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Webinar Speakers



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Agenda




- ~~Session 1 — How Airflow Affects Transmission (1.5 hrs)~~
 - ~~Part A — Covid Transmission and Infection (Lisa)~~
 - ~~Part B — Ventilation Safety Performance (Tom)~~
- ~~Session 2 — How To Optimize Ventilation (1.5 hrs)~~
 - ~~Part A — Evaluating and Optimizing Ventilation Safety (Tom)~~
 - ~~Part B — A Summary of Prudent Measures (Lisa)~~
- **Session 3 - Questions and Answers (1.5 hrs)**

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Agenda

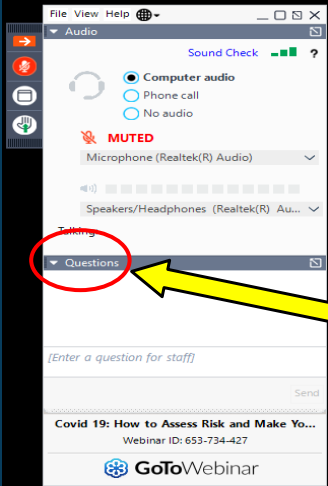
- **Session 3 - Questions and Answers (1.5 hrs)**
 - Brief Review
 - Answers to submitted questions
 - Audience Questions



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Enter your *Questions* and participate in the *Chat*

Expand Control Panel



Enter your questions here

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Commercial HVAC Systems are not designed to protect people from exposure to aerosolized pathogens



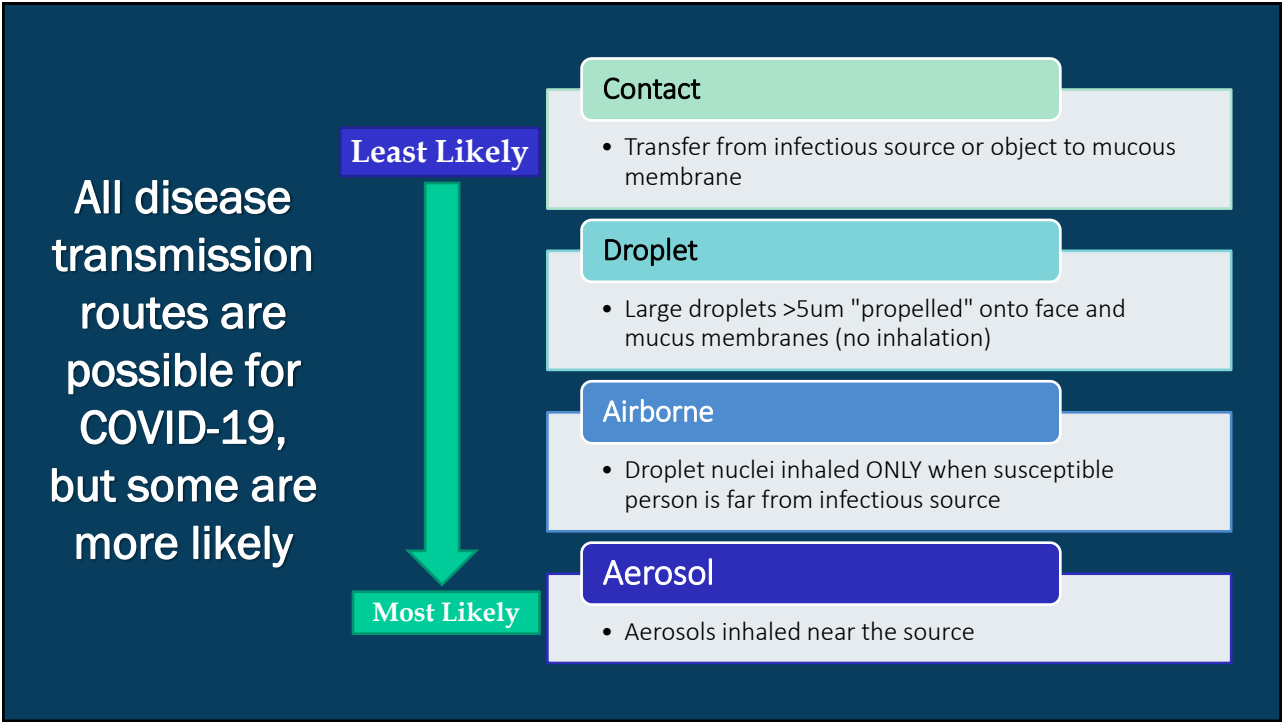
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Risk Factors for Person-to-Person Transmission

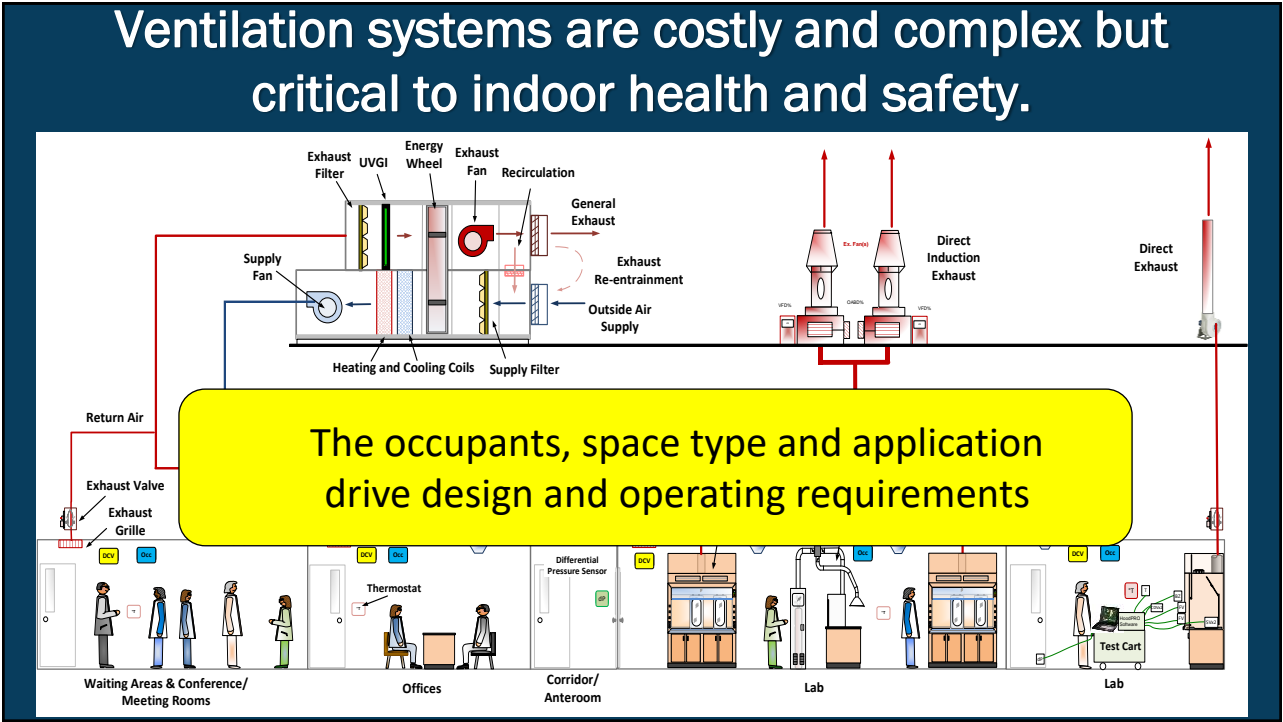


- Indoors & enclosed spaces
- Lots of people
- Long periods of time
- Poor Ventilation

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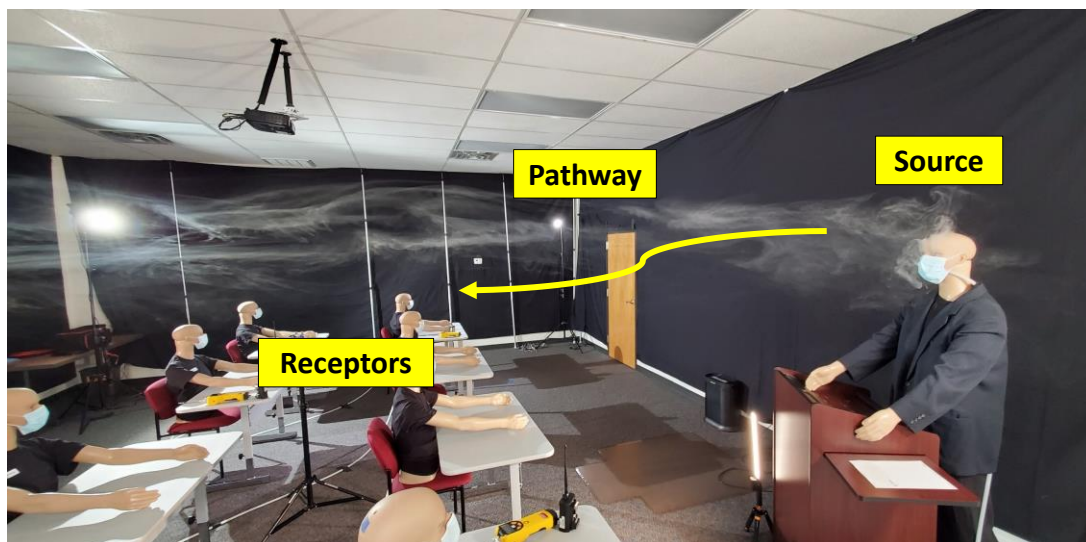


