TLC ENGINEERING SOLUTIONS

COVID 19 Guidance

Aviation

THINK. LISTEN. CREATE.

References

References:

CDC – Centers for Disease Control and Prevention
https://www.cdc.gov/csels/dsepd/ss1978/lesson1/section10.html
https://www.cdc.gov/coronavirus/2019-ncov/php/building-water-system.html

NIOSH - National Institute of Occupational Safety and Health
https://www.cdc.gov/niosh/index.htm

ASHRAE Position Document on Infectious Aerosols 4/14/2020.
ASHRAE Position Document on Infectious Aersols

ASHRAE Handbook – HVAC Applications - CHAPTER 62. ULTRAVIOLET AIR AND SURFACE TREATMENT.

ASM - 2019 Novel Coronavirus (COVID-19) Pandemic: Built Environment Considerations To Reduce Transmission.
http://msystems.asm.org

IES Germicidal Ultraviolet (GUV) – Frequently Asked Questions
https://media.ies.org/docs/standards/IES-CR-2-20-V1-6d.pdf

The RESET® Air Standard
https://www.reset.build/standard#std__download

Summary

The following are guidelines and tools for Owners, Architects, and Engineers to consider for reducing the risks of infection control with building design approach for: Assembly, Transportation, Residential, and Commercial Building Types

A. Existing Buildings

1. Checklist of “Things to look for”.
2. Commissioning HVAC systems.

B. Retrofit of Building Systems

1. What can I do in the next 6 months?
2. Long Term – Recommend review of Life Cycle Cost Analysis.

C. New Building Design

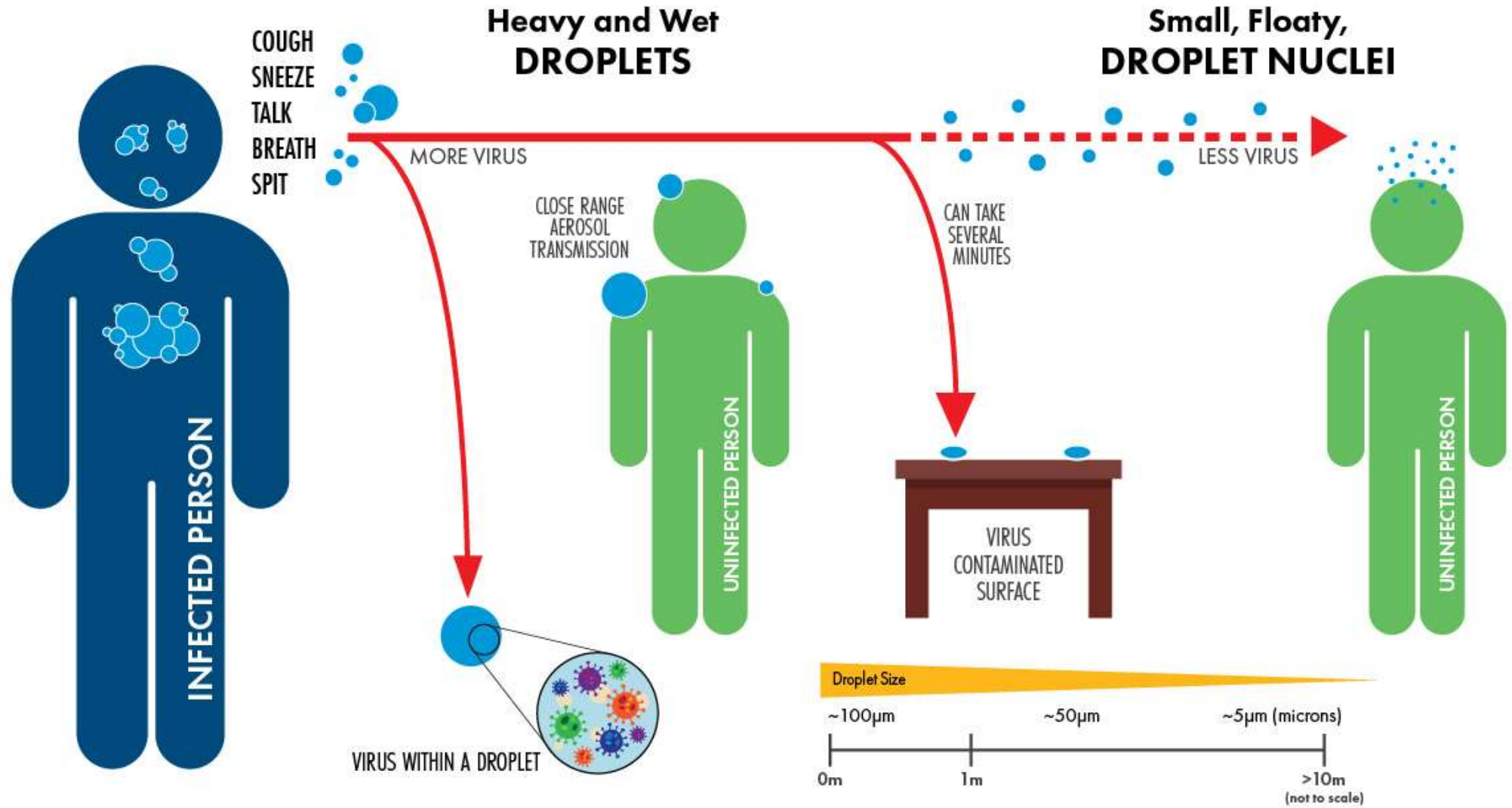
1. HVAC System Designs
2. Good, Better, Best approach for Building types – what are the options?

HVAC System design recommendation ranking is based on the ASHRAE Position Document on Infectious Aerosols, categorized as follows: TLC recommends an Evidence Level of A or B only.

Evidence Level "EL"	Description
A	Strongly recommend; good evidence.
B	Recommend; at least fair evidence.
C	No recommendation for or against; balance of benefits and harms too close to justify a recommendation.
D	Recommend against; fair evidence is ineffective or the harm outweighs the benefit.
E	Evidence is insufficient to recommend for or against routinely; evidence is lacking or of poor quality; benefits and harms cannot be determined.

SARS-CoV-2 Transmission

Before we talk about how to solve the problem, let's review how viruses are transmitted



Fomite(surface contact),Droplets, Aerosol

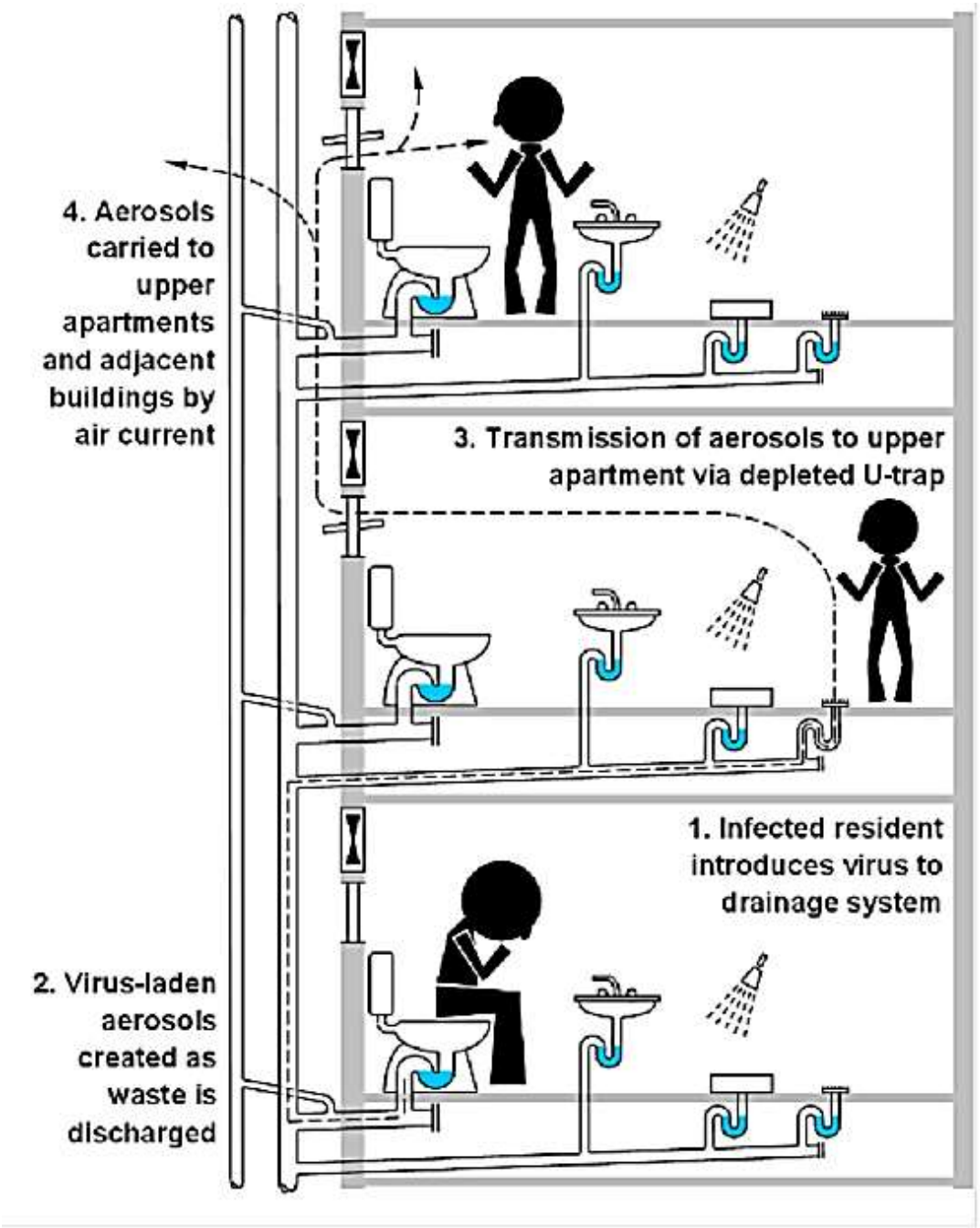
SARS-CoV-2 Transmission

What to look for:

P-Traps: operate flush valves, and verify trap seals are wet.

