Mitigating Pathogen Transmission

ASHRAE Epidemic Task Force

Dilution / Filtration

Presenter:
Dan Hahne (Varitec, Senior Sales Engineer)

VARITEC™
SOLUTIONS

Introduction

- Education:
  - University of Arizona – Chemical Engineering
    - 1974 thru 1976
  - University College London – BFA Degree (Sculpture)
    - 1978 thru 1983
  - Boston University – MFA Degree (Sculpture)
    - 1983 thru 1985

Industry:

- Norman S. Wright SW: Estimator/Sales
  - 1985 thru 1999
- Air Specialty Products/ThermAir Systems – Outside/Engineering Sales
  - 2000 thru 2008
- **Varitec Solutions:**
  - Senior Sales Engineer/Educator (High Performance HVAC)
  - 2016 thru present

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Introduction

- Publications:
  - Co-Authored with Fletcher Clarcq (Smith Group, Phoenix - Mechanical Lead)

Engineered Systems (ES) Magazine
- October 2019
- November 2019

ES FEATURE

By Fletcher J. Clarcq, P.E., CEM, LEED AP BD+C; Eric Martin, P.E., MBA; Dan Hahne; and Steve Lamica

DEBUNKING MYTHS OF ACTIVE CHILLED BEAMS: WHAT YOU THOUGHT YOU KNEW – BUT WERE WRONG, PART 1

How long does it take for condensation to form on an active chilled beam? A group of engineers at SmithGroup used testing and analysis to answer that question and more.

Chilled beams offer building owners greater energy efficiency, reduced building first cost, reduced day-two maintenance, and improved indoor air quality. Unlike conventional mixed-air systems that use air as the heat transfer medium for the total load of a conditioned building, "decoupled" chilled water systems split the latent and sensible loads and drive local interior zone sensible loads directly to chilled water supplied through coils mounted in coil casings called chilled beams. Since water is a denser heat transfer medium than air and can hold 600 times more Btu per pound of heat transfer medium, it requires significantly less volume of water than air to maintain space temperature. Energy efficiency is gained by reducing fan horsepower that would otherwise be required to remove sensible heat from a building using an air-side HVAC design. Chilled beam systems are typically coupled with either a dedicated outdoor air system (DOAS), standard chilled water air-handling units, or energy recovery units in order to control latent loads. The chilled beams then address space sensible loads. Consequently, by "decoupling" the sensible and latent load, a building owner can see 20%–40% or more in energy savings when compared to an ASHRAE 90.1-2013 baseline system. There are two types of chilled beam designs:

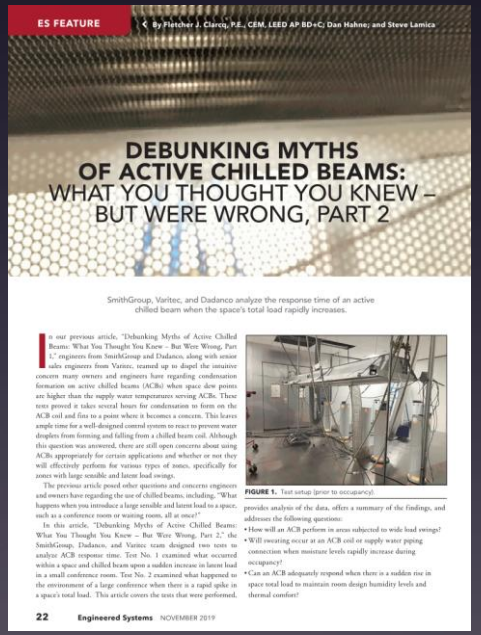
Passive Chilled Beams (PCB)

Passive beams house horizontally mounted chilled water coils in sheet metal enclosures located at the ceiling level. Chilled water is circulated through the coil where heat, local to the beam, is removed by conduction to the beam's chilled water loop. Convection causes the cooler air to drop to lower levels of the conditioned space, allowing for thermal stratification to occur.

FIGURE 1. The active chilled beam condensation test was conducted at Dadanco's environmental test chamber

Active Chilled Beams (ACB)

Similar to passive chilled beams, active chilled beams (ACBs) house a chilled water coil mounted horizontally but in the bottom tier of a two-tiered sheet metal enclosure. Unlike passive beams, which work in spaces designed to maintain a state of thermal stratification, active beam systems are designed to create a thoroughly mixed-air environment to maintain uniformity of temperature throughout the cubic volume of space. To do so, active beams need to deliver primary air at a high velocity through nozzles located in a sheet metal divider plate between the two plenum tiers. Air, injected at high velocities through these nozzles located along both sides of the coil, creates a negative pressure zone above the coil, allowing room air to be induced



ES FEATURE

By Fletcher J. Clarcq, P.E., CEM, LEED AP BD+C; Dan Hahne; and Steve Lamica

DEBUNKING MYTHS OF ACTIVE CHILLED BEAMS: WHAT YOU THOUGHT YOU KNEW – BUT WERE WRONG, PART 2

SmithGroup, Varitec, and Dadanco analyze the response time of an active chilled beam when the space's total load rapidly increases.

In our previous article, "Debunking Myths of Active Chilled Beams: What You Thought You Knew – But Were Wrong, Part 1," engineers from SmithGroup and Dadanco, along with senior sales engineers from Varitec, teamed up to dispel the intuitive concern many owners and engineers have regarding condensation formation on active chilled beams (ACBs) when space dew points are higher than the supply water temperatures serving ACBs. These tests proved it takes several hours for condensation to form on the ACB coil and fins to a point where it becomes a concern. This leaves ample time for a well-designed control system to react to prevent water droplets from forming and falling from a chilled beam coil. Although this question was answered, there are still open concerns about using ACBs appropriately for certain applications and whether or not they will effectively perform for various types of zones, specifically for zones with large sensible and latent load swings.

The previous article posed other questions and concerns engineers and owners have regarding the use of chilled beams, including, "What happens when you introduce a large sensible and latent load to a space, such as a conference room or waiting room, all at once?"

In this article, "Debunking Myths of Active Chilled Beams: What You Thought You Knew – But Were Wrong, Part 2," the SmithGroup, Dadanco, and Varitec team designed two tests to analyze ACB response time. Test No. 1 examined what occurred within a space and chilled beam upon a sudden increase in latent load in a small conference room. Test No. 2 examined what happened to the environment of a large conference when there is a rapid spike in a space's total load. This article covers the tests that were performed, provides analysis of the data, offers a summary of the findings, and addresses the following questions:

- How will an ACB perform in areas subjected to wide load swings?
- Will sweating occur at an ACB coil or supply water piping connection when moisture levels rapidly increase during occupancy?
- Can an ACB adequately respond when there is a sudden rise in space total load to maintain room design humidity levels and thermal comfort?

FIGURE 1. Test setup (prior to occupancy)

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Acknowledgements

Presentation Material by:

- ASHRAE – Epidemic Task Force
- ASHRAE – Position Document on Infectious Aerosols: Guidelines
    - Dilution
    - Filtration
- Dynamic - Filtration

Agenda

- CDC & WHO – Means of Transmission
- ASHRAE Epidemic Task Force
- ASHRAE Position Document on Infectious Aerosols
  - Dilution
  - Filtration

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Modes of COVID-19 Transmission: The Debate

TIME

ARTICLE: Published August 25th, 2020

By: Jose-Luis Jimenez

(Professor of Chemistry and a Fellow of the Cooperative Institute for Research in Environmental Sciences at the University of Colorado-Boulder)

COVID-19 Is Transmitted Through Aerosols. We Have Enough Evidence, Now It Is Time to Act

"Contrary to public health messaging, I, together with many other scientists, believe that a substantial share of COVID-19 cases are the result of transmission through aerosols."

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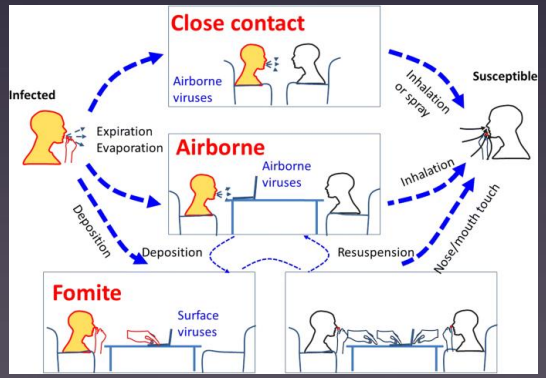
Modes of COVID-19 Transmission: The Debate

COVID-19 Is Transmitted Through Aerosols. We Have Enough Evidence, Now It Is Time to Act

TIME

"There are three possible ways the virus is transmitted, of which two have been emphasized by the WHO and the CDC."



