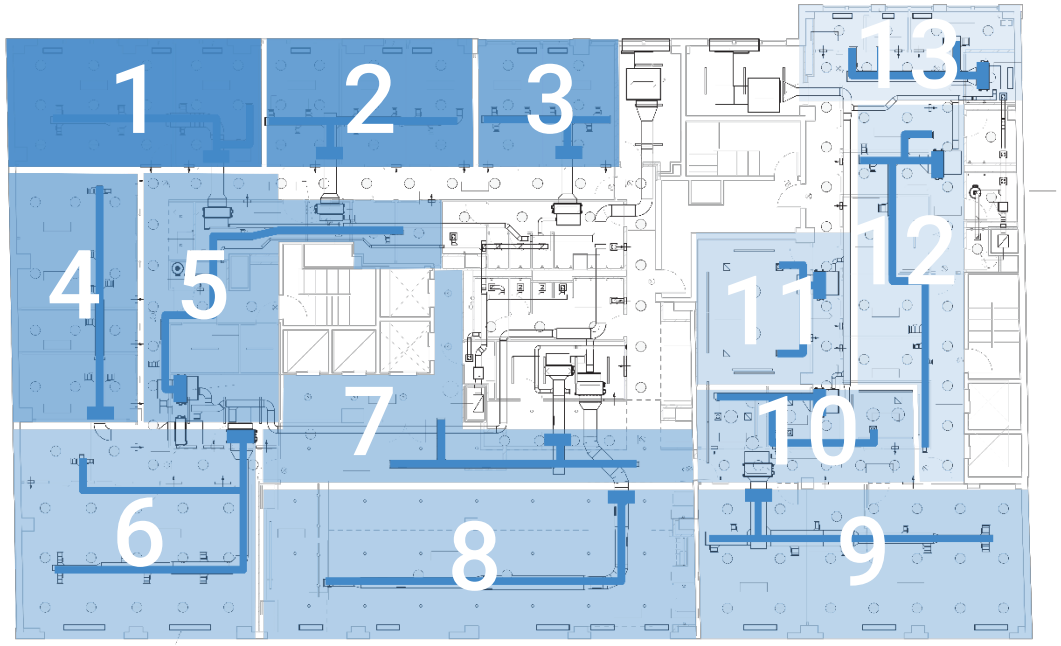
HVAC ZONES

Using smaller zones (500 sf) will lower recirculation of air. Consider use of VRF or DOAS systems.



Typical zoning with Floor-by-Floor AHU

Floor by floor AHU's have a higher efficiency filter (typically MERV 8-13) but the mix of outside air percentage can vary and contamination zones are larger.



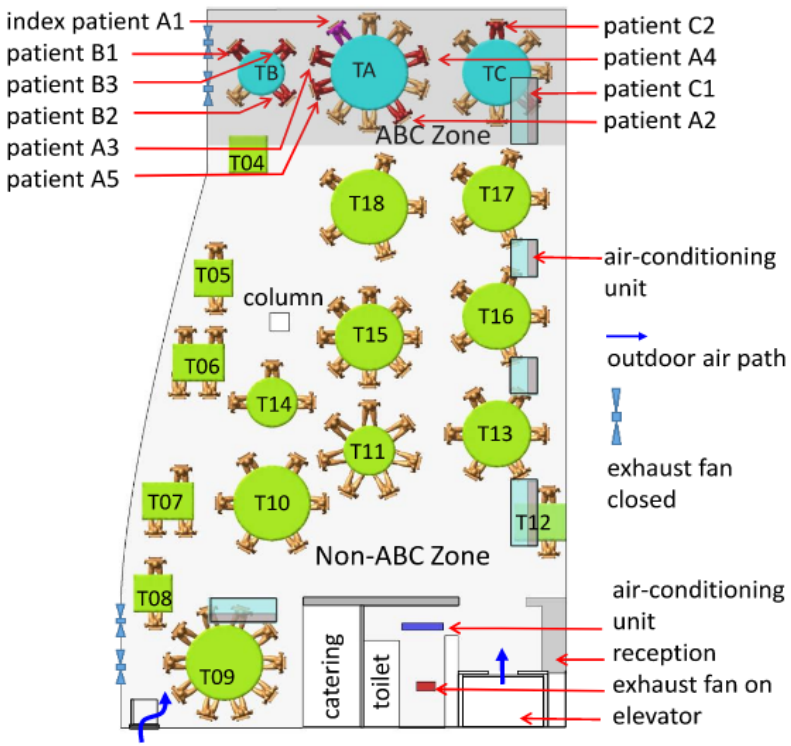
Multiple small zones from use of VRF system