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Consider the Source, the Pathway, and the Receptor



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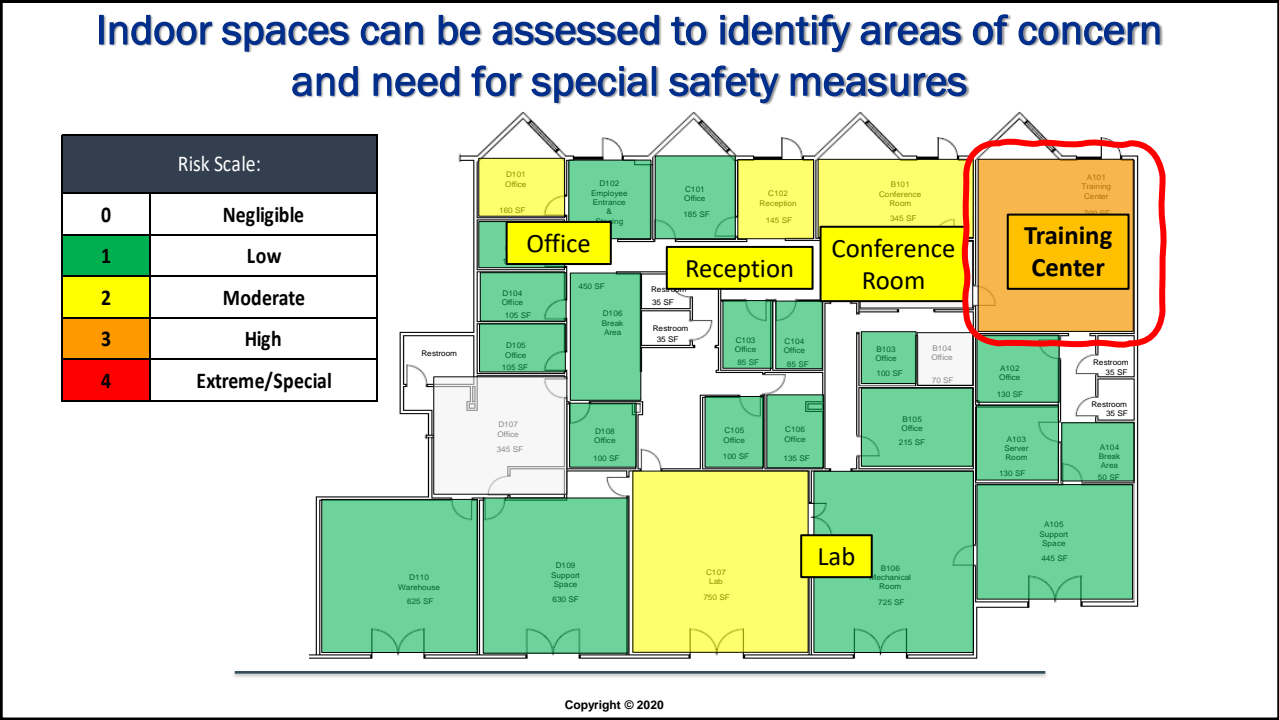
A Ventilation Investigation should reveal opportunities to mitigate risk

- **Part 1 – Evaluate Risk and Demand for Ventilation**
 - Survey and Identify Spaces of Concern
 - Document HVAC and Other Safety Measures
- **Part 2 – Inspect and Measure HVAC Operation**
 - Air Handling and Return Air Units Operational
 - Measure Flow and Calculate Air Change Rates
- **Part 3 – Conduct Airflow Visualization Tests**
 - Generate visible smoke
 - Observe airflow patterns note areas of accumulation and stagnation
- **Part 4 – Conduct Aerosol Tracer Tests**
 - Generate air tracer to simulate contaminant release
 - Measure concentration accumulation, dispersion and decay
 - Determine Ventilation Effectiveness

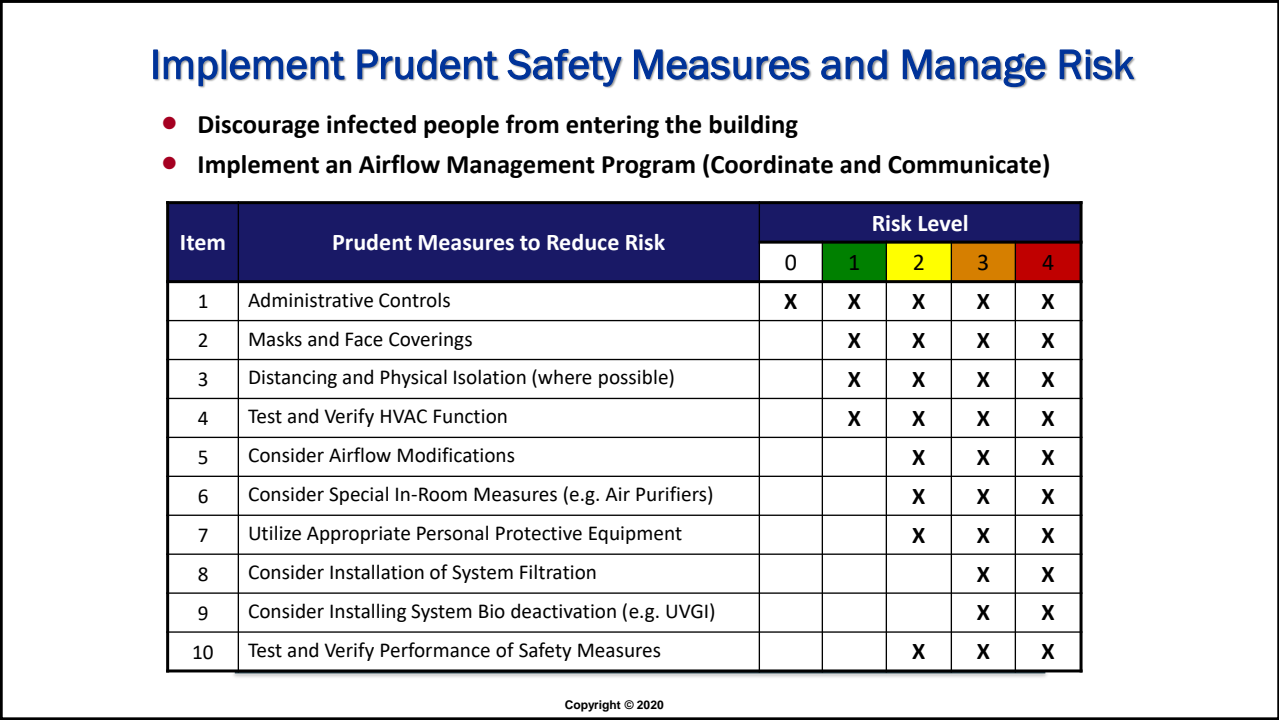


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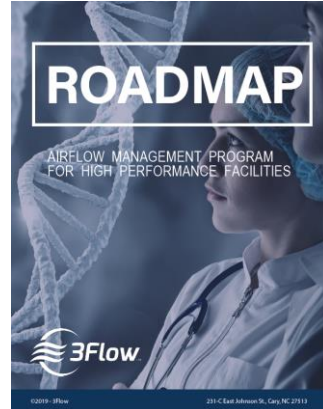
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An Airflow Management Program enables safer spaces now and future resilience

- Training for Building Stakeholders and Staff
- HVAC Drawings and System Line Diagrams
- Risk Matrices
- Operating Modes and Flow Specifications
- Key Operating Metrics
- Building Information System
- Standard Operating Procedures
 - Maintenance and Routine Tests
 - Schedules and Reporting
- Management of Change



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Submitted Question

I'm really interested in hearing your opinions on school ventilation and the safety of returning to in-person instruction.