In the most recent epidemic of a virus similar to Covid-19, the Hong Kong SARS epidemic of 2003-2004, one of the most baffling transmission vapers was the fecal-aerosol route.

There is already some evidence (from the UNMC study) that there is a fair amount of viral shed in infected patients' stool.

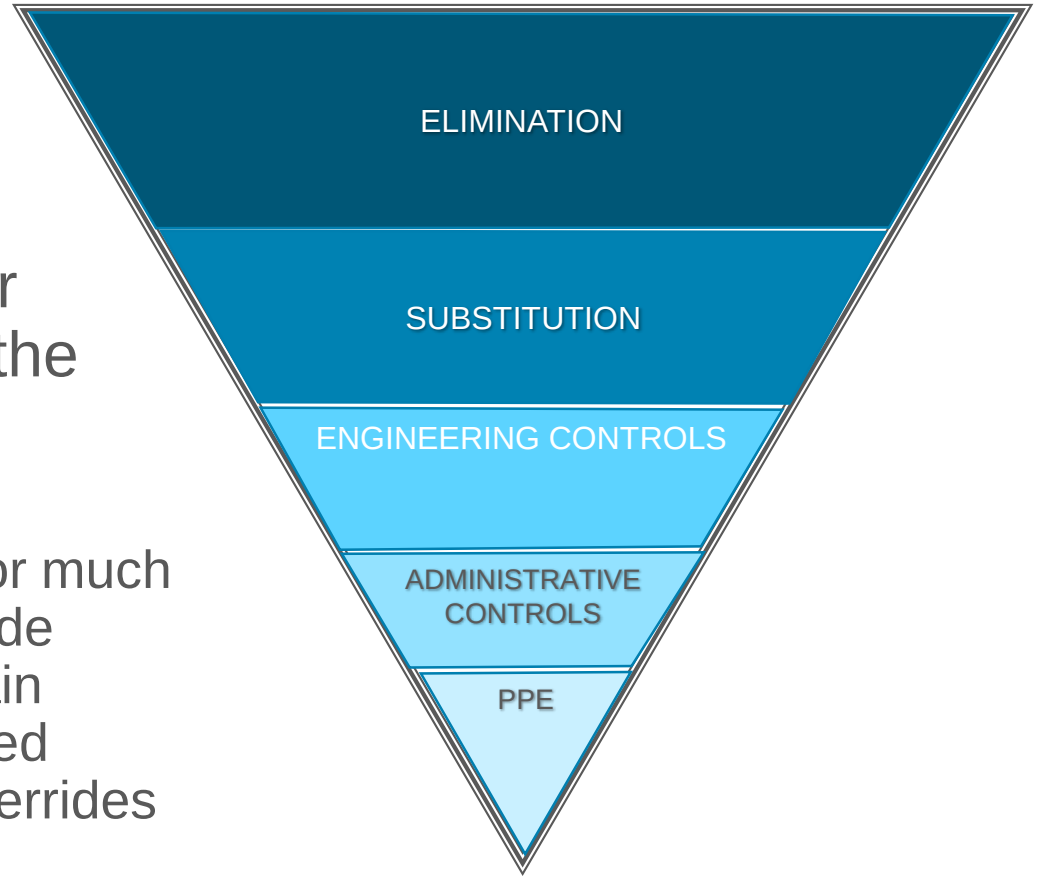


Affect of atmospheric conditions on virus life:

CONDITION	*Temp*	*Humidity*	*Solar*	HALF LIFE
Surface	70-75°F	20%	None	18 hours
Surface	70-75°F	80%	None	6 hours
Surface	95°F	80%	None	1 hour
Surface	70-75°F	80%	Summer	2 minutes
Aerosol	70-75°F	20%	None	~60 minutes
Aerosol	70-75°F	20%	Summer	~1.5 minutes

References

Non-HVAC related actions:



1. Source Control: COVID-19 is transmitted person-to-person; therefore, screening for infected people and keeping them out of the building is the most effective infection mitigation.
    a. This is because the virus can float in the air for much farther than 6 ft, penetrate all but hospital-grade personal protection equipment, and can remain viable for up to 72 hours, especially in enclosed spaces. This person-to-person interaction overrides anything an HVAC system can do.
        1) Caution: because the building types in this guide are considered Public, or readily accessible, this method of control is not likely viable unless the business is ordered closed.
    b. The next best solution is to emphasize cleanliness and disinfection when cleaning rooms. Especially surfaces.

Aircraft Cleaning

DEDICATED TO HELPING BUSINESS ACHIEVE ITS HIGHEST GOALS.

NBAA

AIRCRAFT DISINFECTION AND CLEANING PROCEDURES

RECOMMENDED PRODUCTS

The products listed here are some options, but not the only options, that have been tested and proven safe for use on aircraft interiors. Additional disinfectants for use against COVID-19 can be found on the EPA's website [https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2]. However, these products require testing on interior surfaces prior to full use.

- Disposable medical grade gloves
- Safety glasses or goggles
- N95 respirator mask
- Microfiber towels
- Terry cloth towels
- Sontara aerospace wipes
- Celeste Sani-Cide Disinfectant
- Celeste Sani-Cide EX3
- Celeste Sani-Cide FSC
- Perrone Leather Cleaner & Conditioner

INTERIOR DISINFECTION PROCEDURES

It is recommended that the following procedures are carried out by trained personnel. All manufacturer guidelines and instructions should be followed.

Ensure all crew and passengers have exited the aircraft. Adorn all personal protective equipment.

Use new microfiber and towel products when transitioning between sections of the aircraft. Do not transfer use from one area to another. Replace gloves, respirators and all towel products when moving to a different aircraft.

Galley & Kitchen Areas

1. Aircraft galley and food prep areas should receive disinfection with Sani-Cide FSC. After 30 seconds of contact time, surfaces can be wiped clean with a new microfiber cloth. Surfaces are now ready for use.

2. Trash bins should be emptied, and all garbage removed from aircraft.

3. Mirrors, glass and screens should be cleaned with Sani-Cide EX3.

Cabin Area

1. Working in small areas, spray hard surfaces with Sani-Cide Disinfectant or EX3 and allow a contact time of 5 minutes prior to wiping clean with a microfiber cloth. Following disinfection, surfaces can be cleaned with an interior product to provide a final finish.

2. Spray and wipe leather surfaces with EX3. Follow by cleaning with Perrone Leather Cleaner/Conditioner.

3. Upholstery and carpet should be lightly misted with EX3 and allowed to air dry.

Lavatory Area

1. Spray toilet area with EX3 or Disinfectant and allow the full contact time. Using Sontara wipes or a similar cloth product, wipe all areas clean. Immediately dispose of cloths and gloves into a dedicated trash bin outside of the aircraft.

2. Using new gloves, spray remaining hard surfaces in lav area and wipe clean with a microfiber cloth.

Flight Deck & Cockpit Area

Due to the delicate nature of instruments, screens and components found in the cockpit area, it is recommended to use approved procedures and products in accordance with OEM guidance.

Aircraft Cleaning

- **Allegiant** - Our aircraft are cleaned and disinfected to the highest possible standard, exceeding CDC and Airbus guidance.
  - The air quality on our planes exceeds HEPA standards thanks to our VOC (volatile organic compound) filters, which remove additional organic compounds. On average, cabin air is changed every three minutes through a continuous flow of fresh and VOC-filtered air.
- **American airlines** – This cleaning will use a disinfectant approved by the Environmental Protection Agency (EPA) and includes:
  - In customer areas, tray tables, seatbelt buckles, armrests, window shades and seatback screens. It also includes wiping door and overhead bin handles.
  - In team member areas, enhanced galley cleaning, jump seats and crew rest seats. The new enhancements add cockpit surfaces as well.
- **Delta** - Aircraft will be sanitized before every flight in Delta's network. The disinfectant used is immediately safe to breathe and is similar to what hospitals and restaurants use to sanitize. RELATED: Delta achieves 100% sanitization of flights.
- **Frontier** - To ensure your safety and comfort, our aircraft go through regular disinfection procedures to kill infectious agents. This helps to minimize the risks of spreading diseases. We do this by only using cleaning, sanitizing and disinfecting products that have been deemed by the EPA to be effective against coronavirus.
  - Plus HEPA filters: https://www.flyfrontier.com/travel/travel-info/covid-19/?mobile=true
- **Jetblue** - We have increased aircraft cleaning each night and during extended ground time during the day. We are applying disinfectant that is effective against coronavirus across aircraft interiors including the places customers touch most – the tray tables, seat covers, armrests and seatbelts.
- **Southwest** – Now, as of March 4, Southwest's Aircraft Appearance Technicians enhanced our cleaning procedures by expanding the use of an EPA-approved, hospital-grade disinfectant to address human touchpoints across the passenger cabin, flight deck, and lavatories.