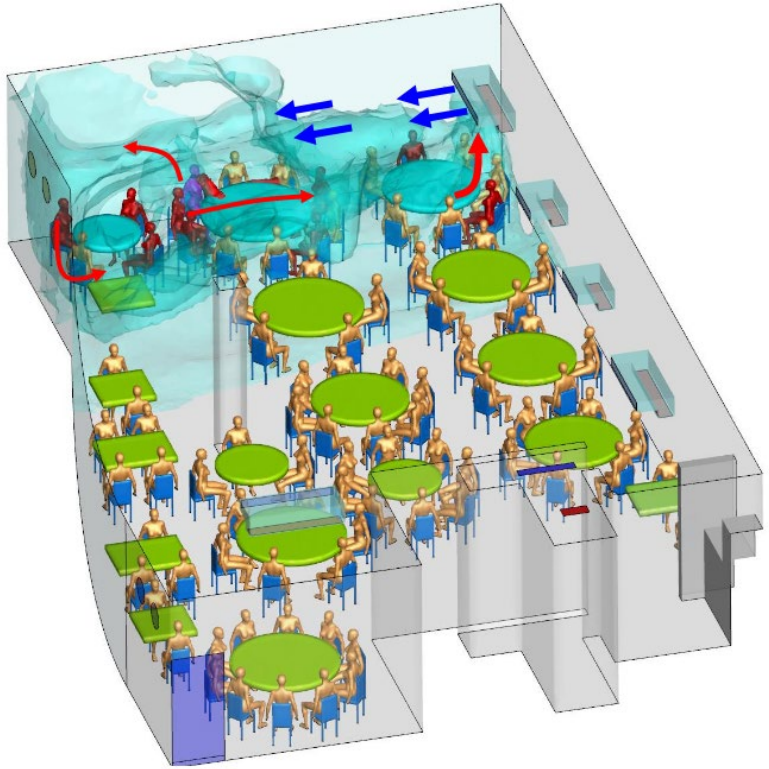
VRFs have a lower efficiency filter but can be retrofitted to accept a MERV 8 or potentially higher efficiency filter. Percentage of outside air is assured.

HVAC ZONES

COVID-19 Outbreak Study within a Restaurant in Guangzhou, China

Air circulation and Ventilation



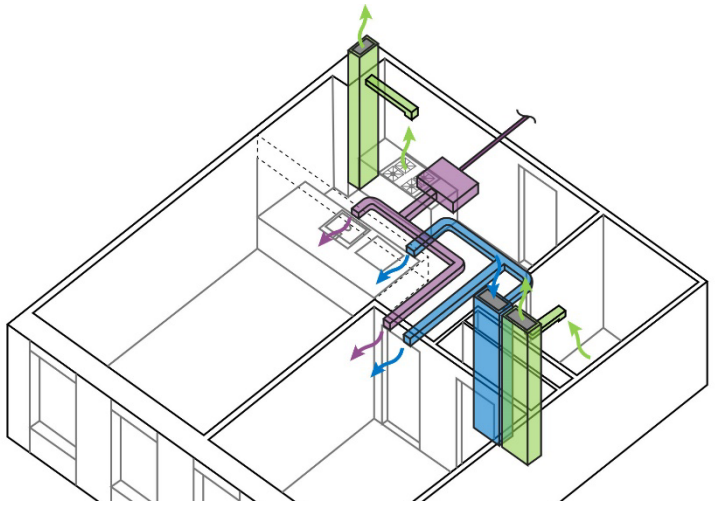


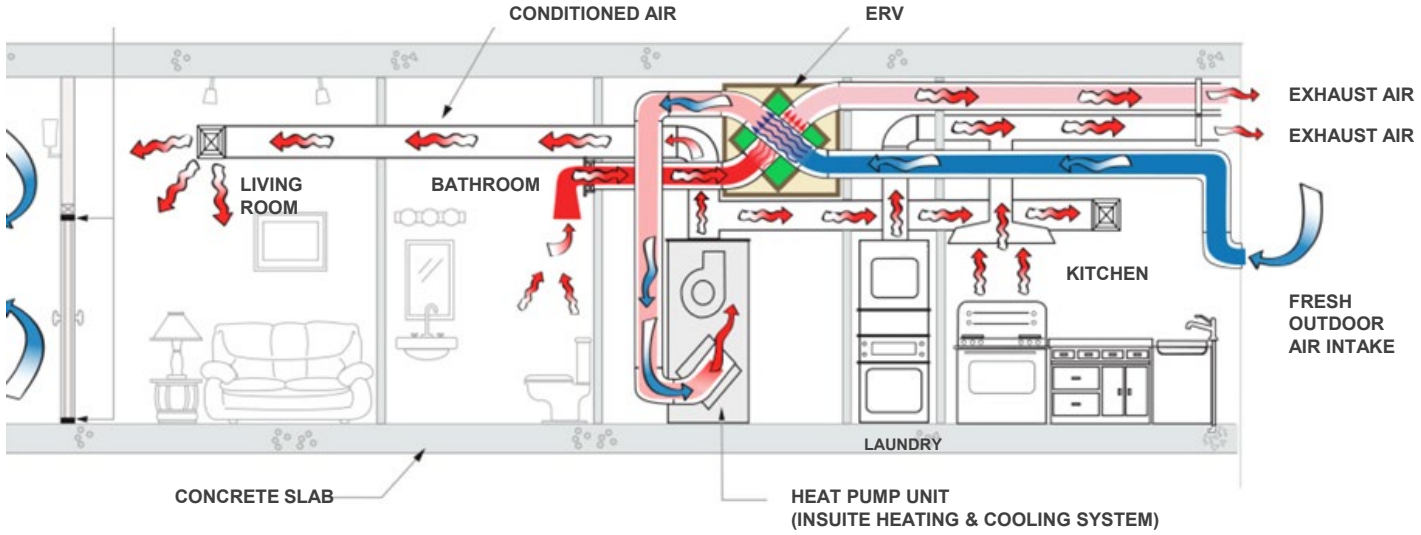
January 24, 2020, 12:00 PM, Chinese New Years Eve luncheon
5-story restaurant, 3rd floor of the restaurant
Exposure time: 53 minutes for TA & TB, 75 min for TA & TC