On a good day, many schools have terrible IAQ issues and ventilation disfunction. Districts do not have the resources to do these kinds of studies and assessments and are requiring staff back to school without any real mitigation strategies around ventilation.

What do we think and recommend?

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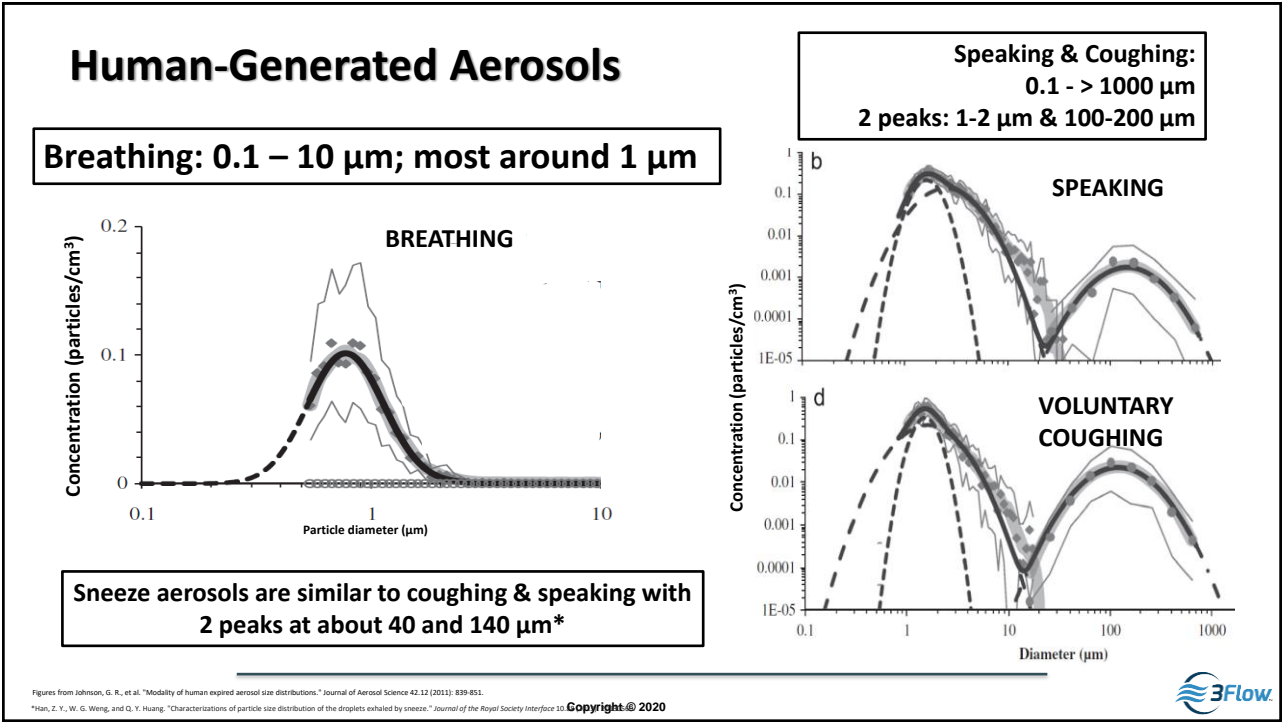
Submitted Question

How are infectious particles generated?

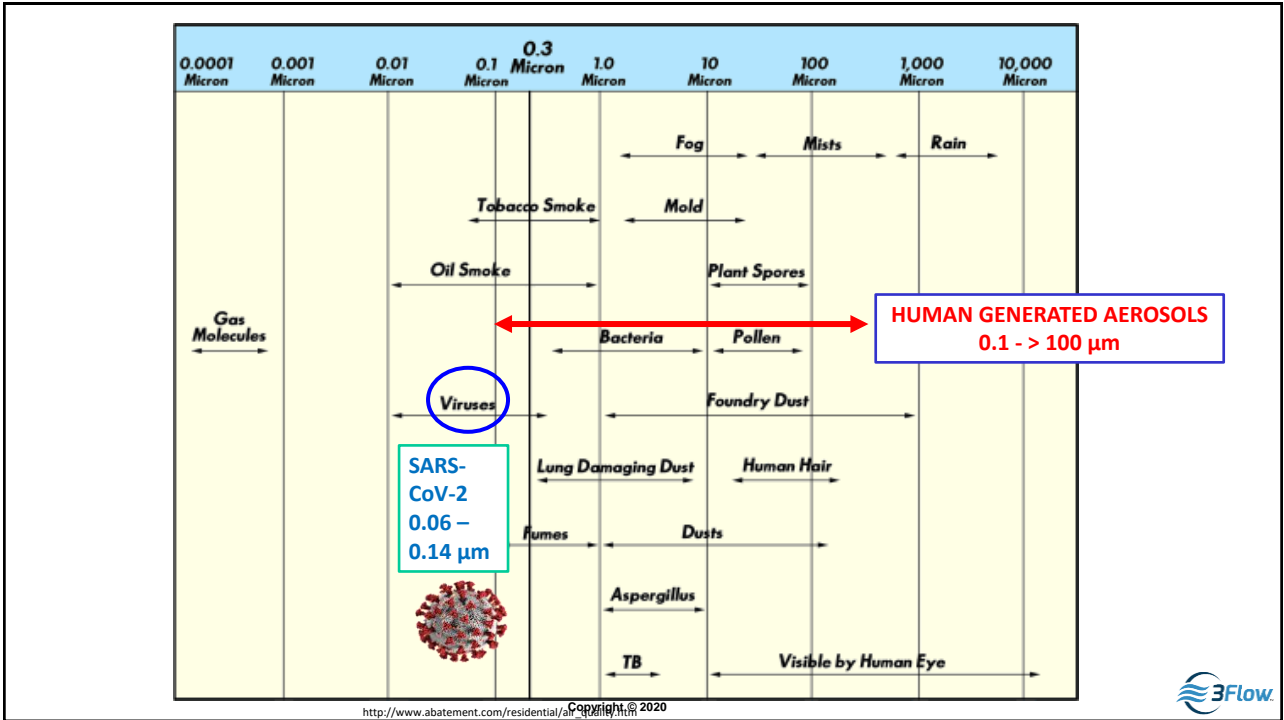
What is the size range for human generated particles?

What can you say about the concentration of virus in different size fractions from a cough/sneeze emission vs normal breathing?

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Submitted Question

What is the difference between respirators and degrees of protection?

A N-95 is a respirator, for workers? Or are you referring to a N-99 or N-100?

Does double masking help?

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Performance of Masks & Respirators Depends on Three Things:

Efficiency of the filter - How well does the filter collect airborne particles?

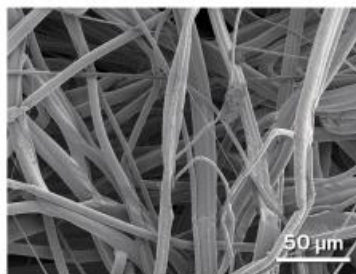
Fit - How well does the facepiece prevent inward leakage of particles?

Proper use - Proper donning and checking the seal may influence performance

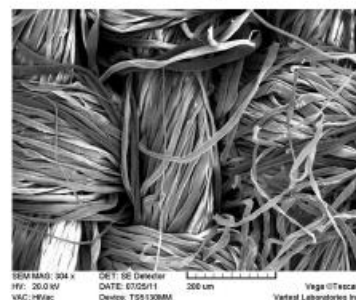
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Fibrous Filters

- Filters are NOT sieves
- Mat of fibers
- Air moves through mat, taking a tortuous path, bringing particles into contact with fibers



N95 fibrous filter (non-woven)



Cloth material (woven)

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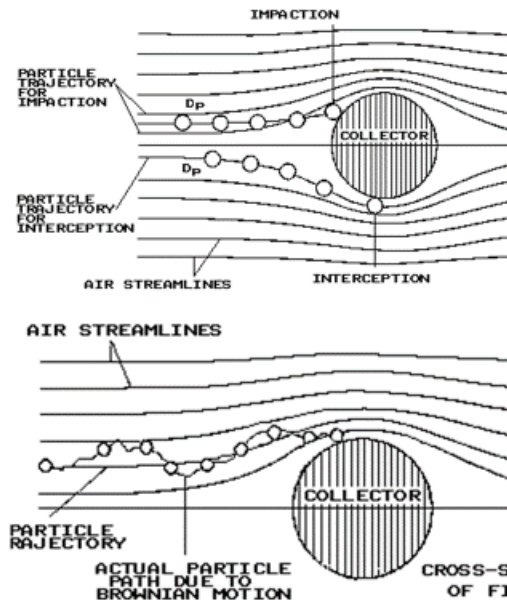
Mechanical Collection of Particles