- **Spirit Air** - Clorox solutions are used in our airports to disinfectant ticket counters, gate areas, and kiosks.
  - We utilize electrostatic cleaning devices to disinfect Spirit ticket counters, gates, break rooms, maintenance centers, and crew bases in our high-traffic airports.
- **United –** We have implemented electrostatic spraying into our cleaning procedures on all inbound long-haul international flights, and mainline overnight aircraft at our U.S. hubs. In June, all aircraft will have electrostatic spray on every one of our departures, in addition to disinfecting customer touch points and surfaces before every flight.

Operations and Maintenance:

2. System Operation for Emergency Response: Maintain HVAC system operations at all times, i.e. 24/7, where systems have an un-occupied cycle.

    a. Maintaining the Outside Air (Fresh Air Intakes), and Exhaust Air operations. In other words, the entire system operation, not just one particular system.
    b. Disable Demand Control Ventilation: and operate continuously at the HVAC system maximum outside air setting, within the operating parameters of the system.
    c. Careful Consideration must be made for outside air volume increases above design, in an effort to over ventilate. The risk is loosing control of the supply air temperature, if the mixed outside air temperature rises above the cooling coil design conditions, which would jeopardize humidity control.

Operations and Maintenance continued:

3. Checklist: “Things to look for”
   a. Commensurate with the CDC Guidelines to clean surfaces, clean the HVAC devices.
   b. Supply and Return grilles – the dust and dirt provide a hosting place.
   c. Temperature Set points – are there un-occupied areas of the building that need to be put into occupied mode, and commanded to a run cycle?
   d. Supply and Exhaust fans – are there known systems undergoing maintenance that could potentially impact the pressure balance of spaces?

4. Commissioning: Making sure that your HVAC systems are working as they were meant to is a very good idea. Please contract with a certified retro-commissioning professional to have them investigate the HVAC systems in your building and to determine if they are operating as they are meant to, and to take measures to get them operating that way.
   a. A commissioned building is safer than one that is not, and will probably cost you less to operate due to utility savings. Operating your systems as they were intended to is also the lowest risk and liability for you as a building owner and operator.
   b. Refer to HVAC System Commissioning.

Operations and Maintenance continued:

5. Re-opening and Potable Water Systems:

a. Perform system flushing:

1) Stagnant, or standing water can cause conditions that increase the risk for growth and spread of Legionella and other biofilm-associated bacteria. When water is stagnant, hot water temperatures can decrease to the Legionella growth range (77–108°F, 25–42°C).
2) Stagnant water can also lead to low or undetectable levels of disinfectant, such as chlorine. Ensure that your water system is safe to use after a prolonged shutdown to minimize the risk of Legionnaires' disease and other diseases associated with water.

b. Hot water system:

1) Operate the main hot water loop at 140ºF ahead of the local 1070 mixing devices while doing the system flush.
2) Some automatic (computer controlled) master mixing valves are capable of doing an overnight re-set for this procedure.

Elements a Building Owner can implement short term:

Short term is intended to be a non-invasive measure that allows the building to operate, and can use readily available products.

1. Sensor operated devices: Mitigate common touch areas by using sensor operations for the following common devices such as: doors, faucets, drinking fountains, water bottle fill stations, water closets and urinals, lighting controls.

   What other common touch areas can benefit from sensor operation?

   a. Elevators and Lobby call buttons. The new voice activation features would replace the elevator push buttons.
   b. Key cards and electronic badges. Already common place in security areas at the Airports, or key cards for Hotel Rooms, this access choice could be more frequently used for Office buildings.

Elements a Building Owner can implement long term:

Long term is intended to be an investment, and overall improvement to the building system. It is expected to have a capital cost, operating cost, payback, and require an engineered system.

1. Ventilation Control (EL-B): One method of reducing aerosol pathogen effectiveness is dilution using fresh air:
   a. Demand Control Ventilation Override for Emergency Operation: Operate ventilation continuously at the maximum outside air setting, within the operating parameters of the system.
   b. Reset ventilation rate based on the capacity of the coil. For example: It is 80ºF DB / 67 ºF WB outside, chances are I can add ventilation and still dehumidify.
      1) Similarly, add night time purge cycles for when the system is below capacity.
   c. Design – of replacement air handlers or dedicated OA units to be capable of ventilation above code minimum.

   Refer to HVAC System Design - Ventilation.

Elements for New Construction:

1. Daylighting: Does adding more daylight to a building decrease the spread of a virus?

   No – Why?

   a. It has been proven, that UV light will neutralize a virus; however, windows filter out the harmful UVB spectrum of light that is effective to harm RNA.

      1) RNA and DNA are nucleic acids, and, along with lipids, proteins and carbohydrates, constitute the four major macromolecules essential for all known forms of life.

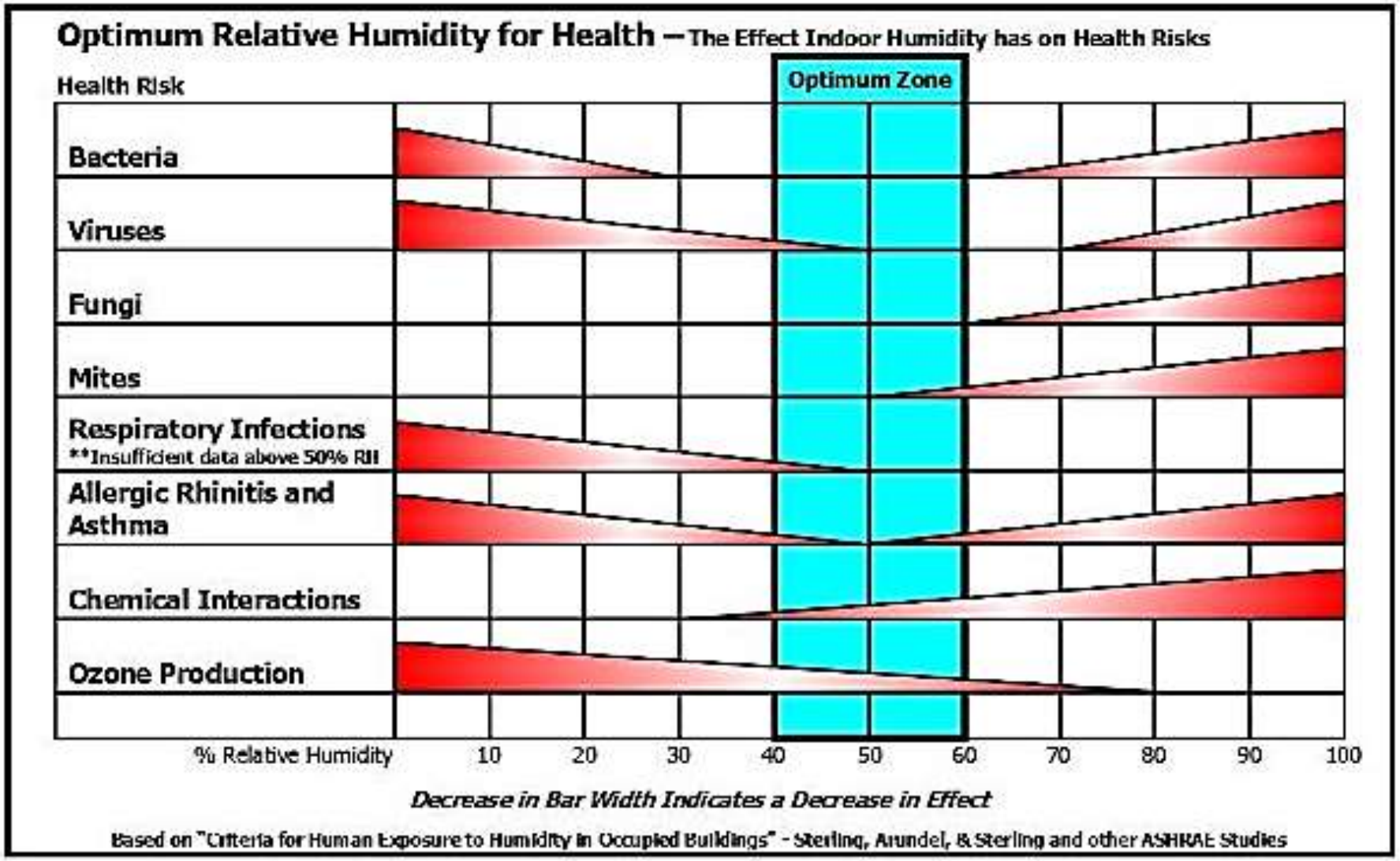
   b. Would require opening a window to get in the UV. Operable windows are less common in commercial buildings, and usually found in hospitality. Caution must be taken because humidity control would be at risk, and this is still important to control the spread of infectious diseases. *Refer to HVAC System Design for parameters.*

According to ASHRAE, CDC, and lessons from previous SARS and MERS outbreaks, here are key control factors for an HVAC System:

(Ranked in order of progressive design steps)

1. Humidity Control (EL-B) – maintain between 40-60% as recommended to reduce transfer of aerosols (viruses, bacteria, etc.).
2. Pressurization and Pressure Relationship Control (EL-A) – Pushing air from clean to dirty spaces, and positively pressurizing the building to prevent aerosols from migrating to adjacent spaces.
3. Airflow Patterns (EL-A) – How to move supply air to decrease recirculation of aerosols in the space.
4. Filtration (EL-A) – How to prevent aerosols from recirculating.
5. Air Cleaning Devices (EL-A) – What works, and what precautions to take.
6. Outside Air Ventilation (EL-B) – Emergency Response – What options exist to over ventilate an area.