Source: Lu J, Gu J, Li K, Xu C, Su W, Lai Z, et al. COVID-19 outbreak associated with air conditioning in restaurant, Guangzhou, China, 2020. Emerg Infect Dis. 2020

DECENTRALIZED SYSTEMS

Decentralizing systems prevents recirculation of air and toilet exhaust into other apartments.





Advantages:

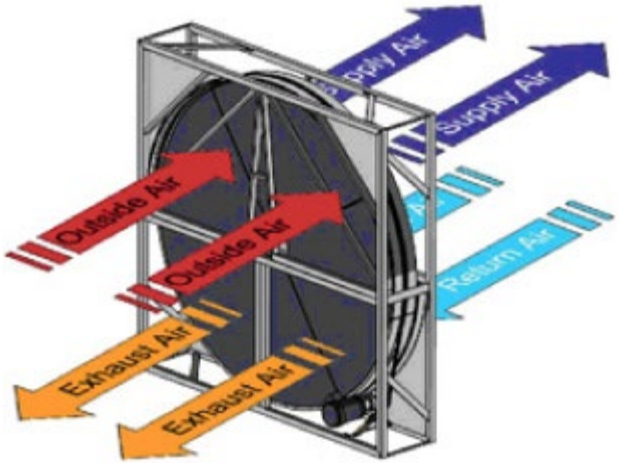
- Energy savings and better indoor air quality
- Eliminates vertical central toilet exhaust systems and shafts
- Cost of operation of exhaust fan will be on tenant and not on base building.

Disadvantages:

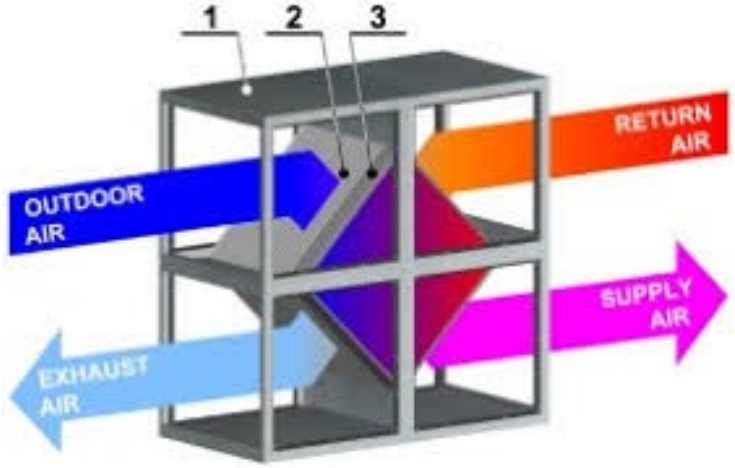
- Additional cost of providing soffits and ceiling in apartments for horizontal ductwork and equipment
- Challenging to locate intake and exhaust louvers on façade away from windows and from each other
- Stack effect issues due to multiple openings on the façade on higher floors
- Potentially more openings in the building facade (aesthetics, sealing/waterproofing)

ENERGY RECOVERY UNITS

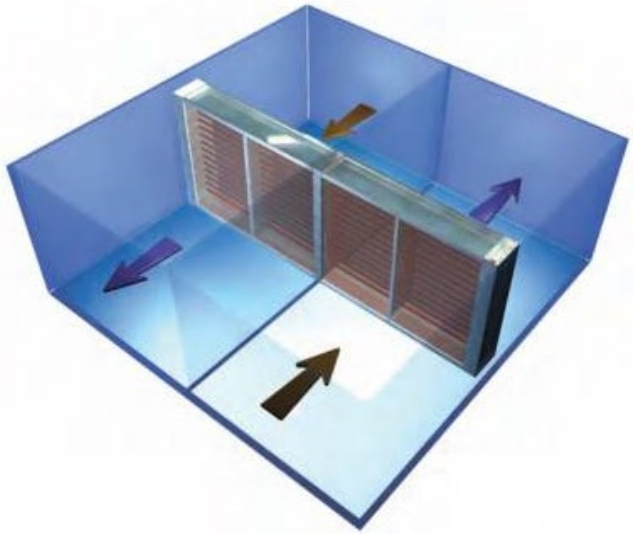
Heat exchangers reduce possibility of cross contamination between air streams. Careful management of the energy recovery unit is necessary for proper disinfection and maintenance of system to prevent air leakage. UV Sterilization, cross flow heat exchangers, and heat pipes are all technology to consider. Certain brands of energy recovery wheel may prevent air leakage better than others.