- **Fomite Transmission**
- **Droplets**
- **Aerosols**

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Modes of COVID-19 Transmission: The Debate

COVID-19 Is Transmitted Through Aerosols. We Have Enough Evidence, Now It Is Time to Act

TIME

"Fomites and droplets have dominated our everyday understanding of COVID-19 transmission. While the WHO and CDC both state that aerosols ***could*** lead to transmission under highly specific situations, both organizations maintain that they are less important.

"**I believe this is a significant mistake** and on July 6 I, along with 239 scientists, appealed to the WHO to reevaluate their stance. WHO updated their position in response, but the agency's language **continues to express skepticism** of the importance of this pathway."

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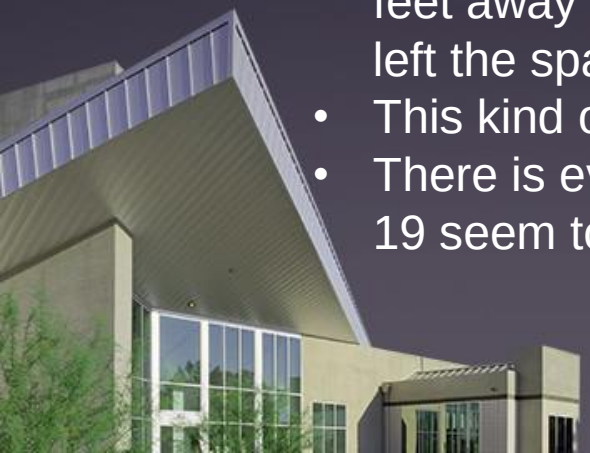
Modes of COVID-19 Transmission: The Debate

The Center for Disease Control (CDC):

- "COVID-19 can sometimes be spread by airborne transmission."
- Some infections can be spread by exposure in small droplets and particles that can linger in the air for minutes or hours.
    - These viruses may be able to infect people who are further than 6 feet away from the person who is infected or after that person has left the space.
    - This kind of spread is referred to as **airborne transmission**…
    - There is evidence that under certain conditions, people with COVID-19 seem to have infected others who were more than 6 feet away.



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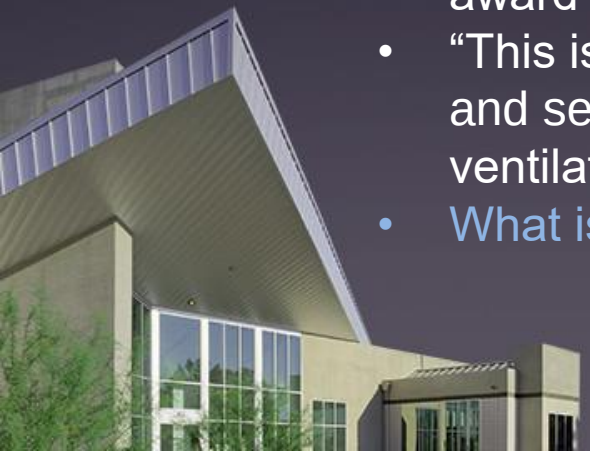
Modes of COVID-19 Transmission: The Debate

MARTIN
UNITED STATES SENATOR for NEW MEXICO
HEINRICH

In August, Senator Heinrich brought together engineering experts from the local New Mexico chapter of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and ASHRAE's Epidemic Task Force for a discussion on air decontamination in schools and businesses.

Senator Martin Heinrich of New Mexico:

- Introduced the Keeping Schools Safe Act bill on October 1st to award grants…
- "This is why I am introducing this legislation to provide elementary and secondary schools with funding to improve air quality and ventilation…"
- What is ASHRAE's position on pathogen transmission?



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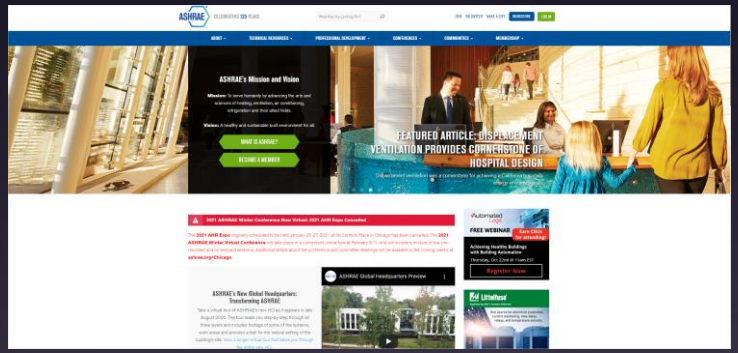
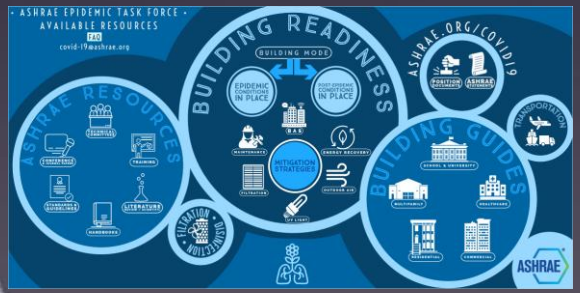
ASHRAE Epidemic Task Force



ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers (www.ashrae.org)

Resource for latest information:

- ASHRAE Position Document on Infectious Aerosols
- Guidance for:
  - Reopening
  - Buildings
  - Filtration/Disinfection
  - Transportation
  - Resources



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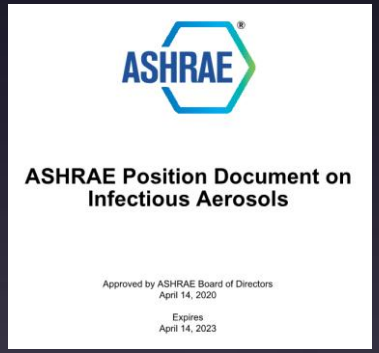
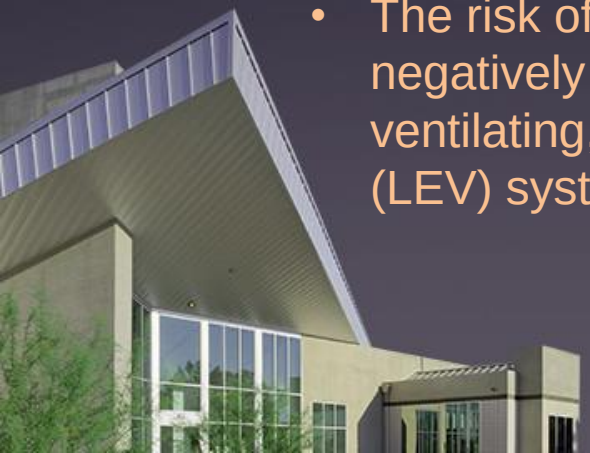
- **ASHRAE's** Position Document on Infectious Aerosols
  - Abstract:
    - "Some diseases are known to spread by infectious aerosols."



- The risk of pathogen spread … can be affected both positively and negatively by the airflow patterns in the space and by heating and ventilating, and air-conditioning (HVAC) and local exhaust ventilation (LEV) systems.



ASHRAE

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• ASHRAE Epidemic Task Force

- ASHRAE's statement on operation of heating, ventilating, and air-conditioning systems to reduce SARS-CoV-2/COVID-19 Transmission.

ASHRAE Issues Statements on Relationship Between COVID-19 and HVAC in Buildings

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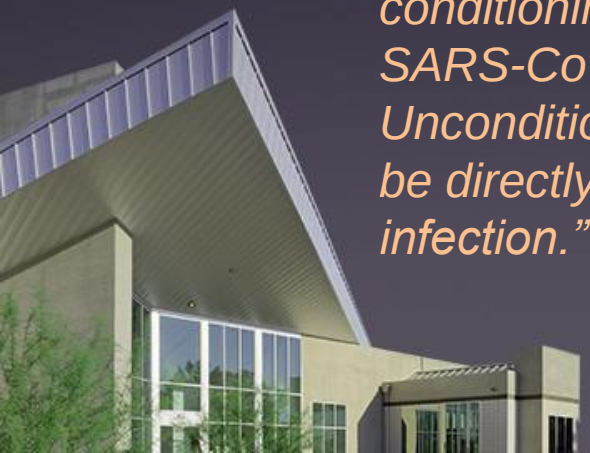
ASHRAE COVID-19 Resources (ashrae.org/covid19)



"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. Unconditioned spaces can cause thermal stress to people that may be directly life threatening and that may also lower resistance to infection."