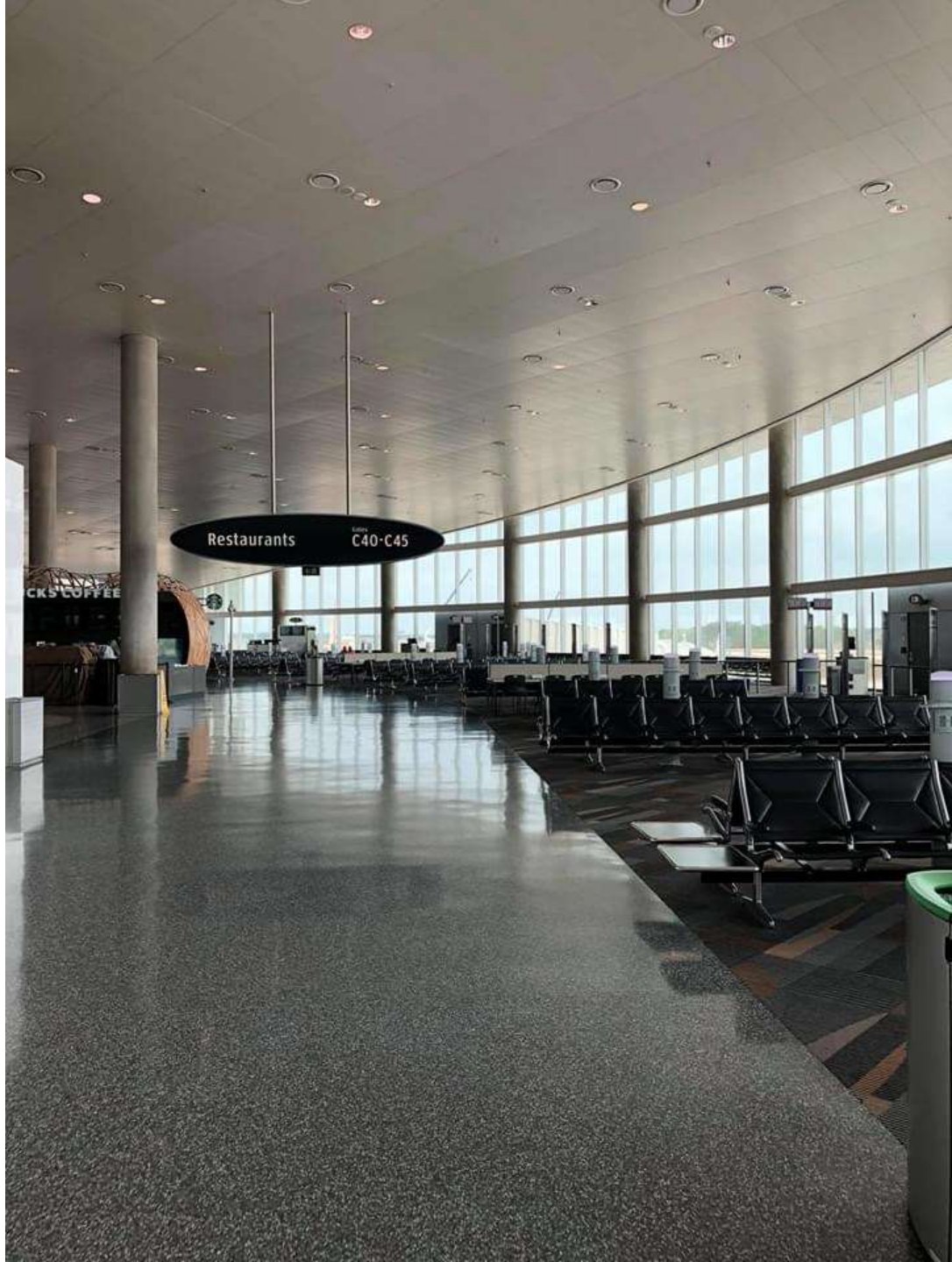
Humidity control (EL-B): Maintain humidity control for public and high density .



Outside Air Ventilation Rates (EL-B)

Hold Rooms: Bettering indoor air quality by maximizing outside air ventilation rates, helps to dilute infectious aerosols.

1. Quantifiable Assessment: According to the CDC, there is no quantifiable relationship between increased ventilation rates and reducing the risk of infection, because results vary. In light of this, ASHRAE recommends that there is fair evidence to pursue as a measure of mitigation.
2. Design Considerations:
   a. High Ceilings (25'): 4 ARCH
   b. 10'-12' Ceiling: minimum 2 CFM/SF (12 ARCH)



Outside Air Ventilation Rates (EL-B) continued:

Review of the ventilation effectiveness table must be customized for each type of building and space.

2. Considerations for increased ventilation rates: Review the occupancy density and space type, which may mean volume, to evaluate the effectiveness of the increased ventilation rate.
    a. For example: If you increase the total ventilation rate to an assembly space, it will be an equal ratio of increase for each occupant. In contrast, if you increase the outside air to a multi-zone air handler, ventilation rates will be driven by the cooling load and modulation of VAV terminal air volume.
    b. Consider using a local CO2 sensor and control to dictate the VAV terminal going to 100% open, to maximize ventilation rates.
    c. Monitor the increased ventilation rate, as a percentage, so the User can see how much more air is being provided.

Outside Air Ventilation Rates (EL-B) continued:

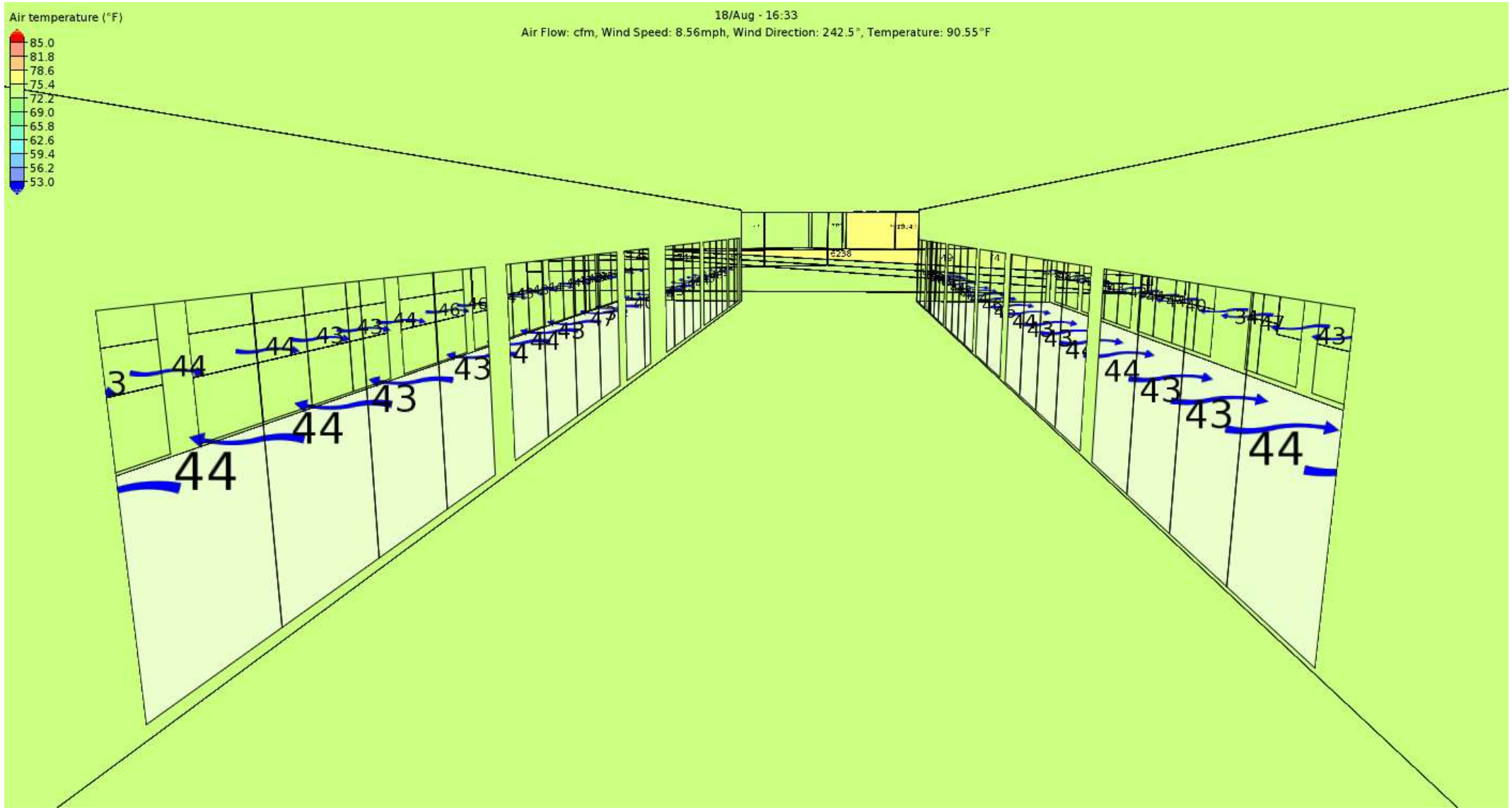
3. Existing Systems: As mentioned in the “Retrofit” section, this would be an emergency response action:
   a. Demand Control Ventilation Override: Operate ventilation continuously at the maximum outside air setting, within the operating parameters of the system.

   b. Increased Outside Air Ventilation Rate: increasing the ventilation rates that go beyond the system’s peak design heating and cooling capability will require a series of design verification and changes:
      1) Verifying the existing ductwork sizing can support more airflow.
      2) Adopting a new outside air volume control strategy: The controls must monitor outdoor conditions, and work within the allowable capacity. This can be done (2) ways to prevent the system from loosing humidity control of the space:
         a) Monitor the supply air temperature control, and set a maximum drift parameter, say 2ºF.
         b) Less optimal would be to measure total enthalpy between the outside air dry and supply air set point. This requires measuring the outside air wet bulb temperature, and is susceptible to going out of calibration quickly.
      3) A reasonable expectation is a 20% increase, but this is not a guarantee.