Energy Recovery Wheel



Cross Flow Heat Exchanger



Heat Pipe

TOUCHLESS TECHNOLOGY

Doors & Entryways

Destination Dispatch Elevators

Automatic Doors (motion sensor, facial recognition, optical foot sensor)

Pantries

App-based coffee and water machines

Motion sensor faucet with 20 second timer and soap dispensers

Touchless cabinets or open shelves for frequently used items

Use bottle fillers instead of drinking fountains

Bathrooms

Motion sensor flushometer, faucet with 20 second timer, and soap dispenser

Paper towels instead of automatic hand dryers

UV disinfecting on seats

UV lamps in bathrooms for after-hours disinfection

Lighting

Lighting Controls

Automated Shading

BMS & app-based controls for lighting controls & automated shading

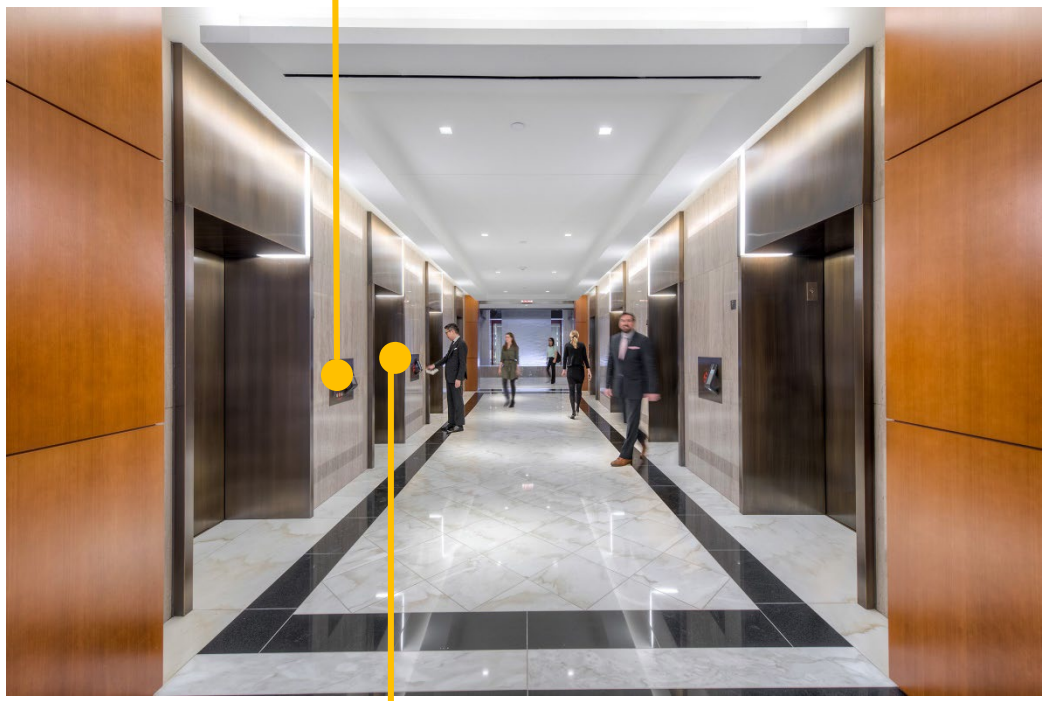
BUILDING LOBBY

Automatic doors

Plexi barrier for security/ reception desks

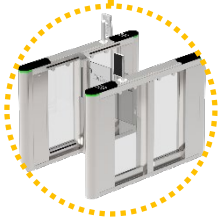
Increase outside air, enhanced filtration, and air treatment systems

Touchless destination dispatch system via card or mobile app. Keep elevator doors open at lobby/floors (note stack effect concern in winter).