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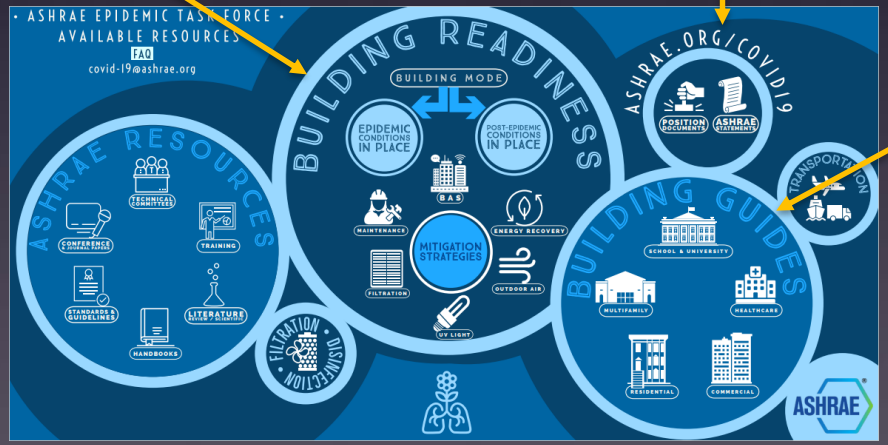
ASHRAE Epidemic Task Force

The Challenge: Navigating the Task Force website

Building Readiness
- Maintenance
- Filtration
- UV Light
- Energy Recovery
- Outdoor Air

ASHRAE.ORG / COVID19
- Position Document on Infectious Aerosols
- ASHRAE Statements



Building Guides
- School & University
- Multifamily
- Residential
- Commercial
- Healthcare

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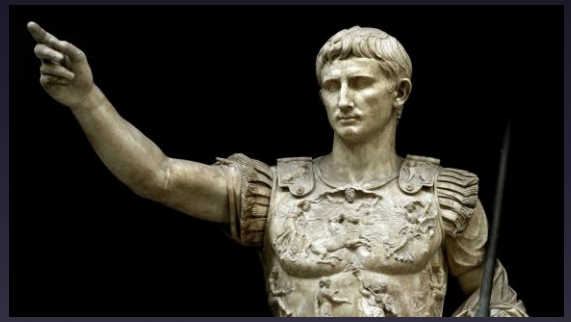
Task Force Navigation:

"All roads lead to Rome"
(Alain de Lille, 1175 A.D.)



(Ceasar Agustus)

"All roads lead to Dilution"
(Varitec Sales Engineer)

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ASHRAE Epidemic Task Force

- Today's Goal:
  - Distill, consolidate and expand upon major concepts drawn from the various navigation tabs.

Bardstown Bourbon Company

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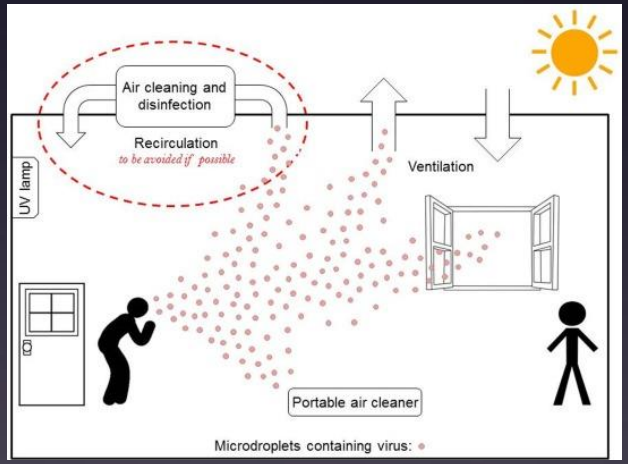
ASHRAE Epidemic Task Force

Task Force Navigation:

- Primary Objective:
  - HVAC systems to reduce airborne active pathogens at the breathing zone
  - Fact: Dilution of active pathogens reduces the threat of transmission



HVAC design dilution solutions:

- Ventilation
- Filtration
- Humidification
- UVGI (Ultraviolet Germicidal Irradiation)

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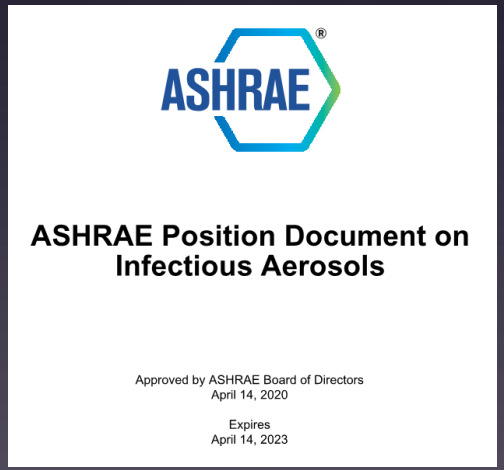
ASHRAE Epidemic Task Force

- ASHRAE's Position Document on Infectious Aerosols



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- ASHRAE's Position Document on Infectious Aerosols
  - Abstract:
    - **ASHRAE** believes that these techniques, when properly applied, **can reduce the risk of transmission of infectious diseases through aerosols"**
    - "…Chief among these ventilation related strategies are:
      - Dilution
      - Airflow patterns
      - Pressurization
      - Temperature and humidity distribution and control
      - Filtration
      - Ultraviolet germicidal irradiation (UVGI)"

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ASHRAE: Position Document on Infectious Aerosols

2. Background:

- This position document covers the dissemination of infectious aerosols and indirect-contact routes of transmission.

Airborne Dissemination:

- (Bischoff et al. 2013; Yan et al. 2018) Pathogen dissemination through the air occurs through droplets and aerosols typically generated by coughing, sneezing, shouting, breathing…talking.

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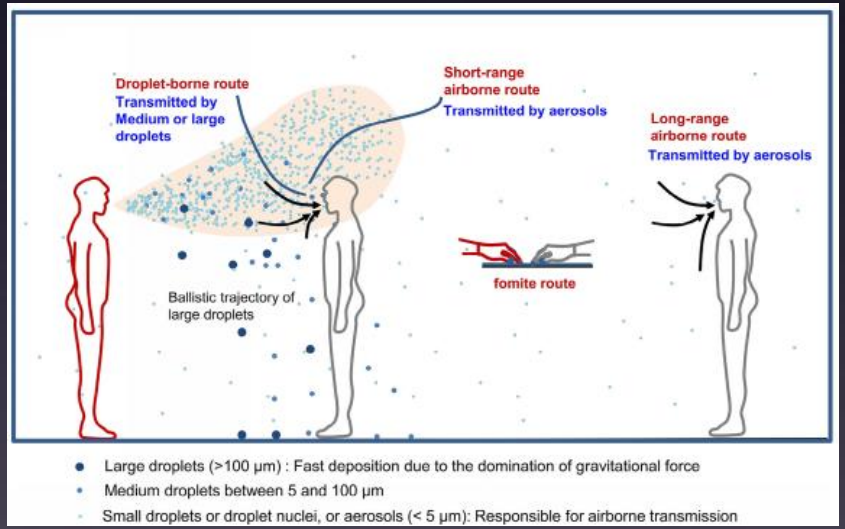
ASHRAE: Position Document on Infectious Aerosols

2.1 Airborne Dissemination:

- …small aerosols, which can stay airborne and infectious for extended periods (minutes, hours, days) and thus can travel longer distances and infect secondary hosts who had no contact with the primary host.”



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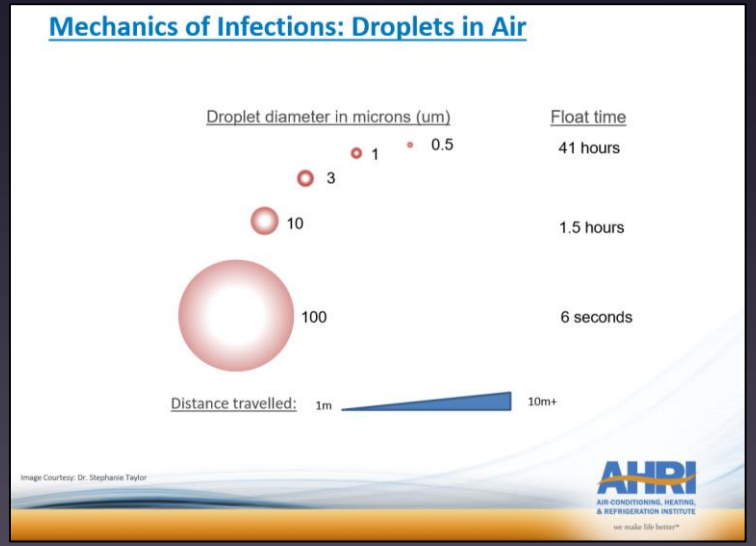
ASHRAE: Position Document on Infectious Aerosols

2.1 Airborne Dissemination:

- While **ventilation systems** cannot interrupt the rapid settling of large droplets, they **can influence the transmission of droplet nuclei infectious aerosols.**



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ASHRAE: Position Document on Infectious Aerosols

2.1 Airborne Dissemination:

- The majority of larger emitted droplets are drawn by gravity to land on surfaces within 3-7 feet from the source.
- General dilution ventilation and pressure differentials **do not significantly** influence short range transmission.