Large particles collected by:

- **Inertial impaction** (large or heavy particles can't follow air streamlines)
- **Interception** (particles brought into contact with fibers)

Small particles collected by:

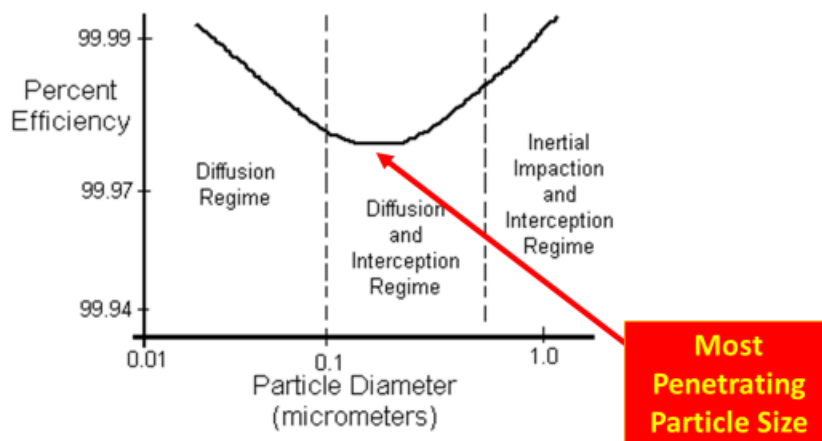
- **Diffusion** (random movements around streamlines)



Images from: <http://www.engr.psu.edu/ae/iecf/abe/control/filtration.asp>

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Mechanical Filter Efficiency Curve



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Respirator Filter Performance

- Respirators are certified by the National Institute for Occupational Safety and Health (NIOSH)
- NIOSH certification tests evaluate the performance of filters by measuring collection efficiency using NaCl (solid) and DOP (liquid oil) aerosols (0.3 μm) charge neutralized **at 85 L/min**
- 3 categories of oil resistance
 - N = not resistant to oil, R = resistant to oil, P = oil proof)
- 3 levels of filter efficiency
 - 95 = 95% efficient, 99 = 99%, 100 = 99.97%
- 9 possible classes of respirators (3 oil resistance x 3 efficiencies)

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Electrostatic Filters

- Charged filter fibers collect particles (large and small)
- Advantages are:
 - Low pressure drop (less breathing resistance)
 - Highly effective collection mechanism
- Most penetrating particle size occurs in the range of 40 - 100 nm (0.04 – 0.1 μm)*
- At 85 L/min (heavy work rate) N95 filtering facepiece respirators generally have filter penetration less than 5% at 50 nm

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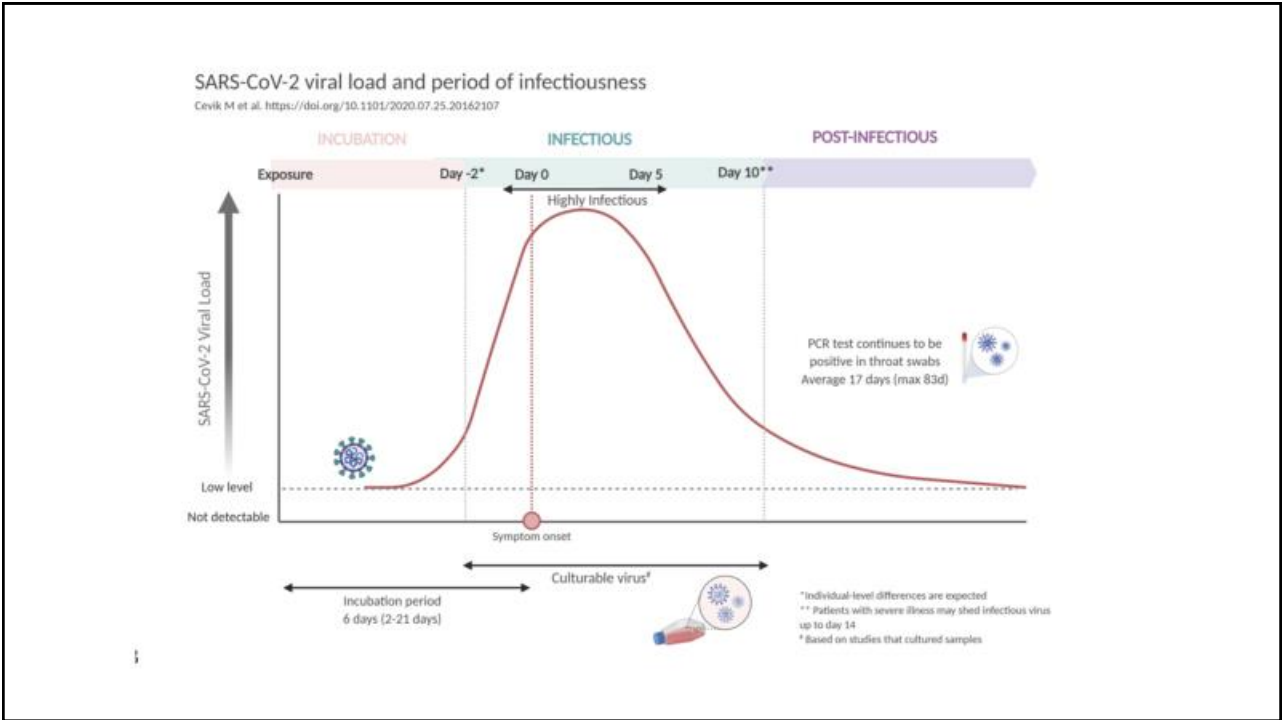
Submitted Question

How long are people infectious?

What about asymptomatic people?

Are Children Infectious?

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Asymptomatic Transmission?

- Viral load is similar for asymptomatic and symptomatic cases (Huff & Singh, Clin Infect Dis, May 2020)
- Asymptomatic infection appears to be more common in young and middle-aged people without underlying disease (Zhao et al., Epi & Inf, June 2020)
- No difference in transmission rates of symptomatic vs. asymptomatic patients (Yin & Jin, JMR Public Health and Surveillance, June 2020)
- Viral loads similar for asymptomatic and symptomatic patients (Ra et al., Thorax, Sept 2020)
- Singapore testing & follow-up of cases found incidence of infection among close contacts of symptomatic cases was 4 x higher than for asymptomatic cases (Sayampanathan et al., Lancet, Dec 2020)

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Children Susceptibility & Transmission of SARS-CoV-2

- *Household data suggest that (Dattner et al., preprint, Oct 2020)*
 - Children 1-20 yrs are 43% as susceptible as adults
 - Children are 63% as infectious as adults
- *Davies et al. (Nat Med, 2020)*
 - Children less than 20 yr are 50% as susceptible as adults
 - Ages 10-19 yrs, 21% show symptoms
 - > 70 yrs, 69% show symptoms
- *Chang et al. (Nat Commun, 2020)*
 - Children are 80% less likely to be symptomatic than adults
- *Munro et al. (Current Opin Inf Dis, 2020)*
 - Children have lower attack rates than adults
 - Children have milder symptoms than adults
 - Risk factors for severe disease in children include chronic lung, cardiac or neurologic disease, and malignancy

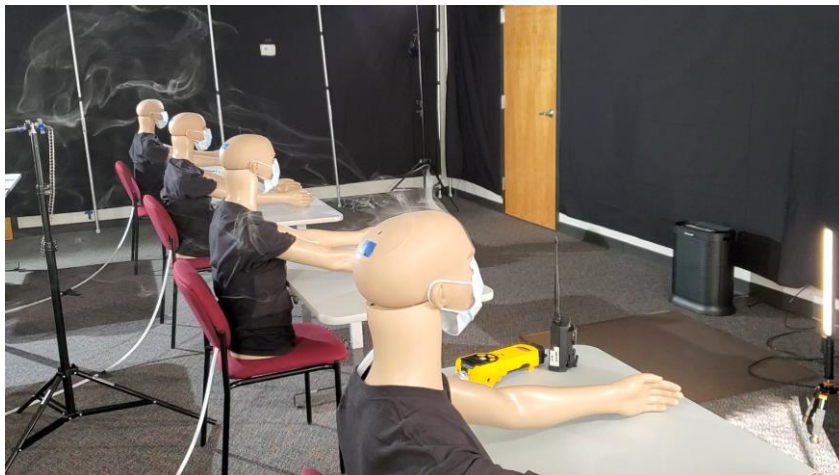
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Submitted Question

Why is the 6-ft distance important and will it keep you safe?

31

Distancing is important to minimize impact of exhaled droplets and avoid near-field concentrations, but airflow patterns and time may negate the value regarding aerosol transmission.