Entryway mats

Sanitization station at entry



Facial recognition/mask scanning, thermal scanning, and touch-free security

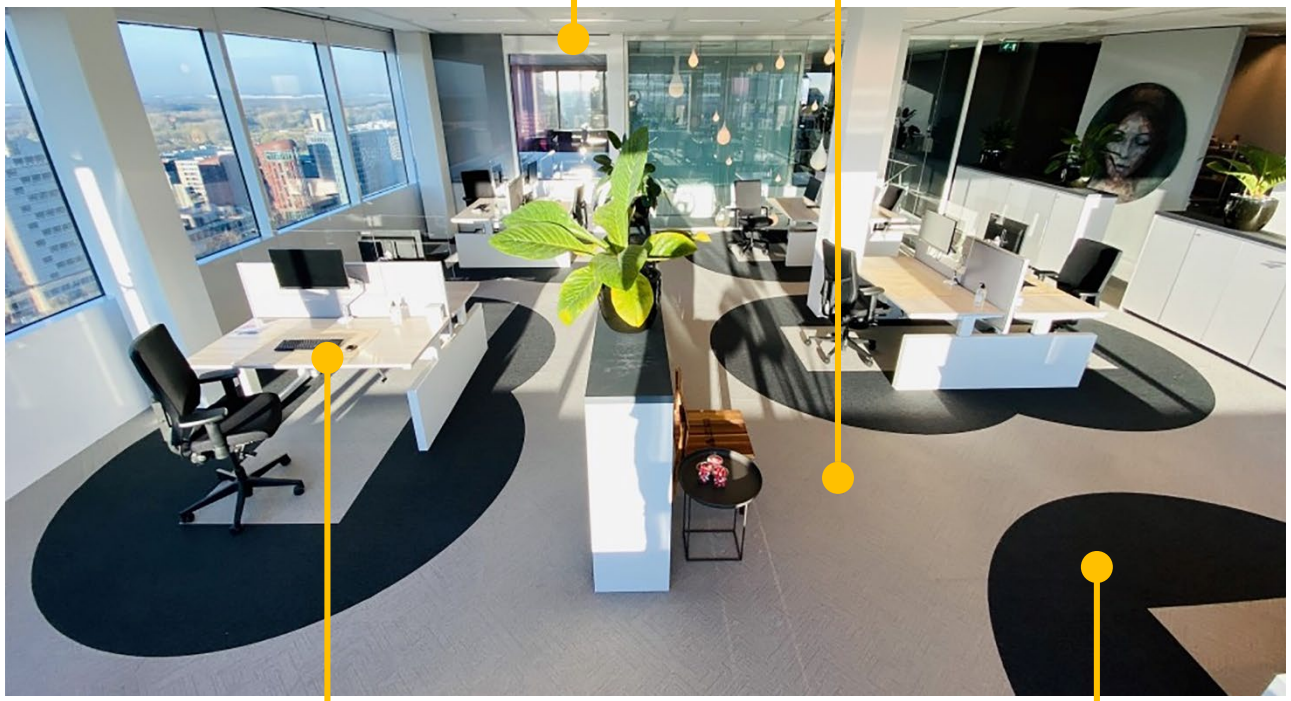
Minimize elevator occupancy and use floor stickers. Consider UV & HEPA filters in elevator cabs.

OPEN OFFICE

Increase outside air, enhanced filtration, and air treatment systems

For conference rooms space out seating, add CO2 sensors, consider portable air filtration. Reduce open collab/touchdown spaces.

Desk dividers for existing desks



Larger or separated workstations, stagger work hours and occupancy (occupy every other desk) for social distancing

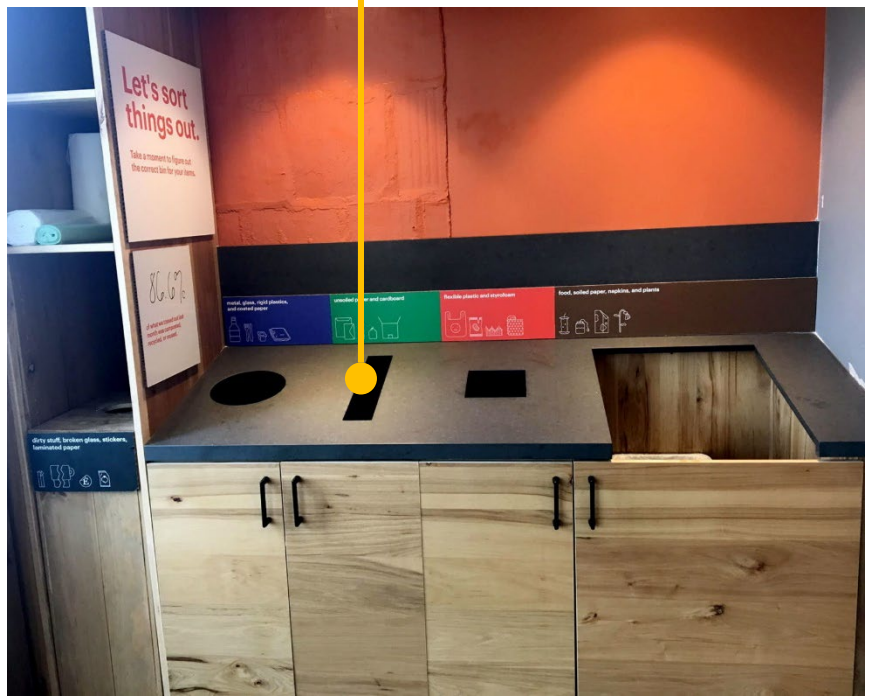
Floor markings for circulation and 6’ separations

PANTRIES

Handwashing education posters

App-based coffee machine and automatic water bottle filler

Countertop cut-outs for touchless waste and recycling system

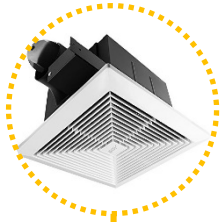


Motion-activated faucet with 20 second timer

Touchless cabinets

BATHROOMS

Increased Bathroom Exhaust

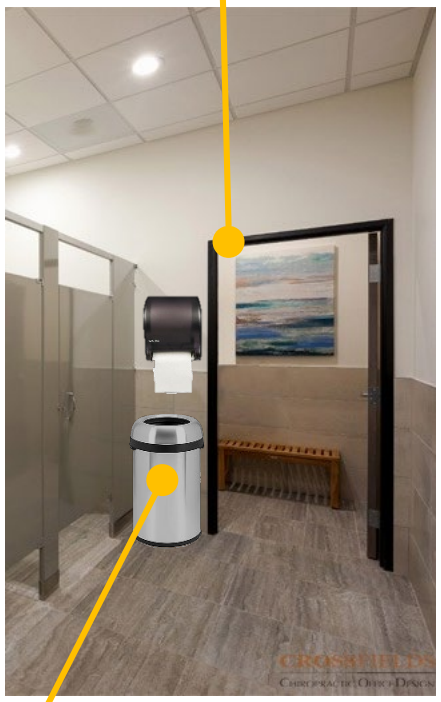


Automatic Flushometers

After-hours UV disinfection

Motion-sensor 20 second faucet and automatic soap dispenser

Automatic bathroom doors or foot pulls



Full-height water closet partitions ($7,500/unit)