Pressurization and Pressure Relationship Control (EL-A)

Commensurate with good HVAC design is positive building pressure, ensuring that there is more Outside Air than Exhaust Air, will mitigate unwanted infiltration, especially humidity.

Pressurization and Pressure Relationship Control (EL-A)



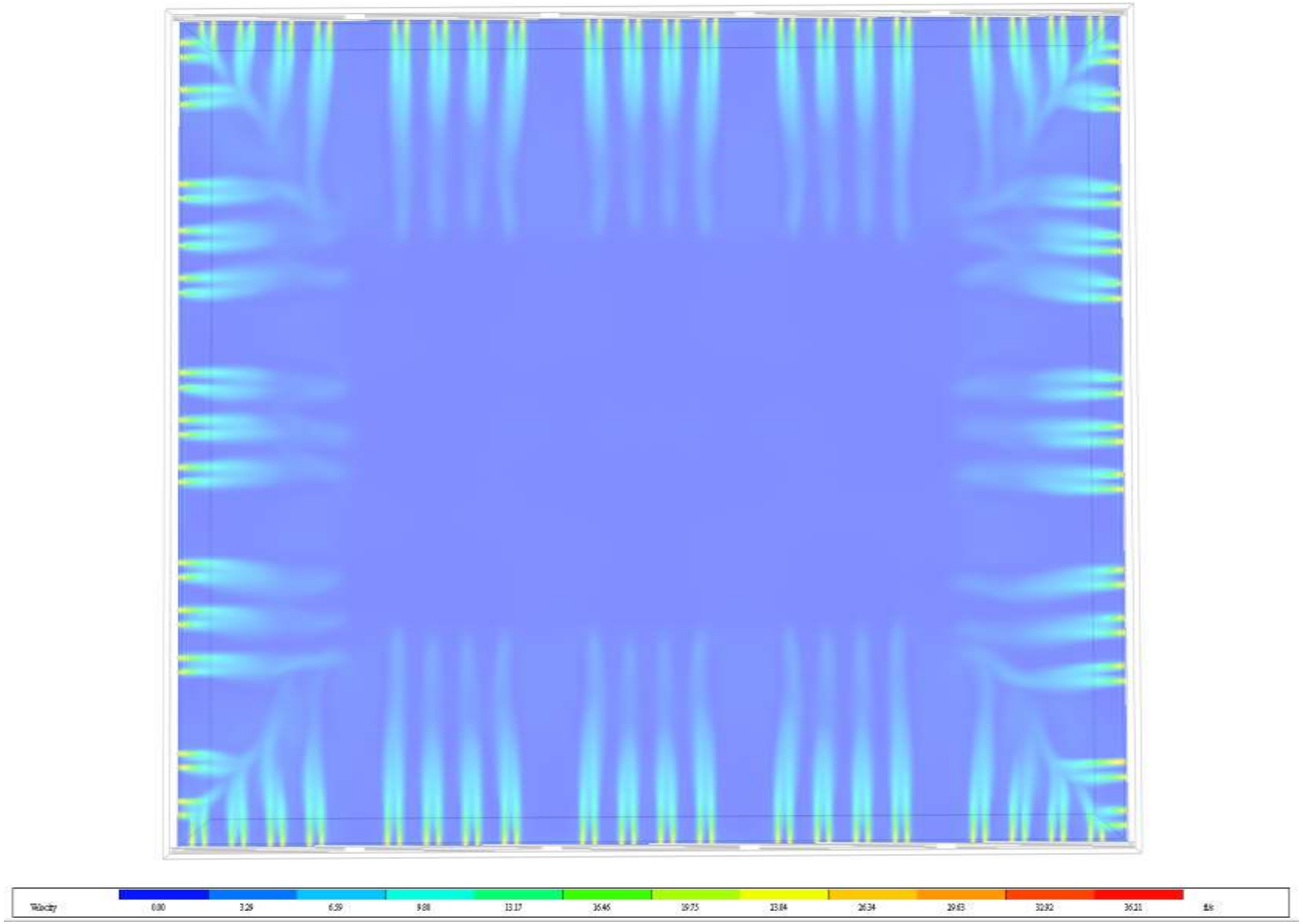
MAT Model: The image above shows the air movement in the boarding lobby out through the closed shuttle doors, maintaining positive air pressure and design temperature at all times

Airflow Patterns (EL-A)

Ventilation effectiveness is contingent upon where the supply and return air devices are located.

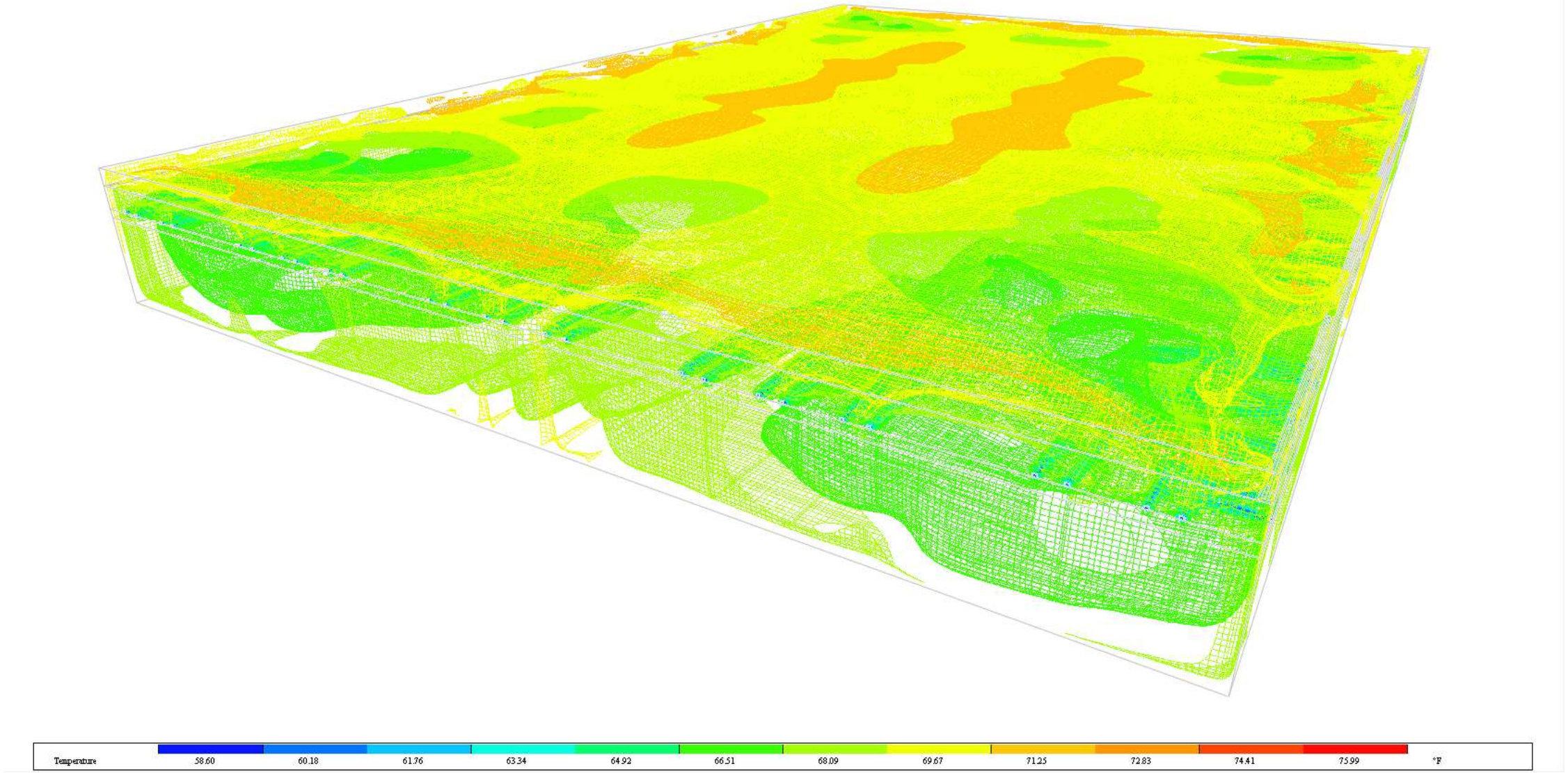
1. To prevent the entrainment of aerosols within the space, consider where the bulk airflow movement is starting from and going to.

Airflow Patterns (EL-A)



CFD Model: The image above shows the nozzle distribution in the area of the 21’ ceiling. The color scale represents the air velocity.