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Submitted Question

How similar is human breathing represented by the smoke generated in these experiments?

How representative is it?

What is the percentage of error of testing using mannequins and real humans ?

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The Air Tracers and Mannequins were used to detect and observe airflow patterns not simulate human breathing



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Air tracers enable observation of concentration dispersion, accumulation, dilution and removal



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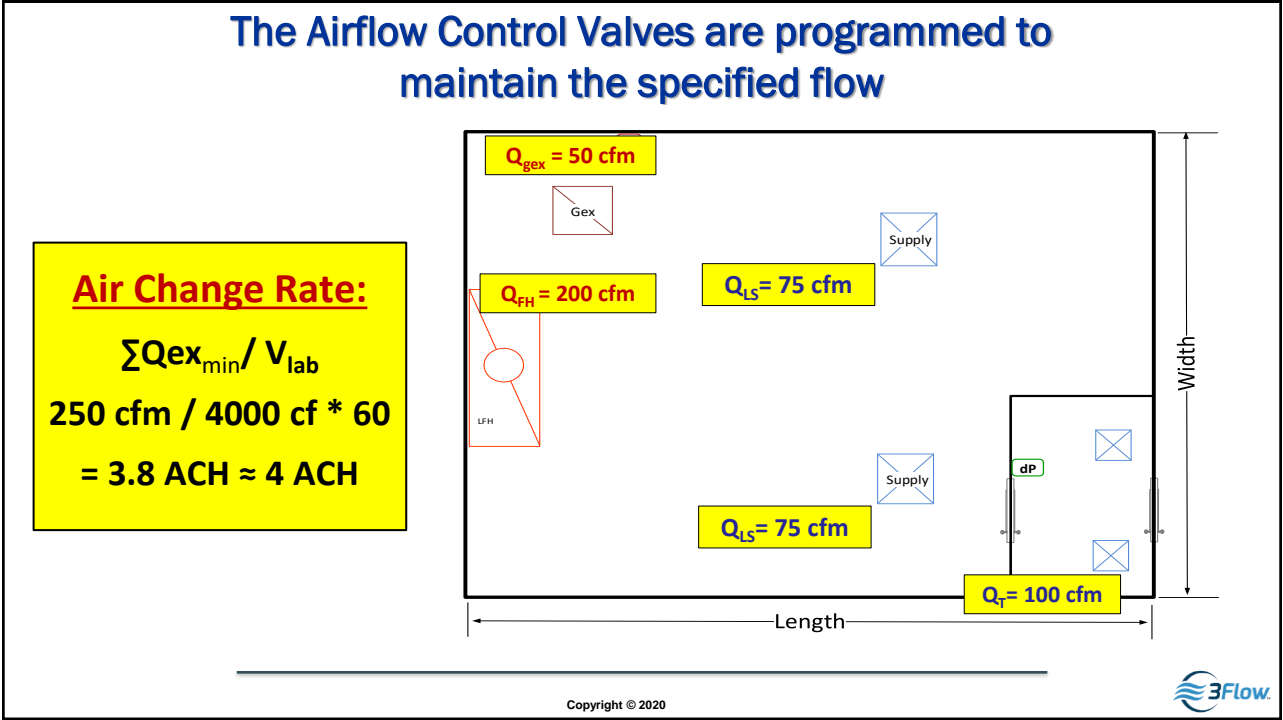
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Submitted Question

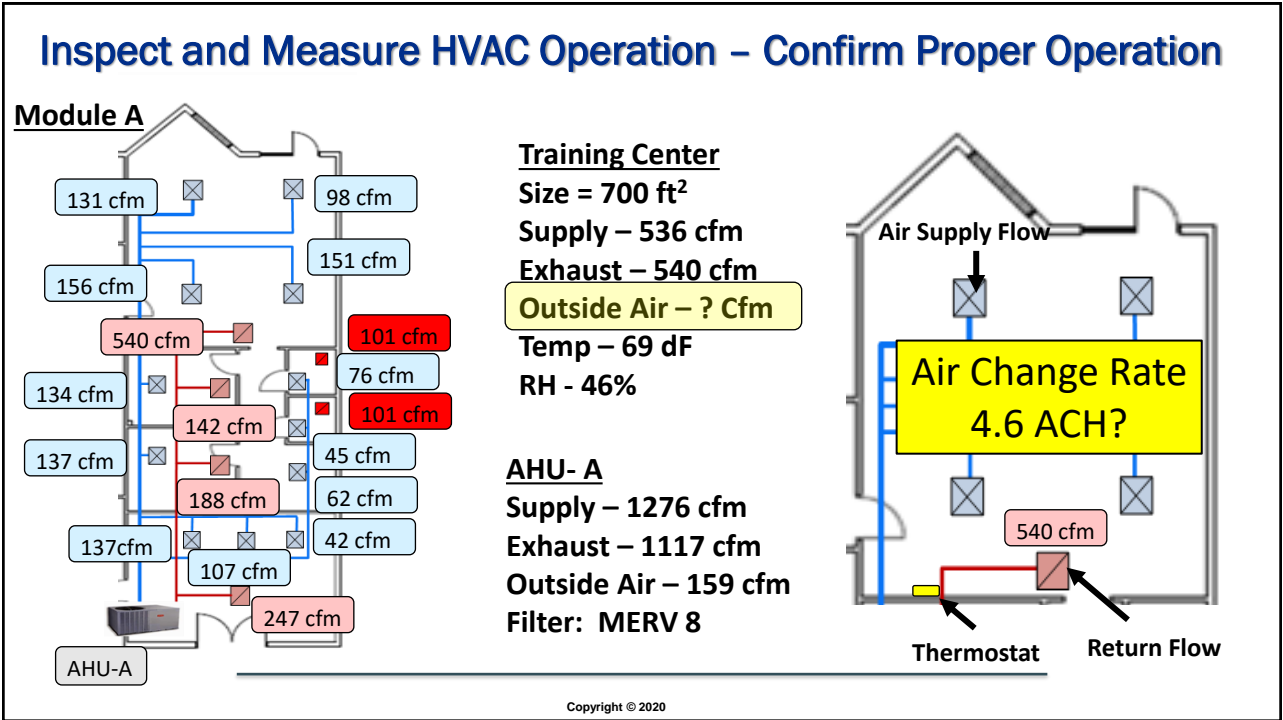
How do you measure and determine ACH?

How do you know that you have 4.6 ACH if the supply and exhaust are roughly equal and you don't know the outside air?

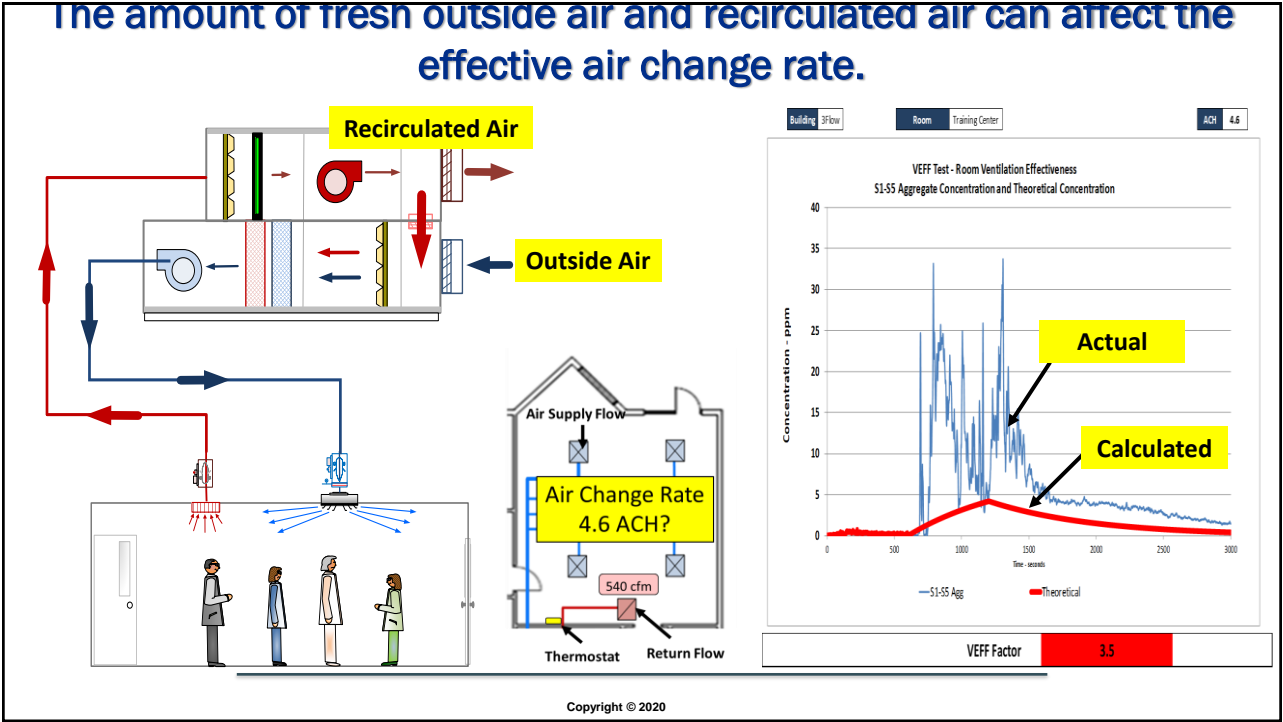
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Submitted Question

If face coverings and 2-6 air changes per hour can only achieve a time to infectious dose of 2 hours, should schools open?