Automatic closing lids, optional UV disinfection (not yet readily available)

Automatic paper towel dispensers and open trash can located by door. Disable air dryers

COMPLEMENTS TO LEED AND WELL

WELL buildings require or encourage:

- UV germicidal irradiation (UVC) as an enhancement to the air filtration system
- Cleaning Products and Protocol
- Humidity Control
- Increased Outdoor Air
- Air Quality Testing
- Air quality monitoring
- Operable windows
- Adequate handwashing facilities
- Emergency preparedness
- Immunization offerings
- Health risk assessments
- On-demand health services
- Health awareness education/promotion

LEED encourages:

- Outdoor Air
- MERV 13 + filters
- Operable windows
- Air quality monitoring

OPERATIONAL CONCEPTS

Proactive things building owners can do

Cleaning

New cleaning protocols

More regular deep cleaning

Frequent cleaning of common touchpoints

Increase supply of sanitizing products

Ductwork and unit cleaning

Air Quality

Changing filters

Monitoring air quality

Extending ventilation hours and after-hour purge with outside air

Screening Protocols

Thermal Camera Scanning/Elevated Body Temperature (EBT) checks

Staggered Arrivals and Departures

Packages Sanitization

Commissioning

Commissioning of systems with periodic validation

Creating operations and maintenance manuals for staff

Create a best practices manual for tenants

INCREASED CLEANING STRATEGIES

Deep Cleaning

Regular deep cleaning of tenant spaces and common areas

Periodic fine mist/fog of space with germicide solutions

Flush building pipes & prime floor drains before reoccupation

Elevator cab UV sterilization

Packages

Sterilization space for incoming packages (with UV sterilization)

Sanitization Stations

Add sanitization stations at entrances and throughout office

Provide tissues, soap, hand sanitizer, and disinfecting wipes in the offices and by copy machines, common areas

Lease Terms

Review lease terms on general cleaning and nightly deep cleaning for building common areas

Update facility maintenance contract to include additional cleaning (such as cleaning of desks, multiple cleanings of common areas on tenant floors)

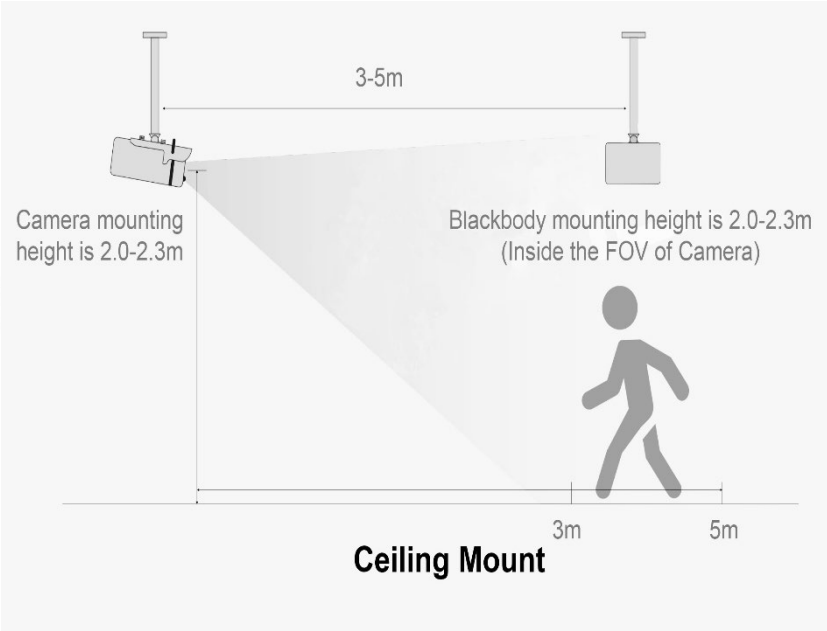
THERMAL SCANNING

This thermal scanning system works at the turnstile and has facial recognition, mask recognition, and thermal scanning. Facial recognition can be turned off to protect privacy.

https://www.youtube.com/watch?v=PLqdXJLo5Uc

THERMAL SCANNING

This solution is for large volume scanning without turnstiles and can scan from 20 feet away.