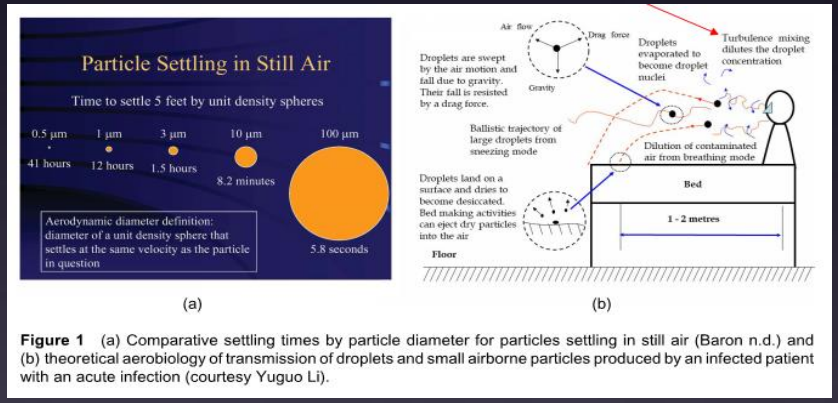

Figure 1 (a) Comparative settling times by particle diameter for particles settling in still air (Baron n.d.) and (b) theoretical aerobiology of transmission of droplets and small airborne particles produced by an infected patient with an acute infection (courtesy Yuguo Li).

- Conversely, dissemination of smaller **infectious aerosols**, including droplet nuclei resulting from desiccation, **can be affected by airflow patterns** in a space in general and airflow patterns surrounding the source in particular.

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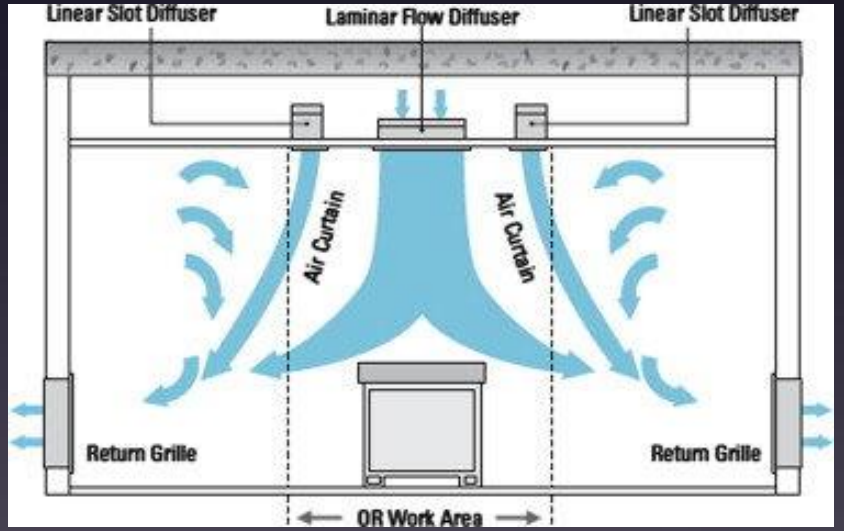
ASHRAE: Position Document on Infectious Aerosols

2.1 Airborne Dissemination:

- Directional airflow can create clean-to-dirty flow patterns and move infectious aerosols to be captured or exhausted



Operating Room Perimeter Air Curtain System

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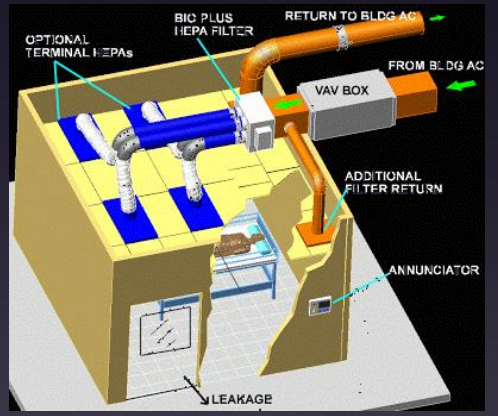
ASHRAE: Position Document on Infectious Aerosols

3.2 Ventilation and Air-Cleaning Strategies:

- (Pantelic and Tham 2013): “Ventilation with effective airflow patterns is a **primary infectious disease control strategy through dilution of room air** around a source and removal of infectious agents (CDC 2005).”



- However, it remains unclear by how much infectious particle loads must be reduced to achieve a measurable reduction in disease transmissions (infectious doses vary widely amount different pathogens)…

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ASHRAE: Position Document on Infectious Aerosols

3. Practical Implications for Building Owners, Operators, and Engineers:

Be Aware:

- “Even the most robust HVAC system cannot control all airflows and completely prevent dissemination of an infectious aerosol or disease transmission by droplets or aerosols.”

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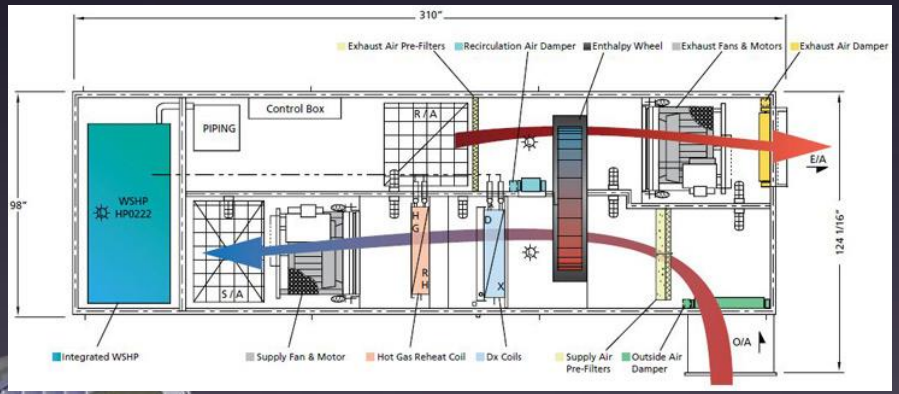
ASHRAE: Position Document on Infectious Aerosols

3.2 Ventilation and Air-Cleaning Strategies:



- **Dilution:**
  - Increase space OSA air changes per hour.
  - Mixed Air System: Maximize mixing in a space.

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Questions?

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ASHRAE Epidemic Task Force

Dilution

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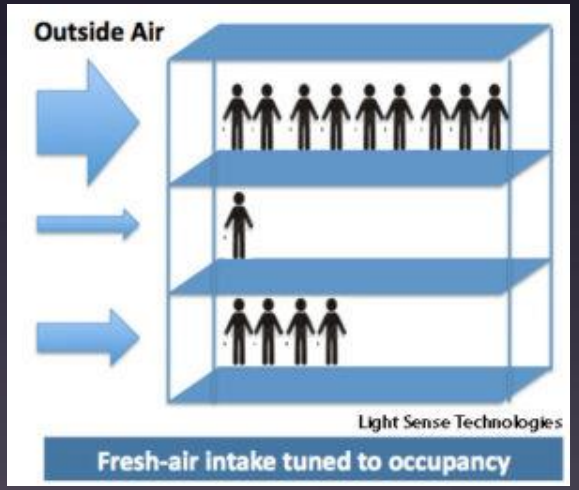
ASHRAE: Dilution

- Dilution: Increase Outside Air
  - Epidemic Task Force – Building Readiness Guidelines (Increased Ventilation Control):
    - It is also important to note that demand controlled ventilation, static pressure reset strategies and the typical supply air temperature reset strategies should be disabled.



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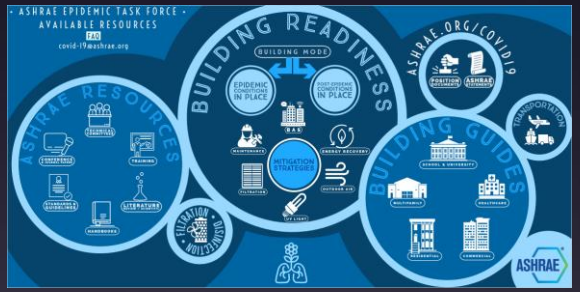
ASHRAE: Dilution

- Dilution: Increase Outside Air ACH
  - Epidemic Task Force – Building Readiness Guidelines (Outdoor Air):
    - Increased OSA air changes per hour:
      - The Building Guidance clearly encourages building operators to **increase their systems outdoor air ventilation** to reduce the recirculation air back to the space
      - The guidance indicates that **this must be done as much as the system and or space conditions will allow.**



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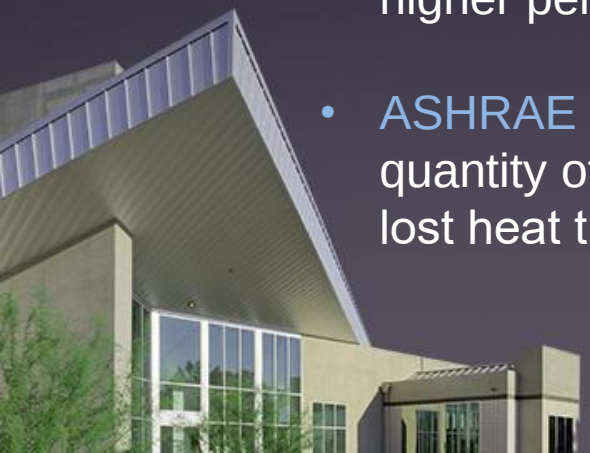
ASHRAE: Dilution

- Dilution: Increase Outside Air ACH
  - Epidemic Task Force – Building Readiness Guidelines (Outdoor Air):
    - "The team should consider adjusting the space comfort set points to increase the system's ability to use more **outside air.**
    - Most buildings do not have the capacity designed into the air handling unit to adequately condition air to a space with a higher percentage of outside air.