<https://indoor-covid-safety.herokuapp.com/>

<https://english.elpais.com/society/2020-10-28/a-room-a-bar-and-a-class-how-the-coronavirus-is-spread-through-the-air.html>

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Submitted Question

How do Air Purifiers Work?

How much noise do the portable air filters create?

Impact in classrooms, theatres, church, etc.

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Submitted Question

How do air purifiers work and how much airflow is required?


With air purifiers what do you mean close to the source - what about using an air purifier in a classroom where the source may not be known?

Without capacity to test in every classroom, are there general directions about placement of portable air filters?

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Supplemental Filtration Units include internal fans and filters

Ceiling Mounted

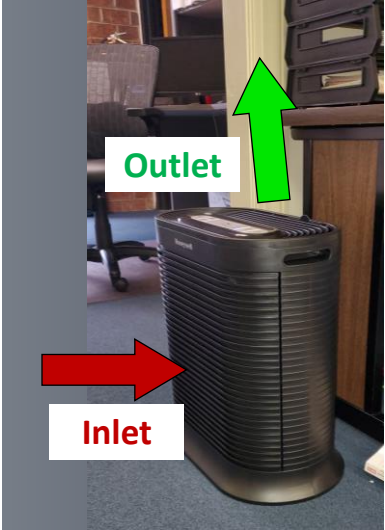


~100 cfm

Floor Unit

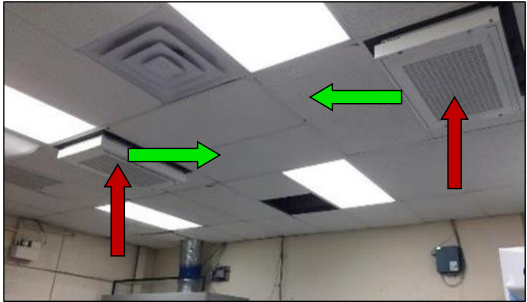


100 - 300 cfm



Outlet

Inlet



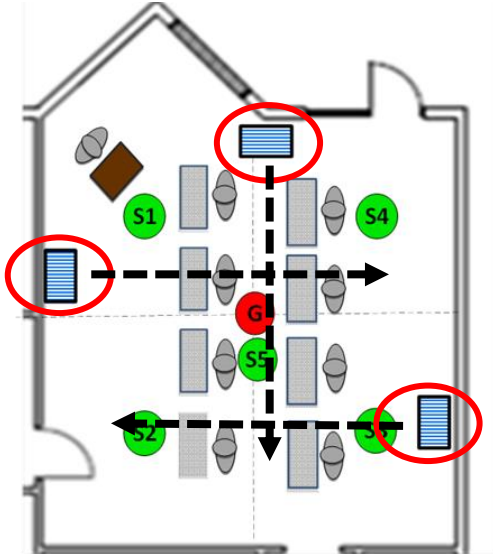
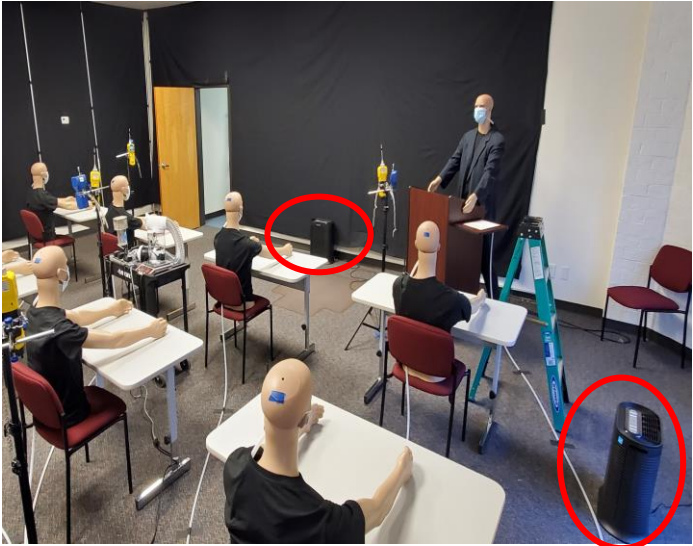
Charcoal Pre-filter

HEPA filter

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Portable Air Filtration Units were installed in the Training Center



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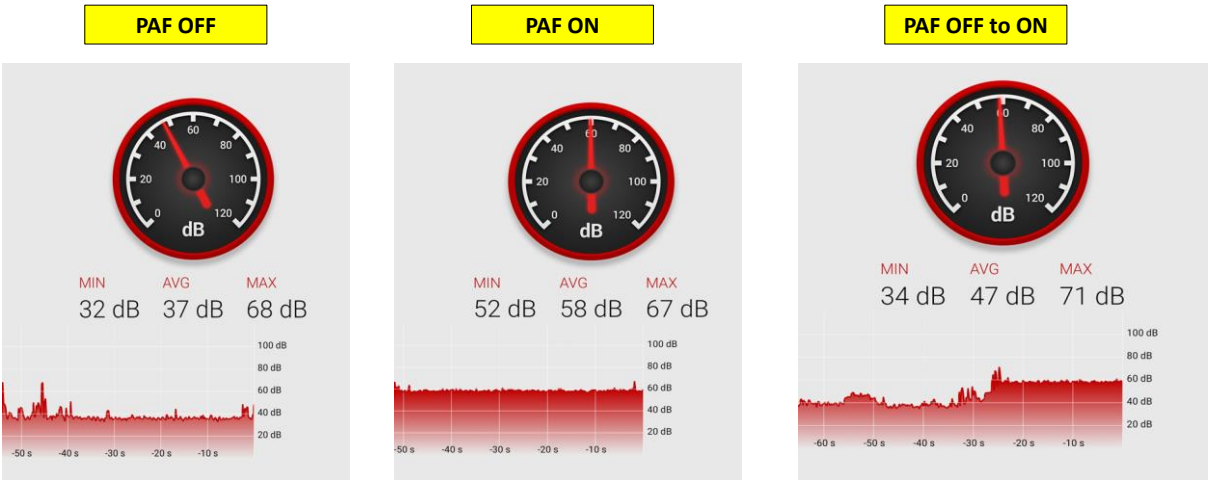
Submitted Question

How much noise do the portable air filters create?

Impact in classrooms, theatres, church, etc.

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Air Purifier Noise Spectra



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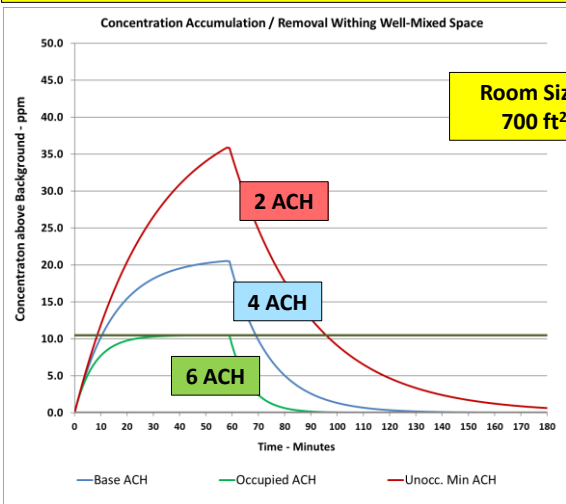
Submitted Question

It would be great to show tracer gas tests. also wondering if another reliable solution to looking at ach is co2 grab samples with a co2 monitor--inside vs outside?