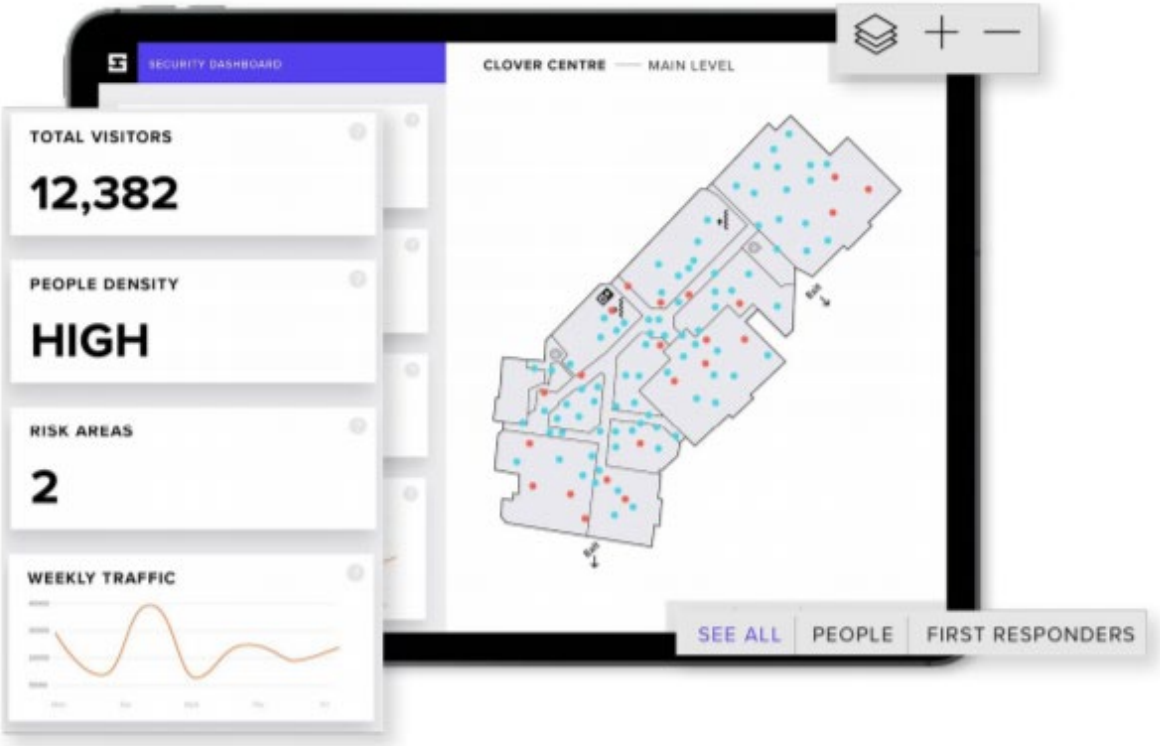


SMART BUILDING WORKPLACE MANAGEMENT

Help maintain social distancing requirements

Contact tracing identification and reporting

Instant communication



Smart Building Digital Platform

- Ultra high-speed connectivity (DAS/5G)
- Artificial Intelligence (AI)
- Analytics - IoT
- Big Data
- CBRS, mmWave
- WIFI 6

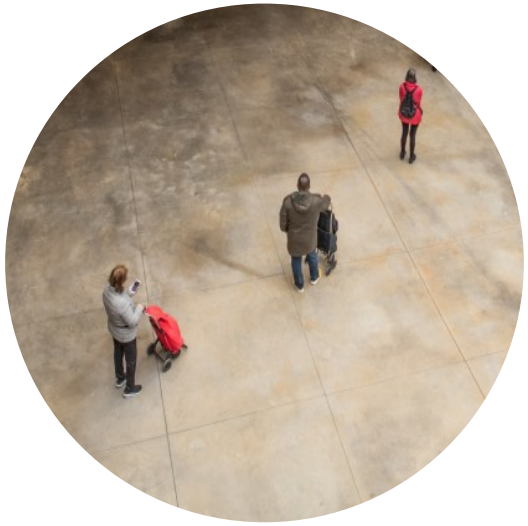
Touchless Environment

- Biometrics (Face ID, Iris, Palm)
- Destination dispatch – touchless lobby turnstiles
- Virtual Assistants/Help Desk
- Voice/Gesture Control – AV and Conference Sys
- Real Time Occupancy Monitoring
- Social distancing density control
- Dynamic Indoor Wayfinding
- Workspace Management Flexible Seating

SOCIAL BEHAVIORS

What the building occupants can do

Social Distancing



Always stay 6’ apart

Shifted work schedules (Different days, different hours)

Staggered reoccupancy

One-way office circulation where possible

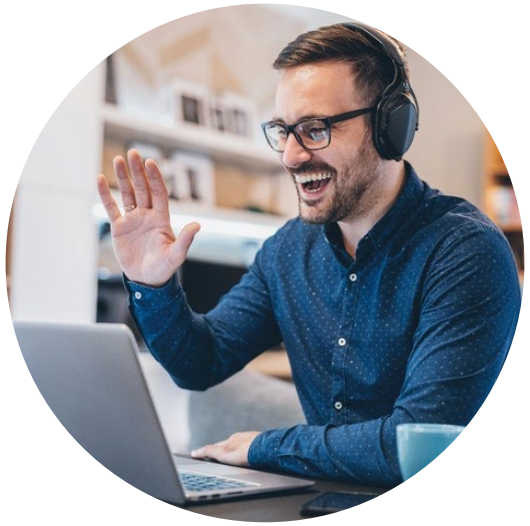
Education

Educational posters about hand washing, wearing masks, touching your face, and other best practices