    - ASHRAE states: "..Another way to potentially increase the quantity of outside air is to clean your cooling coil to recapture lost heat transfer from fouling."



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ASHRAE: Dilution

- Dilution: Increase Outside Air ACH
  - Epidemic Task Force – Building Readiness Guidelines (Increased Ventilation Control):
    - Two options to increase the **outside air**:
      - Option #1:
        - If the cooling coil control valve is less than 90% AND the discharge air temperature (or space temperatures) are satisfied, OPEN the Outside Air Damper [Close the Return Air Damper] 3% every 15 minutes
        - If the cooling coil control valve is greater than 90% OR the discharge air temperature (or space temperatures) is exceeded by 1 degree F, CLOSE the OAD [OPEN the Return Air Damper] 6% every 15-minutes

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ASHRAE: Dilution

- Dilution: Increase Outside Air ACH
  - Epidemic Task Force – Building Readiness Guidelines (Increased Ventilation Control):
    - Option #2: Increased OA based on Space Conditions:
      - This option assumes that a coil leaving air temperature controls the chilled /hot water valve (CHW) to maintain a constant set point.
      - If the space temperatures are satisfied and the (outdoor) relative humidity is less than 55%, OPEN the OAD [CLOSE the RAD] 3% every 15 minutes
      - If the space temperatures are exceeded by 1 degree F OR the relative humidity is greater than 60%, CLOSE the OAD [OPEN the RAD] 6% every 5 minutes

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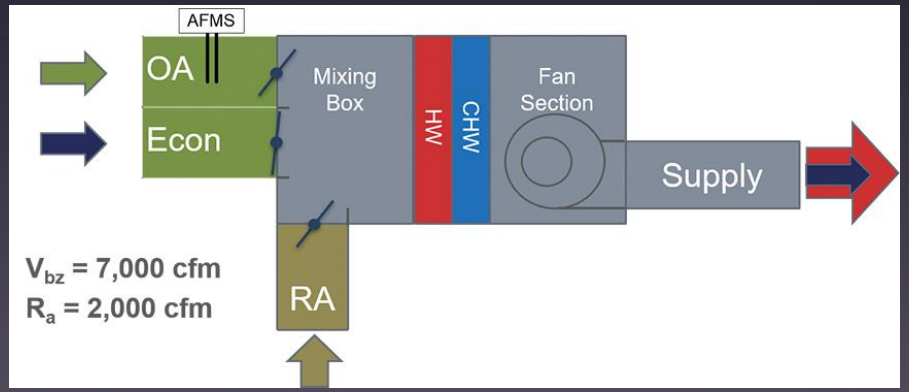
ASHRAE: Dilution

- Dilution: Increase Outside Air ACH
  - Epidemic Task Force – Building Readiness Guidelines (Increased Ventilation Control):
    - These options require different sensors to be installed in the unit to work properly.

- OSA Temp Sensor
- OSA RH Sensor
- CHW coil LAT sensor



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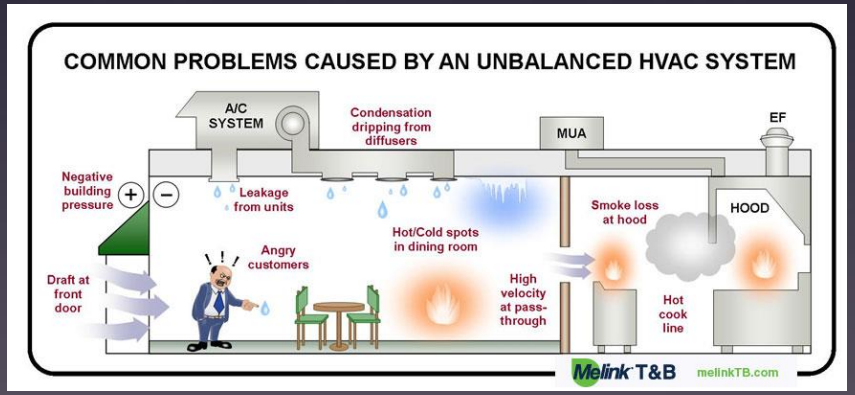
ASHRAE: Dilution

- Dilution: Increase Outside Air
  - Epidemic Task Force – Building Readiness Guidelines (Building & Space Pressure):
    - Care should be taken when increasing **outside air** but keeping exhaust and relief air systems as designed.



Maintain building zone pressure relationships

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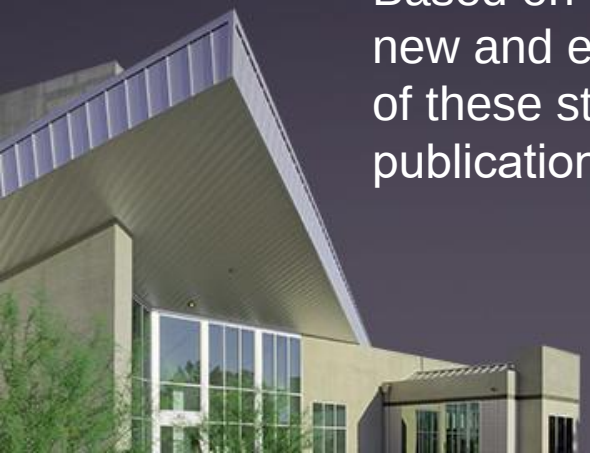
ASHRAE: Dilution

- Dilution: Increase Outside Air
  - Epidemic Task Force – Position Document on Infectious Aerosols:

4.1 ASHRAE's Positions:

- HVAC design teams for facilities of all types should follow, AS A MINIMUM, the latest published standards and guidelines and good engineering practice.
- Based on risk assessments or owner project requirements, designers of new and existing facilities could go beyond the minimum requirements of these standards, using techniques covered in various ASHRAE publications…



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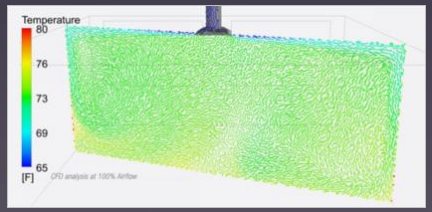
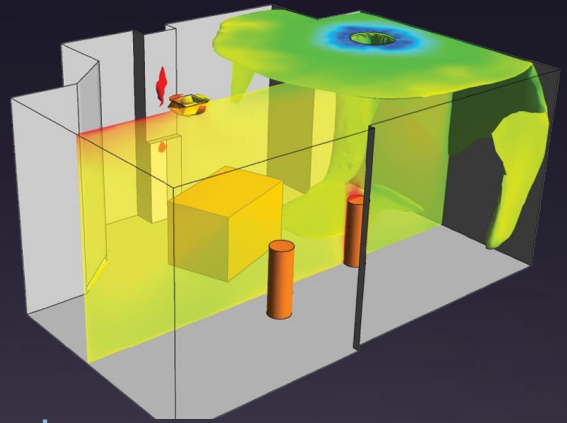
ASHRAE: Dilution

- Dilution: Mixed Air within the space
  - ASHRAE Standard 62.1
    - Sets minimum OSA requirements
    - Based on total airflow to the space
  - Design Objectives:
    - Create uniform temperature in the cubic volume of space
    - Create thorough OSA mixing in space



(Mixed Air Condition 100% flow)



Airflow Design:

- Inject air at high velocity
- Induce room air into supply jet for maximum mixing
- Uniform (maximum) pathogen dispersal

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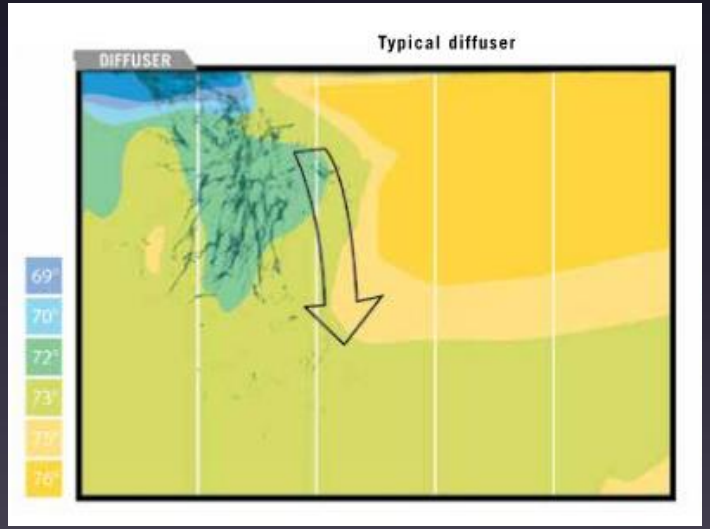
ASHRAE: Dilution

- Dilution: Mixed Air within the space
  - VAV System at Part Load:
    - What if supply air is 50% of design max flow
    - Insufficient air results in dumping
    - Insufficient mixing results in varying concentrations of pathogen released in the space



Result: Insufficient OSA potential atccupant breathing zone.