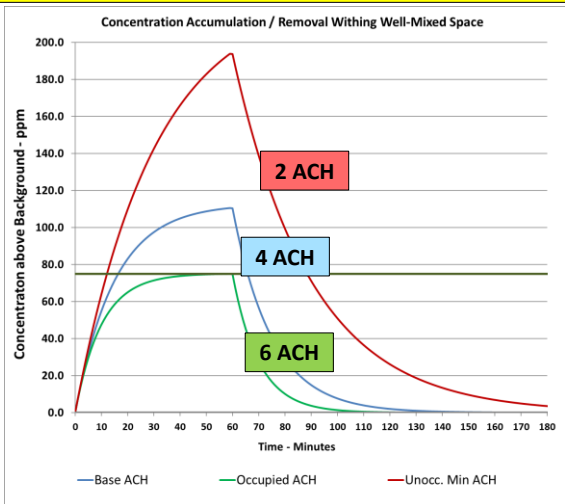
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Humans emit approximately 0.5 grams of Carbon Dioxide CO² per minute

Accumulation with 1 Person breathing for 60 minutes



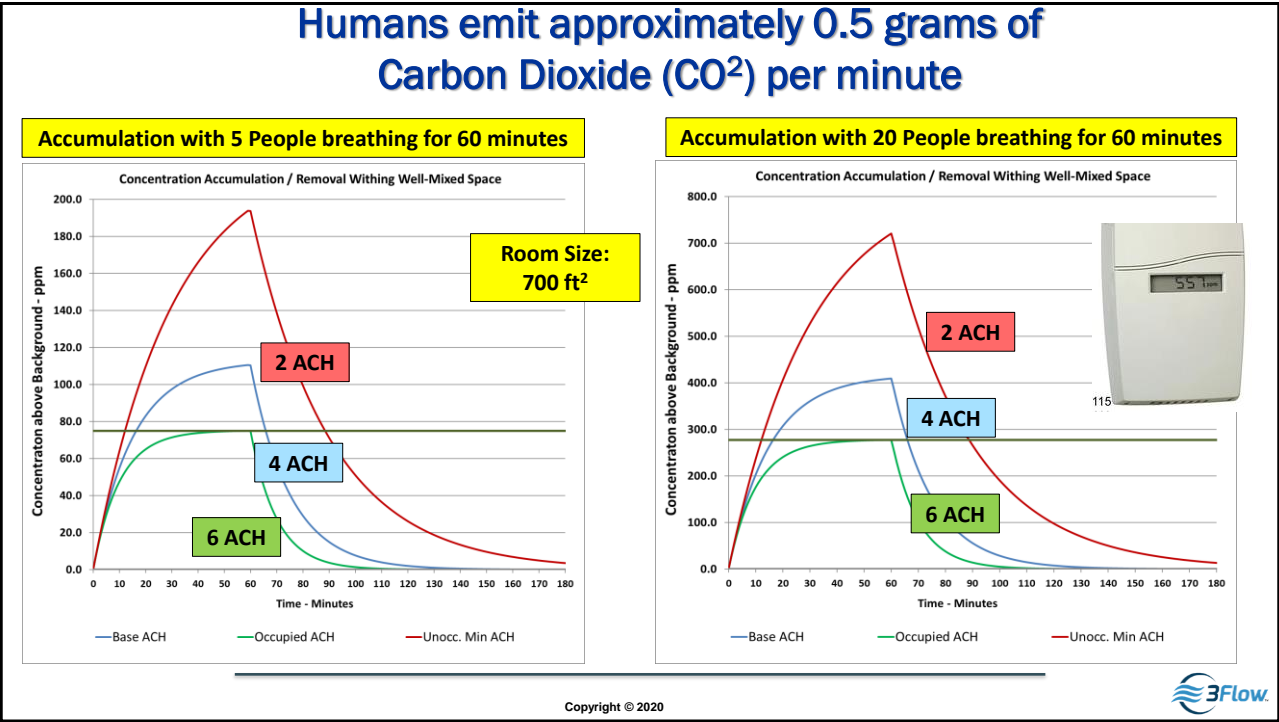
Accumulation with 5 People breathing for 60 minutes



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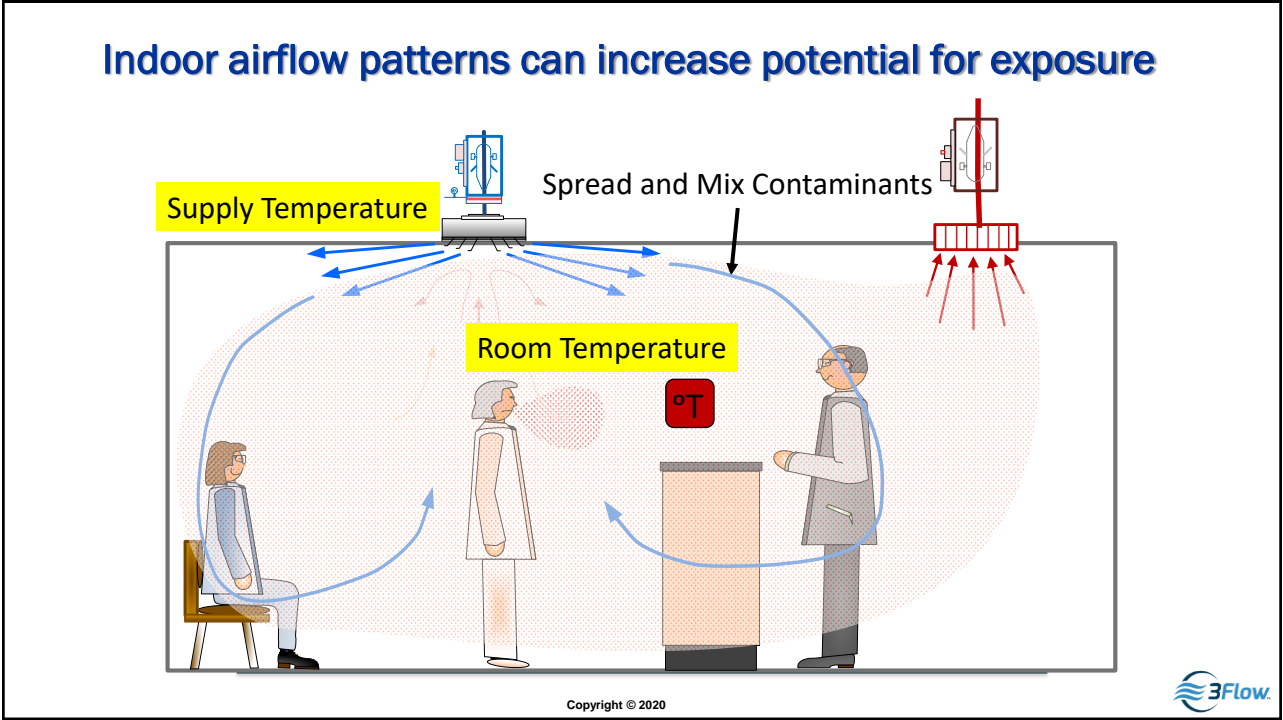


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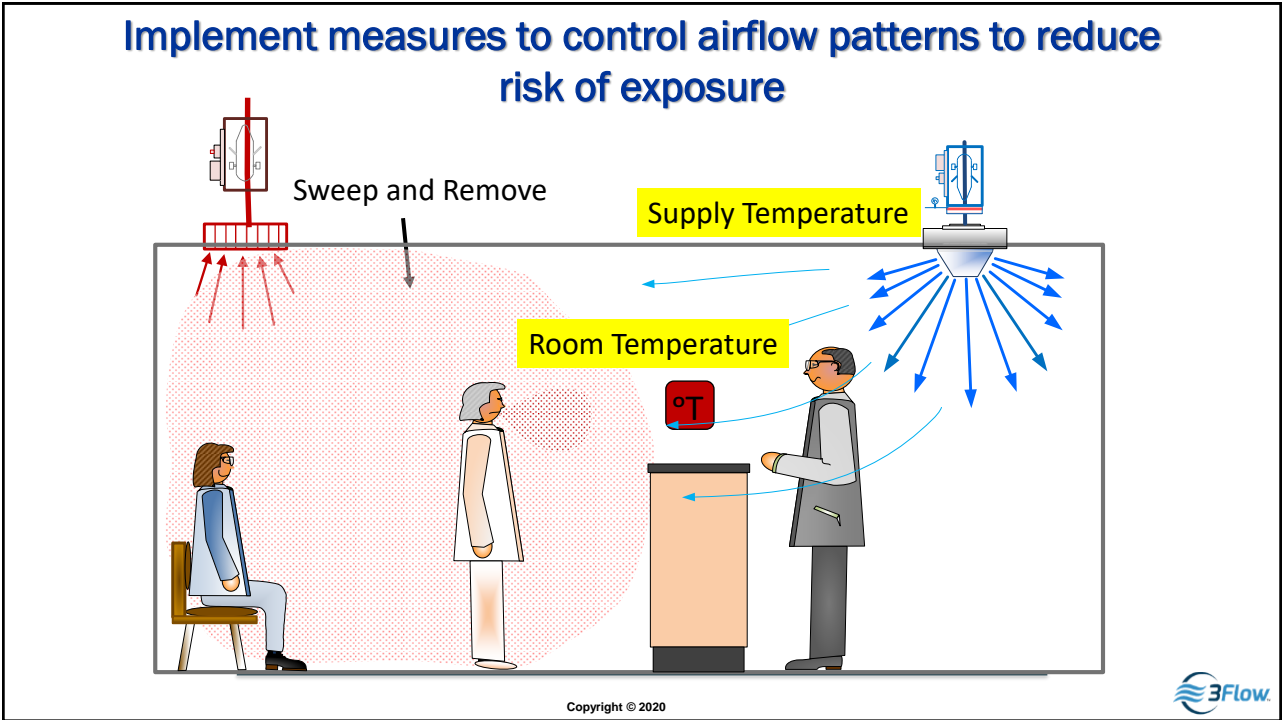
Submitted Question

Does the push/pull method affect occupant comfort?
Particularly with exhaust near floor?