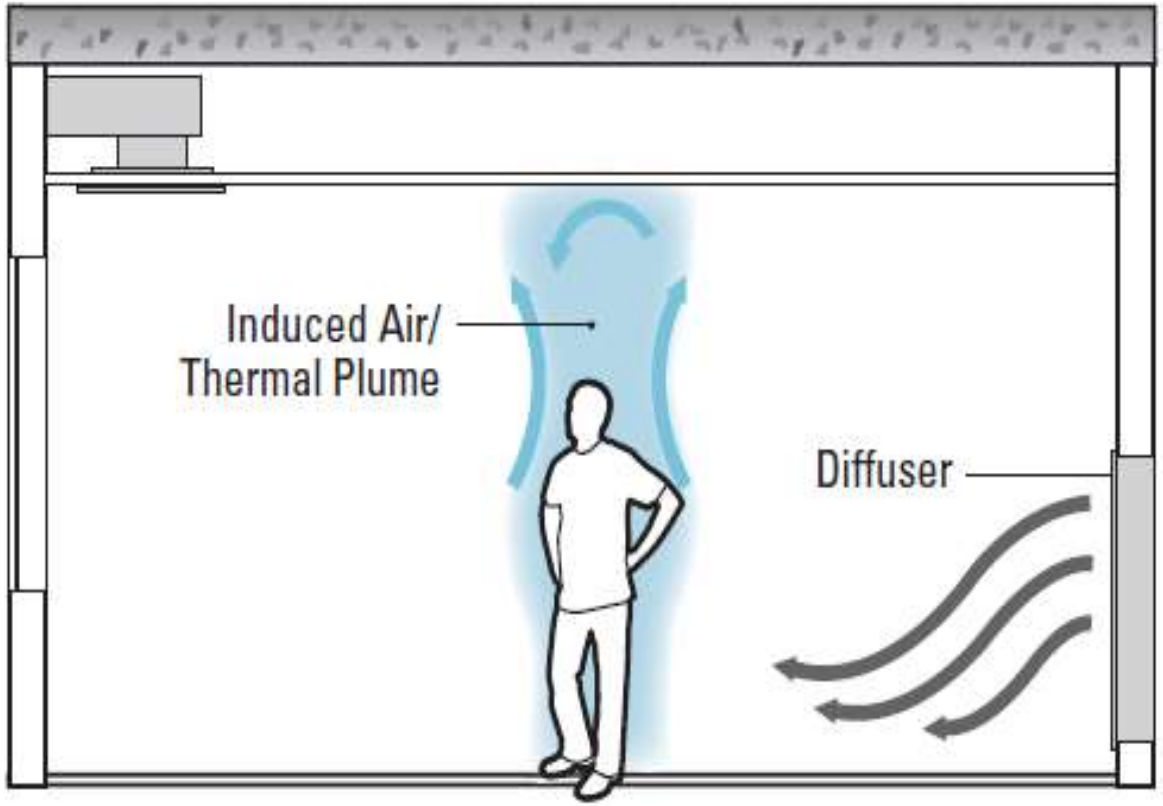
Airflow Patterns (EL-A)



CFD Model: The image above shows the air mixing in the 21’ ceiling area, capable of maintaining air temperatures between 68ºF-70ºF in the occupied zone, with 55ºF supply air temperature.

Airflow Patterns (EL-A)

2. Airport Terminals: typically have very high ceilings, in which ceiling air distribution is neither appropriate nor effective.
   a) Introduce Supply Air into the breathing zone (less than 12 feet above the floor).
   b) Return or exhaust at the ceiling, to allow stratification of hot air, and reduce the overall cooling load, and prevent entrainment of aerosols.
   c) Positive Displacement systems would be excellent candidates for ballroom and meeting spaces. This would also reduce energy costs in high ceiling spaces.



Airflow Patterns (EL-A) continued

3. Office Space –consider Under Floor Air Distribution (UFAD). This is supplying conditioned air from the floor, and returning or exhausting it at the ceiling level, reducing entrainment or mixing of air around the occupant.
   a. UFAD is recommended to reduce entrainment. This works for cooling mode, but in heating mode they typically use fan powered boxes which recirculate local air and are often in the floor, therefore, higher MERV rated filters need to be included in the terminal boxes.
   b. Note: UFAD systems are more commonly employed in heating climates than cooling ones because that is where they yield the most energy savings.

Airflow Patterns (EL-A) continued

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Filtration (EL-A)

The World Health Organization (WHO) states that COVID-19 transmission risk increases in areas of high pollution because Particulate Matter PM level 2.5 and higher has small droplets or fine particles that act as a carrier.

1. Source Control: given COVID-19 is a person to person transmission, capture at the source. Depending on the space type it's a question of where upgraded filters can be applied.

2. Location of Filtration: HVAC systems that serve multiple spaces with a common air handler are less problematic than in-room recirculating units, but they can still pick up virus from one room and deliver it to another room, UNLESS the system is capable of using High Efficiency Particulate Arresting (HEPA) filters. Most commercial grade HVAC systems are not capable of pushing an adequate amount of air through these filters, and adding HEPA filters to an existing system requires a retrofit with professional assistance.

Filtration (EL-A) continued

3. MERV Level of Filtration: ASHRAE recommends that any increase level of MERV rating over the code minimums is a direct benefit.

- The cartridges contain a unique non-toxic and eco-friendly sorbent designed to capture over 250 types of volatile organic compound (VOCs,) carbon dioxide, ozone, and aldehydes. While filters only pick up solid particles, enVerid sorbent cartridges remove contaminant gases and are certified under ASHRAE 145.2.
- Sidestream Filter: Viruses can be carried in the air in small water droplets known as aerosols. Cartridges are rated MERV 11, which means it captures a significant fraction of any aerosols that meet our cartridges.
- The efficiency is at least 72% and may be much higher.
- During regeneration, which is done at 50-60 deg C, the elevated temperature kills viruses captured by the cartridges. Finally, the active material in the cartridges is a potent antimicrobial, which – unlike ordinary particle filters – prevents the formation or growth of any mold, bacteria or other microbial colonies even over extended periods of time.

Filtration (EL-A) continued

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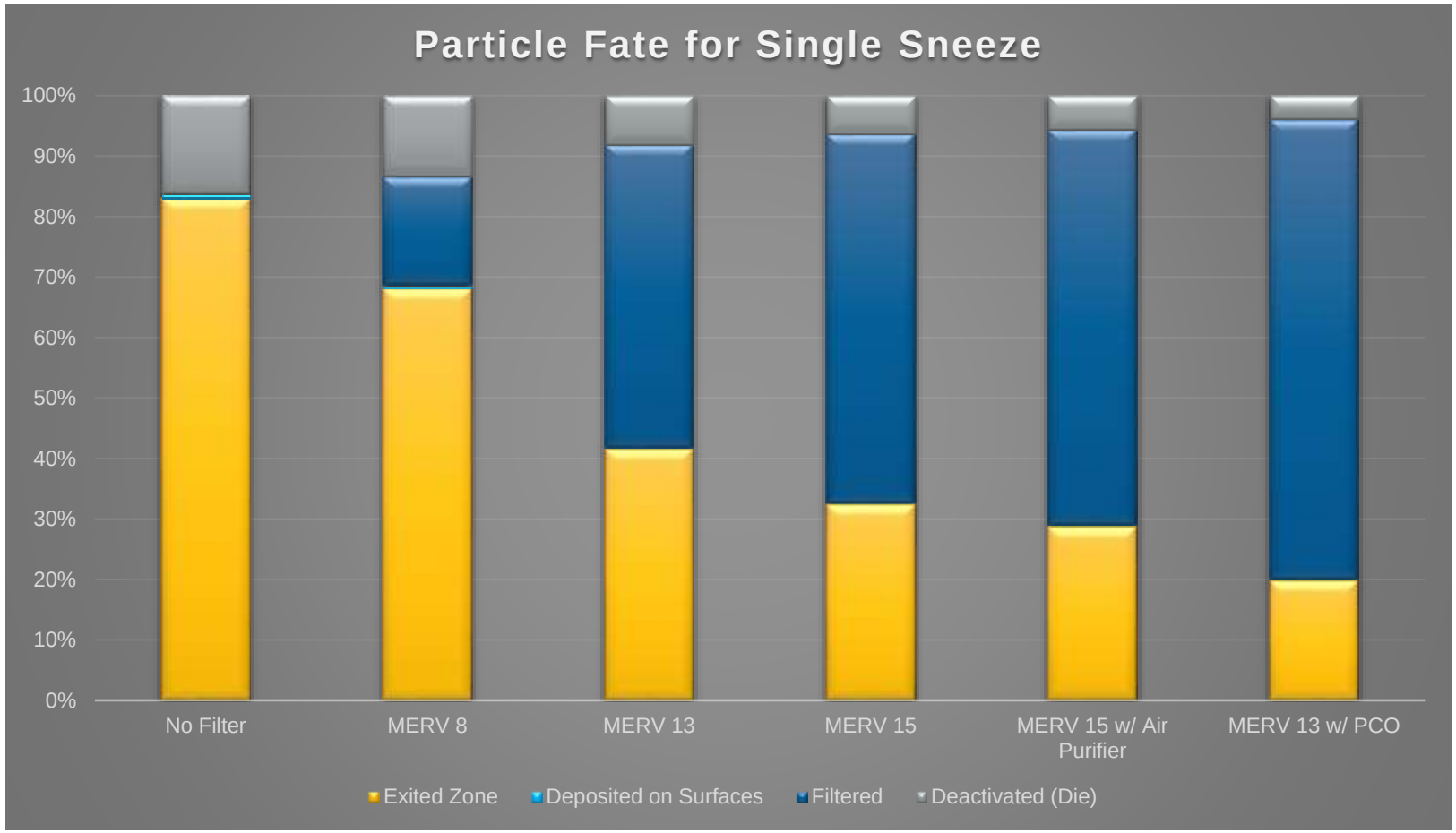
The following graphs show the results of an infected person in the space for one hour. Under the current conditions the virus will remain in the air for over an hour after the person leaves the room but by increasing the filtration from Merv 13 to Merv 15 the air borne concentrations are eliminated 20% faster and 33% faster if a 500 cfm Hepa air filter is added to the space.