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ASHRAE: Dilution

- Dilution:
  - (Taylor Engineering: October 14, 2020)
    - Guangzhou Restaurant Study

(Li et al. 2020)

- Asymptomatic carrier (A1)
- Meal duration, 1 to 1.5 hours
- Release of droplets and aerosols via breathing, talking loudly, laughing.

HVAC system:

- Ductless Fan Coil Unit
- Ventilation: 1.6 CFM/Person (10% of California Code)

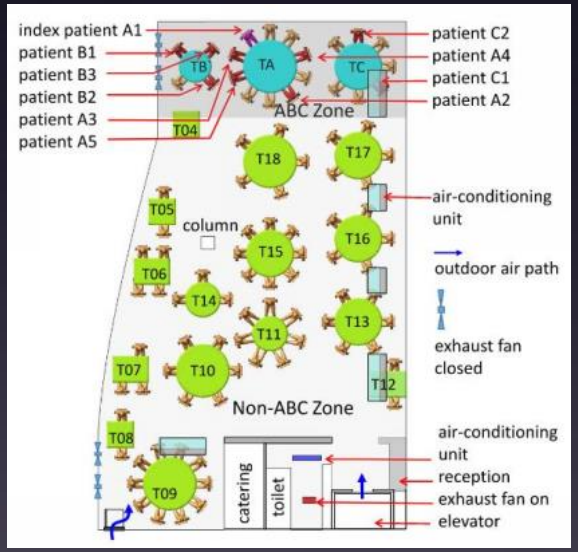

Table TA: 4 People Infected
Table TB: 3 People Infected
Table TC: 2 People Infected

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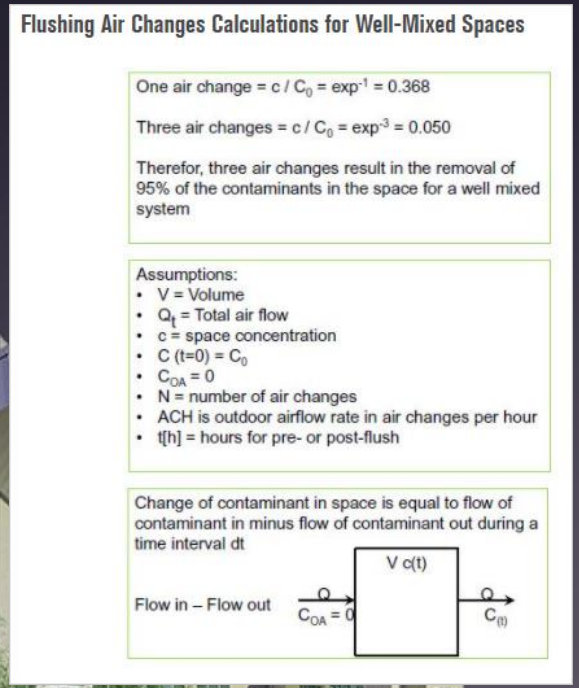
ASHRAE: Dilution

Epidemic Task Force – Building Readiness:

- Pre- or Post-Occupancy Flushing Strategy



- Flush building for sufficient duration to reduce concentration of airborne infectious particles by 95%.
- For a well-mixed space, this would reuqire (3) air changes of outside air

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Questions?

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Filtration

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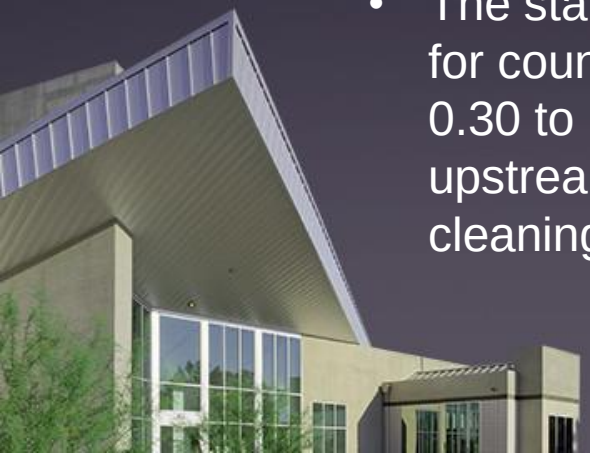
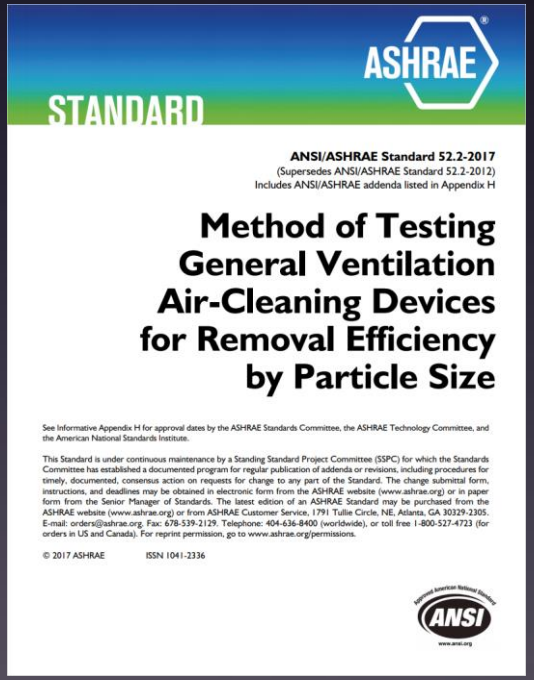
Filtration

ASHRAE: Standard 52.2 (2017):

- Particle Removal Efficiency & Testing
  - This standard describes a method of laboratory testing to measure the performance of general ventilation air-cleaning devices
  - The standard also defines a method for counting airborne particles of 0.30 to 10.0 microns in diameter upstream & downstream of the air-cleaning device.




ASHRAE
STANDARD

ANSI/ASHRAE Standard 52.2-2017
(Supersedes ANSI/ASHRAE Standard 52.2-2012)
Includes ANSI/ASHRAE addenda listed in Appendix H

Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

See Informative Appendix H for approval dates by the ASHRAE Standards Committee, the ASHRAE Technology Committee, and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

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ANSI
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Filtration

ASHRAE: Standard 52.2-2017

- Minimum Efficiency Reporting Value (MERV)
  - Identifies “Dust Holding Capacity”, i.e. “the total weight of synthetic loading dust captured by the air cleaning device over all of the incremental dust loading steps.”
  - Expresses efficiency as a function of specific particle size (PSE).

TABLE 2: ANSI/ASHRAE 52.2 PARTICLE SIZE RANGES

Range	Size	Group
1	0.30 to 0.40	E1
2	0.40 to 0.55	
3	0.55 to 0.70	
4	0.70 to 1.00	
5	1.00 to 1.30	E2
6	1.30 to 1.60	
7	1.60 to 2.20	
8	2.20 to 3.00	
9	3.00 to 4.00	E3
10	4.00 to 5.50	
11	5.50 to 7.00	
12	7.00 to 10.00	

Group E1: Size: 0.30 to 1.00
Group E2: Size :1.00 to 3.00
Group E3: Size: 3.00 to 10.00

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Filtration

ASHRAE: Standard 52.2 (2017)

- Minimum Efficiency Reporting Value (MERV)