Periodic hand washing reminders

20 second timers at faucets

Go Digital



Flexible work from home policy

Use videoconferencing for meetings when possible

Postpone large gatherings

Assess risk of travel

New Protocols

Wearing face masks

Keeping your desk clean

Minimize elevator occupancy

Communication with staff

RECOMMENDATIONS AND CONSIDERATIONS

For Commercial and Public Areas

	Current Installation	Recommendations & Considerations	Comments
Outside Air Quantity	Varies by building	Increase to maximum design availability	Review building capacities for opportunities to increase outside air
Air Filtration	Likely MERV 13 for central and MERV 8 for floor by floor	Increase MERV rating (target MERV 14+)	Review system capabilities
Air Treatment	None	Consider bipolar ionization	Helps with general air clean-up/odors and potentially surface contamination
UV lights at coils	None	Consider UV lights facing coils in central air handling units to mitigate bacteria growth	Review cost and feasibility
Humidification of Outside Air	None	Consider adding humidification	Review what level of humidification façade can support due to condensation, first cost and operational cost
Operable Windows	Varies by building	Ensure operable windows are easily operational	Provides access to outside air
Recirculation Zone Sizes	One per space	Zones 500 sf or less via a DOAS system	Reduces recirculation zone

RECOMMENDATIONS AND CONSIDERATIONS

For Commercial and Public Areas

	Current Installation	Recommendations & Considerations	Comments
Extending Hours of Operation and Nighttime floor purging	Varies by building	Extending building ventilation operating hours including nighttime floor purging	Increasing ventilation and nighttime flushing improves air quality upon tenant entry. Review building capabilities for automatic operation.
Demand-control ventilation	Varies by building, energy saving feature	Disable operation to maximize outside air	Ensures maximum outside air to all spaces
Lobby/Public Space Ventilation	Varies by building	Increase outside air where possible and consider ionization	To be reviewed
Bathrooms		Increase toilet exhaust, consider UV sanitization, all touchless fixtures including pre-timed faucets, and automatic doors. Consider full-height water closet stalls.	To be considered for any new installations and to be reviewed for existing. Note concern on multi-tenanted floor as each tenant would have to follow healthy protocols.
Package Rooms/Mailrooms		UV Sanitization of packages and 100% exhaust	
Frictionless Entry		Automatic entry doors and consider latest technology for facial recognition	
Thermal Scanning		Add thermal scanning camera to screen building occupants	
Commissioning of systems		Re-commissioning to ensure proper operation	

RECOMMENDATIONS AND CONSIDERATIONS

For Commercial and Public Areas

	Current Installation	Recommendations & Considerations	Comments
Elevators		Destination dispatch elevators with touchless card or mobile swipe and staggering entry and minimizing elevator occupancy. Consider UV sterilization. Elevator doors to remain open when at a floor level.	
Separation of building occupants/services		Review visitor policy and separate different occupancies from each other	Will visitors be allowed up to tenant floors?
Limiting visitor access to tenant areas		Shared tenant amenity spaces on ground floor/second floor to accommodate visitors to minimize guests going to tenant floors	Will visitors be allowed up to tenant floors?
Entryway Mats		Entryway mats	
BMS Monitoring		Consider BMS monitoring of outside air and indoor air quality monitoring sensors where possible	
Continuous cleaning of public spaces		Nightly deep cleaning to ensure tenants can re-enter following a confirmed illness	
Special filtration for public amenity lounges/conference rooms		Provide air filtration units with HEPA/UV visible to occupants	

RECOMMENDATIONS AND CONSIDERATIONS

For Residential

	Original/Current Standard	Recommendations & Considerations	Notes
Outside Air/Exhaust Energy Recovery Unit (ERU)	Included (heat wheel)	Consider use of heat pipe or cross-flow heat exchanger in lieu of total energy heat wheel. If heat wheel is used, perform proper set-up and maintenance.	Reduces possibility of cross contamination between air streams. Service contract needed for disinfection and proper maintenance of system.
Public Area Recirculated Air Filtration	MERV 13	Target MERV 14+ (or accommodate space for bypass for future HEPA)	Enhanced filtration of outside air
Public Area Recirculated Air Treatment	None	Air treatment (Bipolar Ionization / UV Sanitization) for common areas	Helps with general air clean-up/odors and potentially surface contamination
Humidification of Outside Air	None	Consider humidification	Helps reduce virus transmission but careful consideration of the façade is needed to prevent condensation
Local apartment filtration/humidification	None	Accommodate independent filtration/humidification unit. Consider bipolar ionization.	Improves air quality
Decentralization of systems	None	Individual Apartment ERU	Apartments are self-contained
Apartment Air Balance	Part of standard design	More blower door tests during construction. Apartment sealing techniques (Aeroseal). Apartments negative pressure, corridors positive pressure.	Prevents air leakage apartment to apartment and into the hallway.
Toilet Exhaust	Shared	Consider single exhaust per apartment	
Package room sterilization	None	UV sterilization for the package room	

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