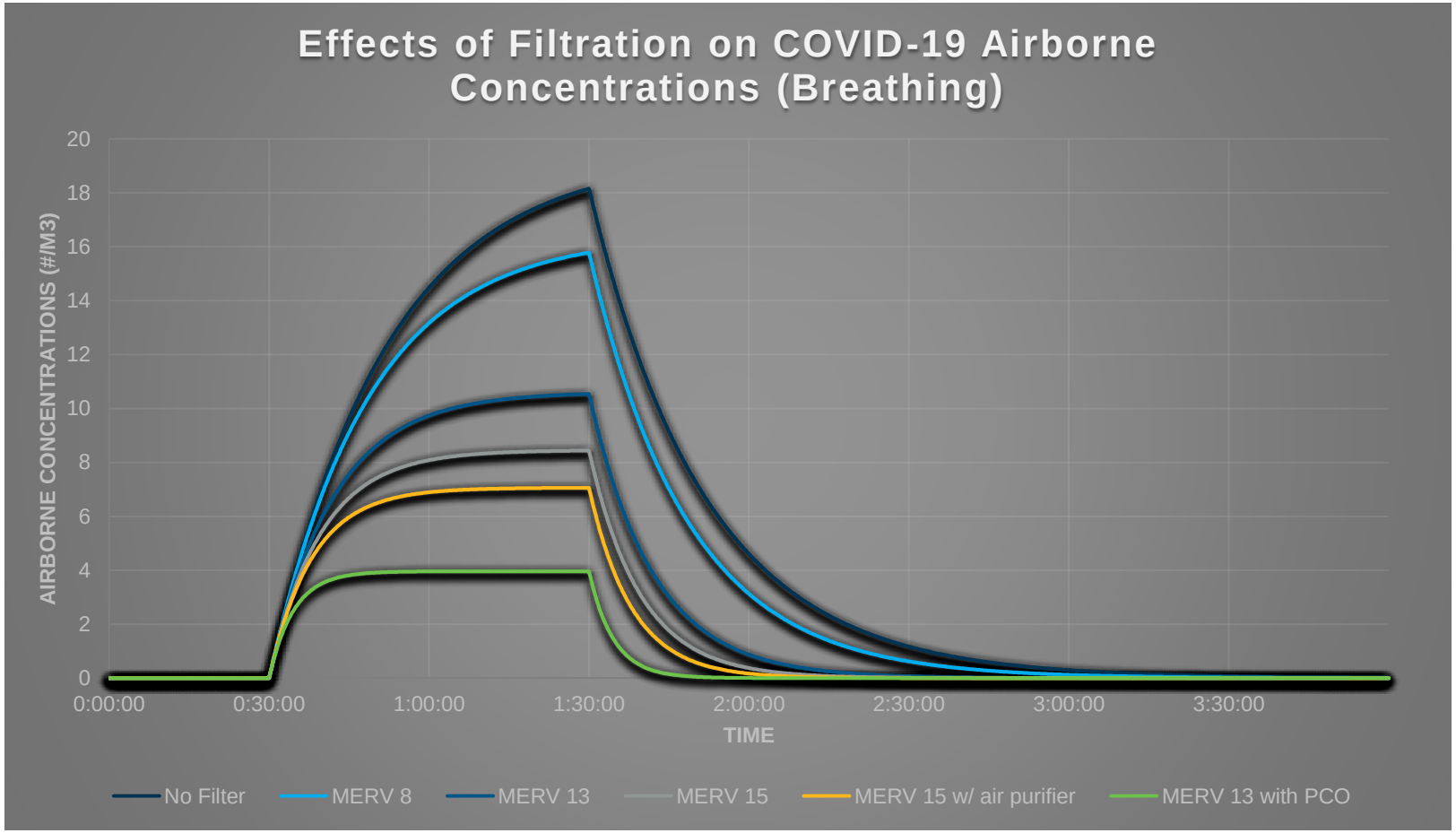
Filtration (EL-A)



Effects of single infected person sneezing once in the space starting at t=30 min(person enters space)

National institute of standards and technology (NIST) has software called fate of transport of indoor microbiological aerosols (FaTIMA) which allows us to determine the fate of Covid and other airborne contaminants associated with ventilation, filtration, and dipositive and inactivation mechanisms. The FaTIMA illustrates a representation of single well-mixed mechanically served zone and incorporates particle source and removal system

Filtration (EL-A)



Effects of single person breathing in the space starting at t=30 min(person enters space)

It was found that using a Merv 15 filter is the most cost effective filtration simulated, however, the use of a MERV 13 filter paired with photocatalytic oxidation (PCO) is the most effective air cleaning solution found to limit the spread of the virus. The use of a standalone HEPA air purifier is also very effective without the steep up front cost associated with PCO technology. It is suggested by ASHRAE to size the system for minimum 2 air changes per hour.

Air Cleaning Devices (EL-A)

There is no single bolt on solution to mitigating a virus, and it is important to know what industry or vendor suggested products are capable of.

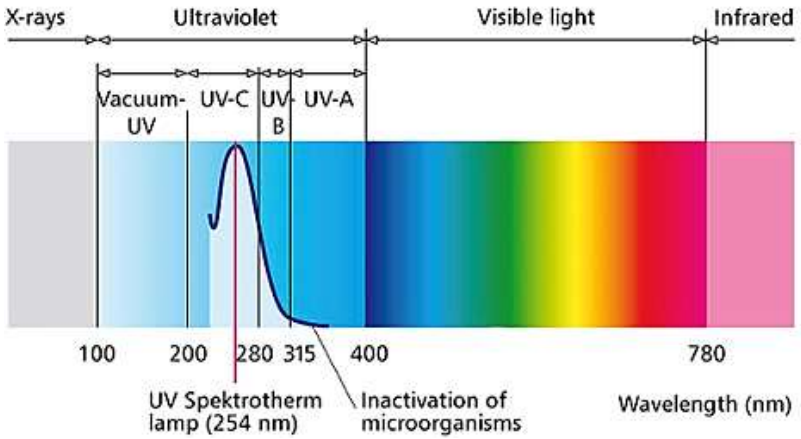
1. Ultra-Violet (in Duct): UV lamps are popular for in duct applications, where the use is to keep a cooling coil, and the interior of the air handler free of bacteria, mold, and potentially any viruses living on the surfaces.
    a. This use however, does NOT mitigate airborne pathogens that are passing through the air handler, because the contact time is too short.
2. Ultra-Violet (Upper Room Level): In this application, shielded UVC fixtures wall mounted, above the occupant (>8 feet above the floor), and requires design assist from the manufacturer to determine necessary coverage.
    a. HVAC – The counterpart to this system, requires that the room HVAC continue to run to recirculate air into the “kill zone” of the room.

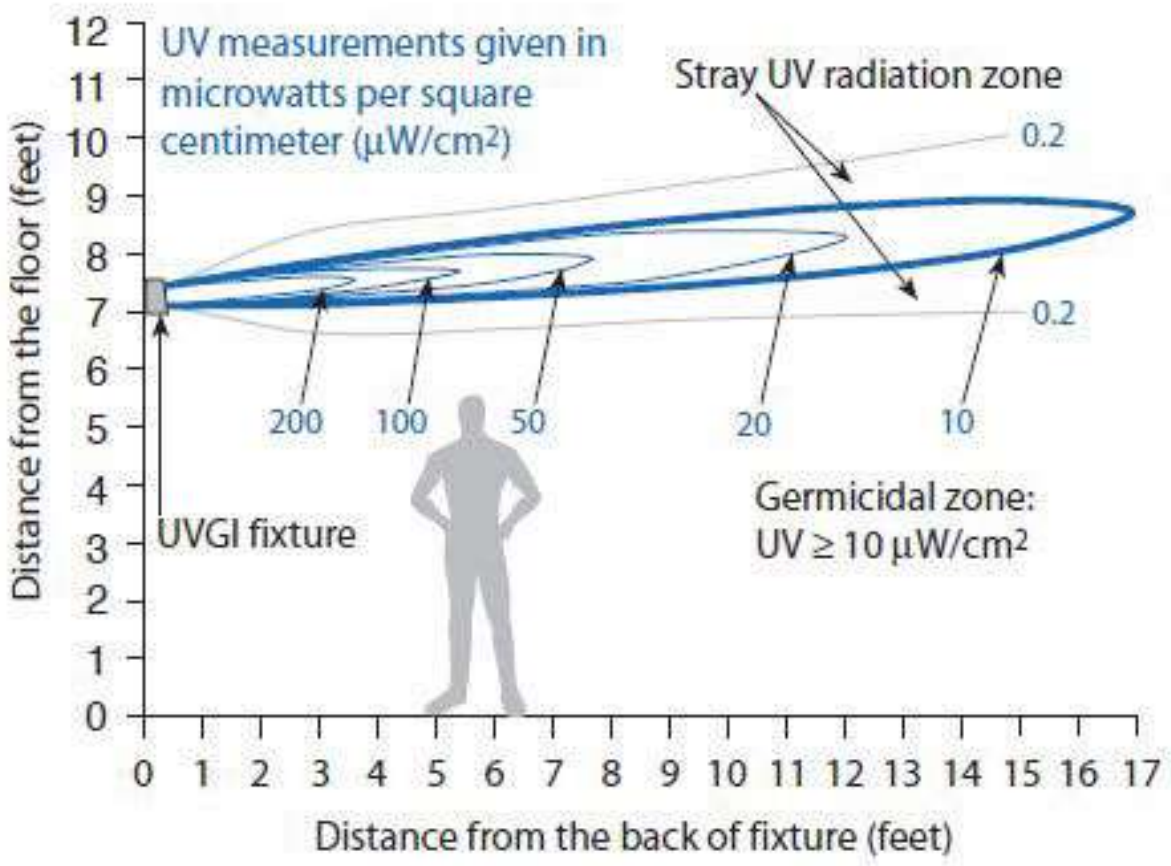
Air Cleaning Devices (EL-A) continued:

Mounting heights for Upper Room UVC.