Standard 52.2 Minimum Efficiency Reporting Value (MERV)	Composite Average Particle Size Efficiency, % in Size Range, µm			
	Range 1 0.30 to 1.0	Range 2 1.0 to 3.0	Range 3 3.0 to 10.0	Average Arrestance, %
1	N/A	N/A	$E_3 < 20$	$A_{avg} < 65$
2	N/A	N/A	$E_3 < 20$	$65 \le A_{avg}$
3	N/A	N/A	$E_3 < 20$	$70 \le A_{avg}$
4	N/A	N/A	$E_3 < 20$	$75 \le A_{avg}$
5	N/A	N/A	$20 \le E_3$	N/A
6	N/A	N/A	$35 \le E_3$	N/A
7	N/A	N/A	$50 \le E_3$	N/A
8	N/A	$20 \le E_2$	$70 \le E_3$	N/A
9	N/A	$35 \le E_2$	$75 \le E_3$	N/A
10	N/A	$50 \le E_2$	$80 \le E_3$	N/A
11	$20 \le E_1$	$65 \le E_2$	$85 \le E_3$	N/A
12	$35 \le E_1$	$80 \le E_2$	$90 \le E_3$	N/A
13	$50 \le E_1$	$85 \le E_2$	$90 \le E_3$	N/A
14	$75 \le E_1$	$90 \le E_2$	$95 \le E_3$	N/A
15	$85 \le E_1$	$90 \le E_2$	$95 \le E_3$	N/A
16	$95 \le E_1$	$95 \le E_2$	$95 \le E_3$	N/A

ASHRAE Standard 52.2-2017 Minimum Efficiency Reporting Value (MERV)

MERV8: (microns/%)

- 0.30 to 1.0: N/A
- 1.0 to 3.0: 20% or less
- 3.0 to 10.0: 70% or less

MERV13: (microns/%)

- **0.30 to 1.0: 50% or less**
- 1.0 to 3.0: 85% or less
- 3.0 to 10.0: 90% or less

MERV14: (microns/%)

- 0.30 to 1.0: 75% or less
- 1.0 to 3.0: 90% or less
- 3.0 to 10.0: 95% or less

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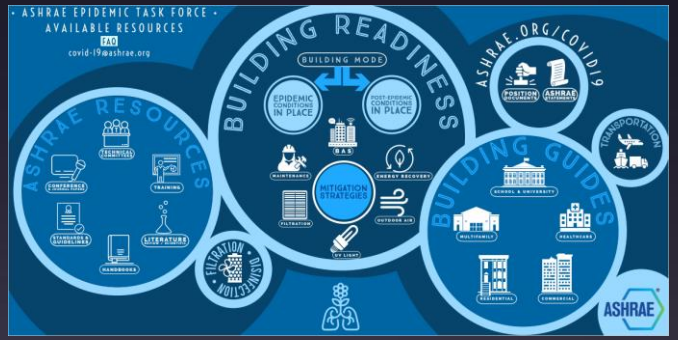
Filtration

ASHRAE: Epidemic Task Force

- Filtration & Disinfection Guidelines



- Mechanical Air Filters
- High-Efficiency Particulate Air (HEPA) Filters
- Electronic Air Filters
- Gas-Phase Air Cleaners
- In-Room or Portable Air Cleaners

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Filtration

ASHRAE: Epidemic Task Force

- Filtration & Disinfection Guidelines
  - Mechanical Air Filters:
    - MERV Ratings:
      - MERV ranges from 1 to 16: Higher MERV = higher efficiency
      - MERV 13 or greater: Efficient @ capturing airborne viruses
      - MERV 14: Preferred
      - High Efficiency particulate air (HEPA) filters

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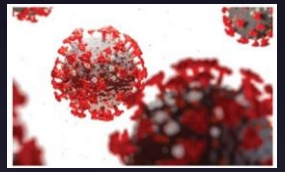
Filtration

ASHRAE: Epidemic Task Force

- Filtration & Disinfection Guidelines



(SAR-SCoV-2 = ~0.125 microns)

Standard 52.2 Minimum Efficiency Reporting Value (MERV)	Composite Average Particle Size Efficiency, % in Size Range, µm			
	Range 1 0.30 to 1.0	Range 2 1.0 to 3.0	Range 3 3.0 to 10.0	Average Arrestance, %
1	N/A	N/A	$E_3 < 20$	$A_{avg} < 65$
2	N/A	N/A	$E_3 < 20$	$65 \le A_{avg}$
3	N/A	N/A	$E_3 < 20$	$70 \le A_{avg}$
4	N/A	N/A	$E_3 < 20$	$75 \le A_{avg}$
5	N/A	N/A	$20 \le E_3$	N/A
6	N/A	N/A	$35 \le E_3$	N/A
7	N/A	N/A	$50 \le E_3$	N/A
8	N/A	$20 \le E_2$	$70 \le E_3$	N/A
9	N/A	$35 \le E_2$	$75 \le E_3$	N/A
10	N/A	$50 \le E_2$	$80 \le E_3$	N/A
11	$20 \le E_1$	$65 \le E_2$	$85 \le E_3$	N/A
12	$35 \le E_1$	$80 \le E_2$	$90 \le E_3$	N/A
13	$50 \le E_1$	$85 \le E_2$	$90 \le E_3$	N/A
14	$75 \le E_1$	$90 \le E_2$	$95 \le E_3$	N/A
15	$85 \le E_1$	$90 \le E_2$	$95 \le E_3$	N/A
16	$95 \le E_1$	$95 \le E_2$	$95 \le E_3$	N/A

ASHRAE Standard 52.2-2017 Minimum Efficiency Reporting Value (MERV)

MERV8: (microns/%)

- 0.30 to 1.0: N/A
- 1.0 to 3.0: 20% or less
- 3.0 to 10.0: 70% or less

MERV13: (microns/%)

- **0.30 to 1.0: 50% or less**
- 1.0 to 3.0: 85% or less
- 3.0 to 10.0: 90% or less

MERV14: (microns/%)

- 0.30 to 1.0: 75% or less
- 1.0 to 3.0: 90% or less
- 3.0 to 10.0: 95% or less

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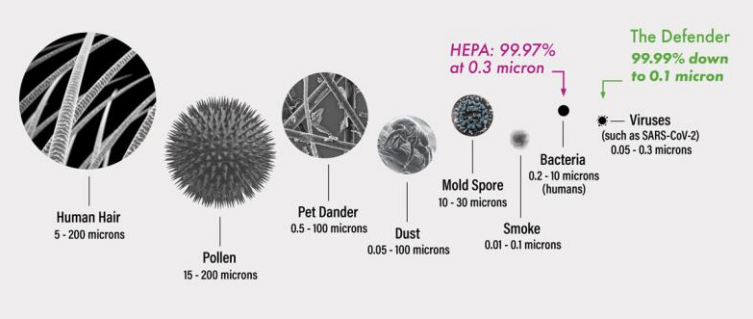
Filtration

ASHRAE: Epidemic Task Force

- Filtration & Disinfection: Mechanical Air Filters
  - MERV ≥ 13: Efficient at capturing airborne viruses
  - MERV 14 filters are preferred
  - High Efficiency particulate air (HEPA) filters are more efficient than MERV 16



Velocity, fpm	MERV rating	Pressure drop, in. wc
500	14	0.55
500	13	0.38
500	11	0.29

TABLE 1. Clean pressure drop.

- Particles with a diameter around 0.3 microns are most penetrating

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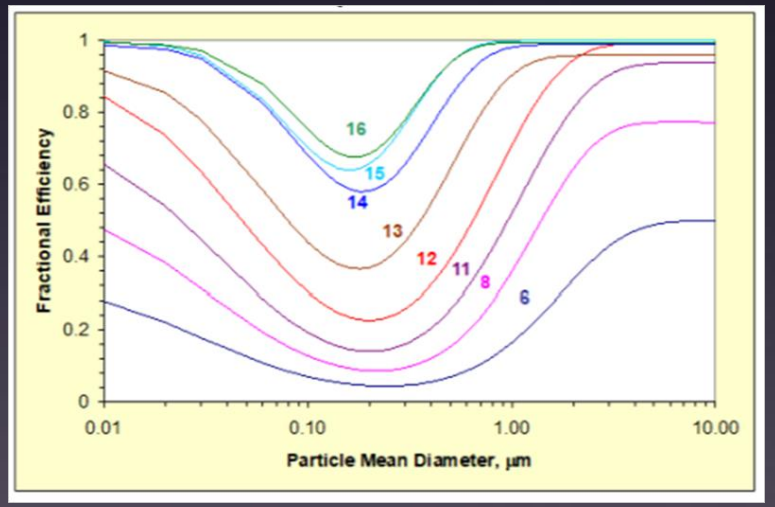
Filtration

ASHRAE: Epidemic Task Force

- Filtration & Disinfection: Mechanical Air Filters
  - Overall effectiveness of reducing particle concentrations
    - Filter efficiency
    - Airflow rate through the filter
    - Size of the particles
    - Location of the filter in the HVAC system…



MERV Rating/Particle Mean Diameter/Fractional Efficiency

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Filtration

ASHRAE: Epidemic Task Force

- Filtration & Disinfection: HEPA Filters
  - HEPA filter efficiency is better than MERV16
  - HEPA filters may not be an appropriate option for some HVAC systems due to high pressure drops and the likelihood that systems will need new filter racks to allow sufficient sealing to prevent filter bypass.
  - To function properly, HEPA filters must be sealed properly in filter racks
  - Filters are often delicate and require careful handling to prevent damage and preserve performance.