50



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Submitted Question

Instead of a focus on office buildings, which have adapted well to remote operation, can you provide examples from grocery stores, restaurant kitchens, manufacturing, meat and seafood processing, where problems need to be evaluated?

Do you have any examples with different/ odd shaped rooms?

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Submitted Question

If you can't measure or get mechanical plans for a big industrial space, what is the best way to calculate air changes?

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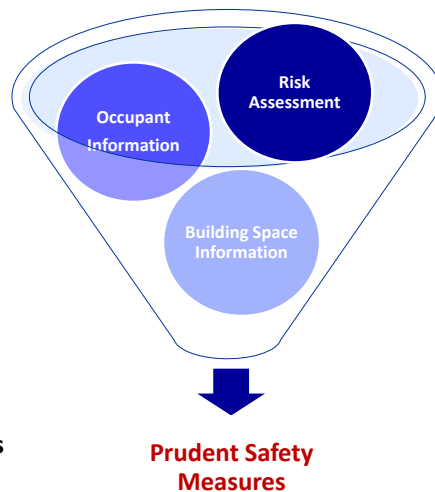
Submitted Question

How should you implement and start with a space evaluation?

55

Implement an Airflow Management Plan

- Gather Building and Space Information
- Evaluate Space Utilization
 - Types of Occupants
 - Occupant Density
 - Occupant Duration
- Implement Administrative Plans
- Evaluate HVAC Operation
- Conduct Space Risk Assessment
- Test Performance of Airflow Systems
- Implement Applicable Safety Measures
- Update Airflow Management Program



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Submitted Question

It appears your offices are in a large complex with other tenants. How do you communicate your airflow needs to a building owner?

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Submitted Question

If you designed for control of Covid – would that space be appropriate for normal operating conditions?

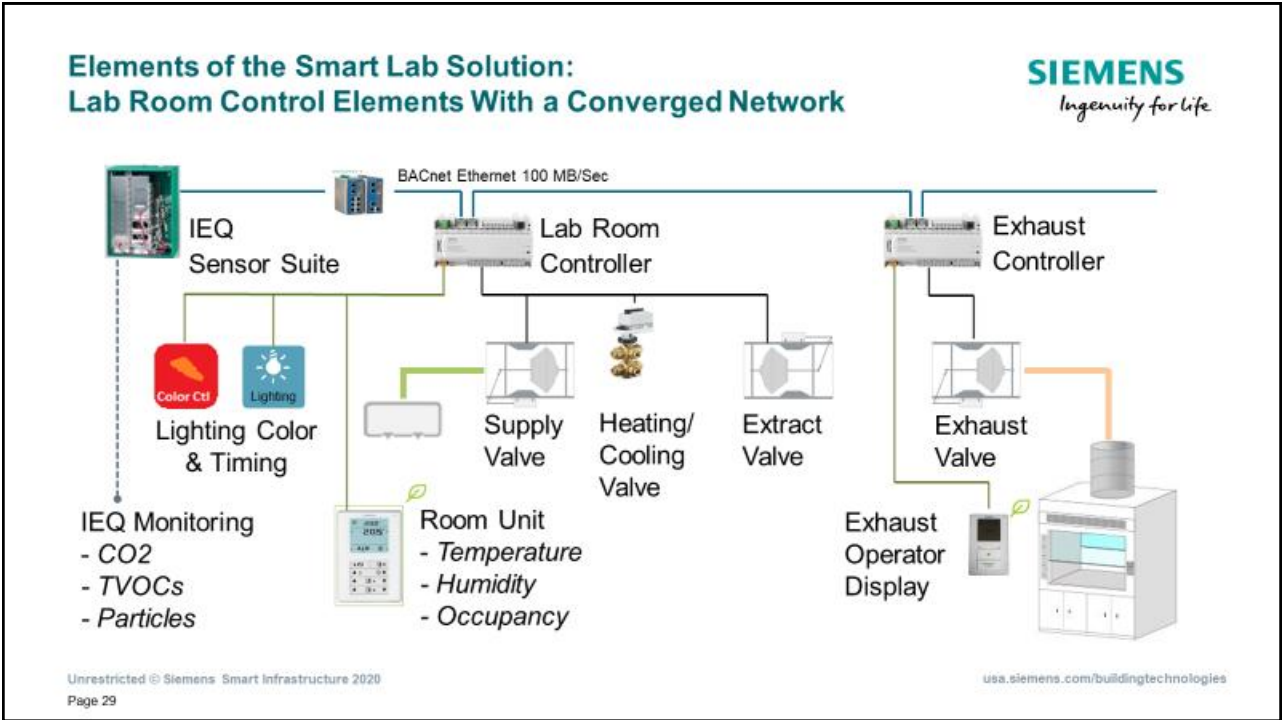
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Submitted Question

**As you think about increasing productivity of workers...
aside from ventilation, how else do you see the built
environment contributing to worker productivity?**

Many problems with IAQ started with the energy crisis in the 70's and the tightening of buildings, today we have better standards and more advanced controls, monitoring and information systems

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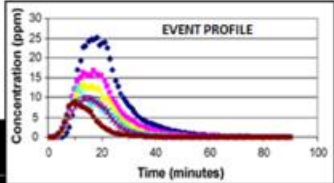


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Using the Smart Lab Solution: Lab Energy Savings Strategies Support Safe Operations

Manage Ventilation to Match Measured Exposure Risk
From a week in the life of a Smart Lab at UC-Irvine...

- > Monitor VOCs & Occupancy
- > Set minimum ventilation rates:
 - o Occupied => 4 ACH
 - o Unoccupied => 2 ACH
- > Push to 12 ACH when air quality event is detected
- > Periodically reassess hazards to confirm appropriate minimum flows.



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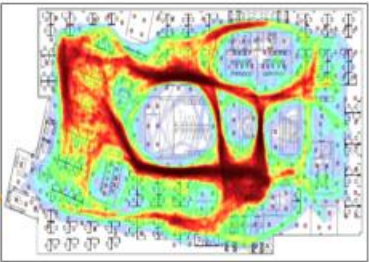
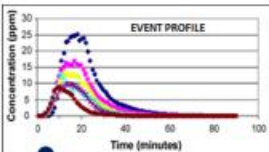
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Using the Smart Lab Solution: Support Safe Work Practices & Operations while saving energy

Example: Mesh space use & mobile apps with air quality monitoring and Demand Control Ventilation.

- Detect Chemical Hazard Event and increase ventilation.
- Change Light Color to alert occupants to new hazard status
- Push notification of new hazard status to occupants' mobile apps **AND get feedback immediately.**
- Update ventilation plan and risk assessment with real data.
- Update contact tracing database if hazard event included particulate.



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Raise your hand if you have a question to ask



The image shows a screenshot of a webinar interface. On the left, there is a window titled 'Audio' with a 'Sound Check' status. It lists 'Computer audio' as selected, with options for 'Phone call' and 'No audio'. Below this, it says 'MUTED' and 'Speakers/Headphones (Realtek(R) Audio)'. A red circle highlights a 'Raise Hand' icon in the bottom left corner of the audio window. A yellow arrow points from this icon to a 'Control Panel' on the right. The 'Control Panel' is a vertical bar with several icons, including a 'Raise Hand' icon at the bottom. A yellow box with the text 'Raise Hand' is positioned between the two arrows.

Control Panel

Raise Hand

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Thank You!

Stay Safe – Stay Upwind



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