MOUNTING HEIGHTS:

Ceiling Height	Fixture Height
8-9 ft.	7 ft.
10 ft	7.5 ft
11 ft.	8 ft.
12 ft.	8.5 ft.





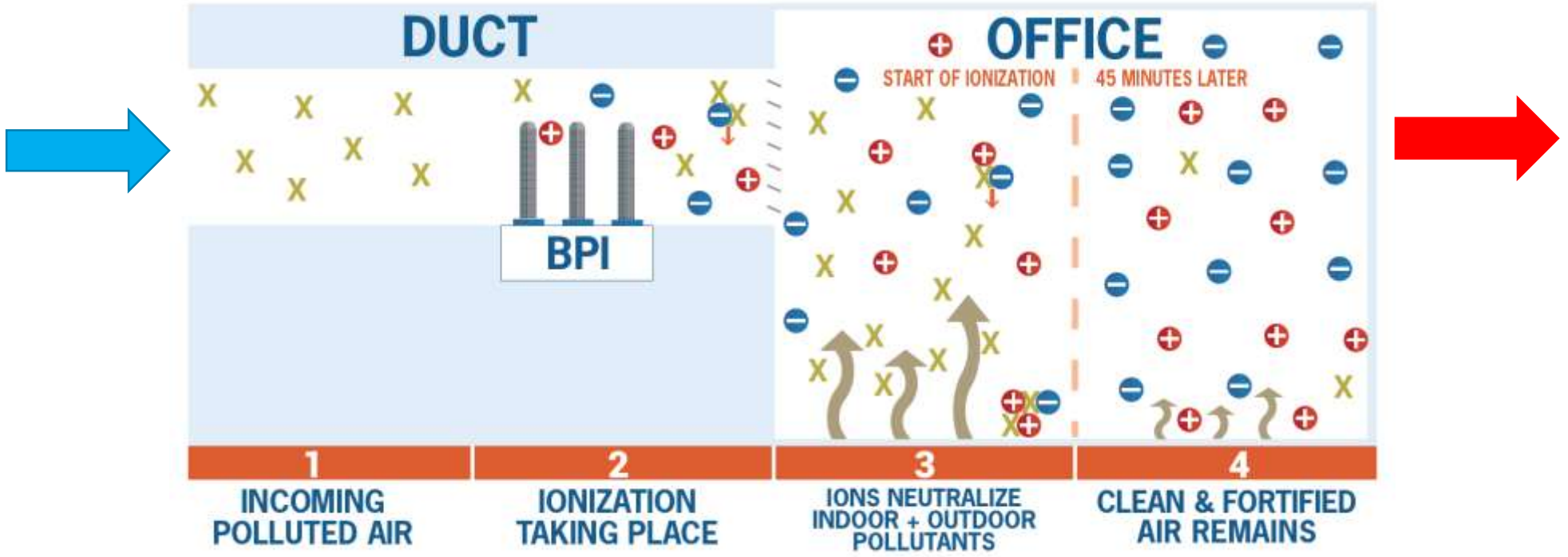
Air Cleaning Devices

PRECAUTIONS

1. Ultraviolet light is harmful to skin and eyes, as well as to paints, plastics, finishes and organic matter (like plants and animals) – that's why it is so good at inactivating the virus.
2. Seek professional guidance on installing and using these fixtures well above people's heads and in a way that they cannot look directly into the lamps in the fixtures.

Air Cleaning Devices (EL-N/A) continued:

1. Bi-Polar: Use of positive and negative ions reduces airborne particles (i.e., dust, pet dander, pollen) through agglomeration.
   a. The ions attach to the airborne particles. The particles are subsequently attracted to one another, effectively increasing their mass and size. The air filtration system easily captures the larger particles, increasing the capture efficiency of your HVAC system.



Air Cleaning Devices (EL-N/A) continued:

b. Airborne Pathogens: The ions steal away hydrogen from the pathogens, that neutralizes the bacteria or virus.

c. Odors: cleaning process chemicals, pet, cooking, and other odors are broken down into basic compounds, typically separating the connection to water vapor.

Air Cleaning Devices (EL-N/A) continued:

2. Bi-Polar: General statements regarding use of this technology:
   a. ASHRAE does NOT have a position on use of this technology.
   b. ASHRAE 62.1 committee, and TC 145.2 and 2.3 have reached out to all the BPI manufacturers to come up with a testing procedure, and here were the results:
      1) For many years, BPI manufacturers have refused to allow ASHRAE to conduct their tests.
         a) Maybe because the BPI manufacturer wants to maintain control of the procedure?
      2) BPI manufacturers met with ASHRAE, and can't decide on how the technology should be tested:
         a) Small room, long duct, short duct. Why not have specific procedures for specific technologies? What's the issue?
      3) Issues with the MRSA report:
         a) No power is reported for the test. The model number is reported though (GPS-iBAR-36). It is no longer on the website though.
         b) A 60 minute kill time for a sample in a space small enough to be mixed by a computer fan doesn't sound equivalent to a commercial installation. How effective would this be in an AHU at 400 fpm?
         c) Testing stand volume not reported.
         d) This test does not include sampling for creation of any byproducts at the reported kill rate.
      4) UL 867 test may still have a loop hole that does not require the power setting to be reported in the test results.
      5) ASHRAE is looking for a single pass performance – otherwise containments are considered to be recirculated.

Air Cleaning Devices (EL-N/A) continued:

Owner's may elect to use this technology, so be educated:

1. Pro's: Ions neutralize airborne viruses by inhibiting them from attaching a host cell.
   a. Device lifespan – generally speaking would be 10-15 years.

2. Con's: Air must recirculate several times through the air handler to be effective.
   a. Treats the air, and not necessarily the fomites at the surface.
   b. Timeframe for effectiveness depends on many factors, such as total room air change rates, cleanliness of the air, meaning too many particles will take longer for device to be effective. Refer to manufacturer's effectiveness tables for actual air changes required.
   c. Reduces the good microbiome in the space, eliminating "good" microbes, while deactivating the "bad" ones. Unknowns: What other byproducts occur due to this process?
   d. No standardized performance testing to know that what you got is working, or is as effective as needed.

Air Cleaning Devices (EL-N/A) continued:

3. Cautions: Use needle point style devices, that don't produce Ozone.

   a. Ionization air cleaners must meet UL 2998 and UL 876 (to not produce ozone).

   b. Design your systems capable of all outside air requirements. Then the addition of this device's performance does not interfere with the your design meeting performance requirements.

   c. If you looking to use this to reduce airborne pathogens, consider how you will in fact measure it's performance – i.e. through particle sensors.

HVAC Air Quality Design

Indoor Air Quality: Contaminants inside a building can be reduced by ventilation strategies to either dilute them with the input of clean air, or using HVAC devices to clean the air in the space. First step is to determine the source of air pollution. If the source is the ambient environment, then careful balancing of ventilation and exhaust rates, along with filtration of the incoming ventilation air should reduce risks to the occupants. If the source is internal to the building, then once the source is addressed, HVAC strategies can include cleaning of the air, or dilution with clean air, in accordance with ASHRAE Std 62.

Air Quality:

Exposure to air pollutants can lead to compromised health, both respiratory and cardiovascular. Preliminary results of a recent study show a small increase in long term exposure to PM2.5 leads to a large increase in the COVID-19 death rate*.

List of “Criteria” air pollutants: World Health Organization (WHO) and other regulatory bodies such as the U.S. EPA have created this list with established permissible levels for these “criteria” air pollutant based on epidemiological studies that show the relationships between concentrations of these pollutants, duration of exposure and health risks. For a list of pollutants and their recommended permissible levels, go to U.S. EPA site https://www.epa.gov/criteria-air-pollutants#self or review the WELL standard https://v2.wellcertified.com/v/en/air

Ambient Air Quality: The U.S. EPA sets ambient Air Quality standards (NAAQS). The performance of various U.S. locations can be seen at https://www.airnow.gov/national-maps/

Air Quality:

Current advances in technology allow building owners to install inexpensive air quality monitors in their building spaces, providing continuous feedback to their HVAC control stations. Knowing the air pollutant levels in the space allows an owner or tenant to address the issues.

RESET certification of a building's air quality is a sensor-based, performance-driven certification program. A byproduct of creating the certification program is that the air quality monitors must meet an quality standard that is verifiable and data driven. Most air quality monitors do not meet this criteria.

- The TLC Orlando office renovation includes Awair Omni AQ monitors. These devices are RESET certified.

* April 27, 2020 preprint of a Harvard University article "*Exposure to air pollution and COVID-19 mortality in the United Sates: A nationwide cross-sectional study*"

Good, Better, Best Approach

System Design by Building Types - Assembly:

Good: (Is baseline for good design and code compliance)

1. Humidity Control – at the unit and VAV terminals.
2. Building Pressurization – at entry doors and in each space.

Better:

1. Upgraded Filtration – MERV 14 or better.
2. Demand Control Ventilation overrides for temporary purposes.

Best:

1. Airflow Pattern – UFAD, Displacement Ventilation
2. Design heating and cooling coils to allow higher ventilation rates in emergencies.
3. Air Cleaning Devices – to aid in filtration of particulates.

Frequently Asked Questions

FAQ:

Q: Why is Bi-Polar listed as Evidence Level “N/A”?

A: Because ASHRAE has not performed testing or studies on this approach.

Q: What is the best thing I can do for my building?

A: Design and maintain a clean and commissioned HVAC System.