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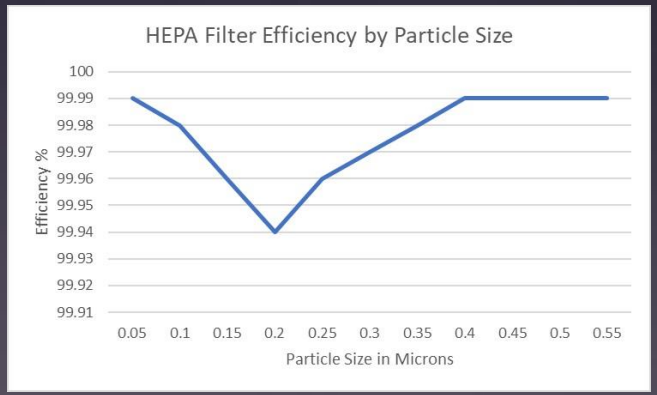
Filtration

ASHRAE: Epidemic Task Force
Filtration & Disinfection: HEPA Filters

- High Efficiency Particulate Air (HEPA) Filters
  - By definition, true HEPA filters are at least 99.97% efficient at filtering 0.3 micron mass median diameter (MMD) particles in standard tests.
    - Most penetrating particle size may be smaller than 0.3 micron, so filtration efficiency of most penetrating particles can be slightly lower



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Filtration

ASHRAE: Epidemic Task Force

- Building Readiness: Commercial
  - Practical Approach to Increase MERV in an AHU

Practical Approach to Increase MERV in an AHU: | Return to Top

The following are practical steps an owner can take to evaluate the maximum MERV rating and HVAC system can accommodate while maintaining acceptable system performance:

1. Consider retaining the services of a qualified design professional, a certified commissioning provider (CxP) or a certified testing, adjusting and balancing (TAB) service provider especially for larger, more complex HVAC systems or for systems serving critical buildings or spaces within buildings.
2. If available, gather the documents described above under the System Evaluation section of this document. One of the most valuable documents to have on hand for analyzing filter upgrades would be the original TAB report if the building configuration, use and occupancy has not changed since the building was originally constructed. Consider having readings taken to confirm the values in the TAB report.
3. Determine the manufacturer, size and thickness and MERV rating of the existing filters. For example, 20 inches by 20 inches square, 1-inch thick, MERV 8. Obtain the filter's operating characteristics from the manufacturer or the manufacturer's website.
4. Inspect the filter frames inside the air handling equipment where the filters are installed to determine the filters fit tight within the frames and seals around the perimeter of the frame to minimize any air leakage around the filters (often called bypass air). For most filter frames, it would be wise to add silicone sealant on the upstream and downstream side of the frame as it meets with the AHU wall.

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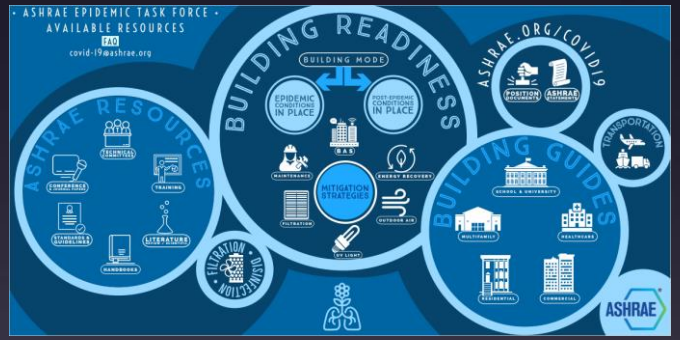
Filtration

ASHRAE: Epidemic Task Force

- Building Readiness: Commercial
  - Article #5: HVAC Systems
    - General: If there are significant energy impacts, use minimum outside air as required by Std 62.1 with MERV-13 filter minimum



- Operate & Maintain HVAC System
  - Update or replace existing HVAC air filtration to a minimum of MERV 13 or the highest compatible with the filter rack, and seal edges of the filter to limit by-pass.

COMMERCIAL

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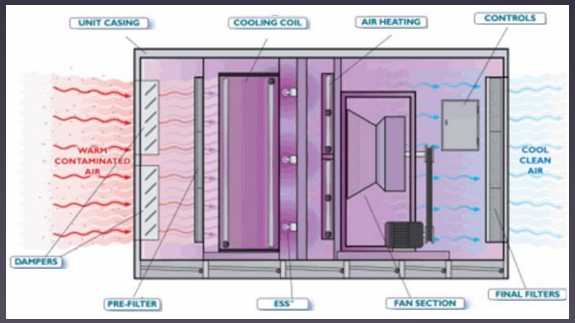
Filtration

ASHRAE: Epidemic Task Force
Building Readiness: Commercial

- Design Consideration:
  - “Increased filter efficiency generally results in increased pressure drop through the filter. Ensure HVAC systems can handle filter upgrades without negative impacts to pressure differentials and/or air flow rates prior to changing filters”.

Increase in fan motor HP will require higher electrical demand. Is additional electrical service available?



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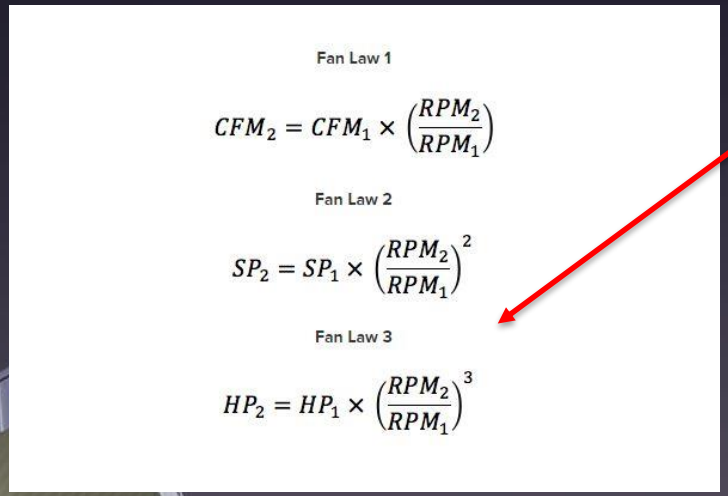
Filtration

ASHRAE: Epidemic Task Force
Fan Affinity Laws



Existing:

- Fan supplying 2000 CFM @ 0.5” esp
- HP = 0.389 BHP
- FRPM = 1089
- Nominal HP = 0.5 HP

With “CLEAN” MERV 13 Filtration:

- Fan supplying 2000 CFM @ 0.8” esp
- HP = 0.51 BHP
- FRPM = 1195
- Nominal HP = 0.75 HP

What happens with filters load

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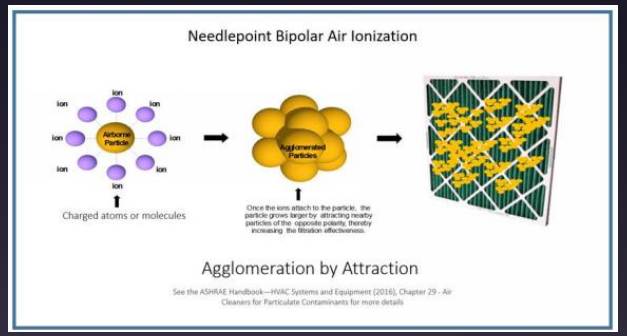
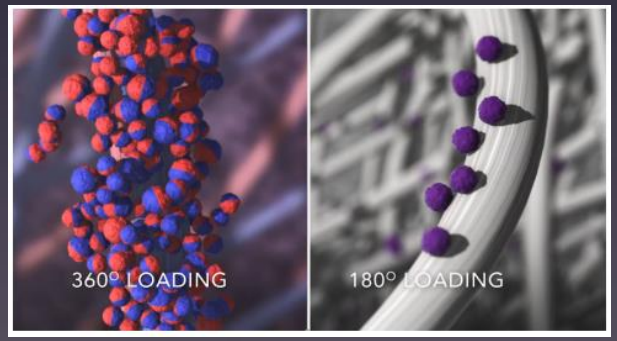
Filtration

ASHRAE: Epidemic Task Force

- Design Considerations:
  - To enhance filtration without increasing static pressure drop apply particle agglomeration technologies





- Bi-Polar Ionization
- Polarized-Media Air Cleaners

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Questions?

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ASHRAE: Dilution

Session Two:
Minimizing & Neutralizing Pathogen Transfer

Wednesday October 28th, 2020
Time: (12:00 Noon)

- Humidification
- UV Technology
- Bi-Polar Ionization

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Thank you.

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Filtration

ASHRAE: Epidemic Task Force
Filtration & Disinfection: HEPA Filters

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