The Role of Building Ventilation in Indoor Infectious Aerosol Transport

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AIVC Webinar: Building ventilation
How does it affect SARS-CoV-2 transmission?
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NIST National Institute of Standards and Technology
U.S. Department of Commerce

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Outline

Which airflows and their magnitudes

Reducing aerosol exposure with airflow

Ventilation suggestions to reduce viral exposure

Summary

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Some Key Concepts

Ventilation
(ASHRAE Standard 62.1) the process of supplying air to or removing air from a space for the purpose of controlling air contaminant levels, humidity, or temperature within the space

Every building is different

Buildings are not tight unless built that way

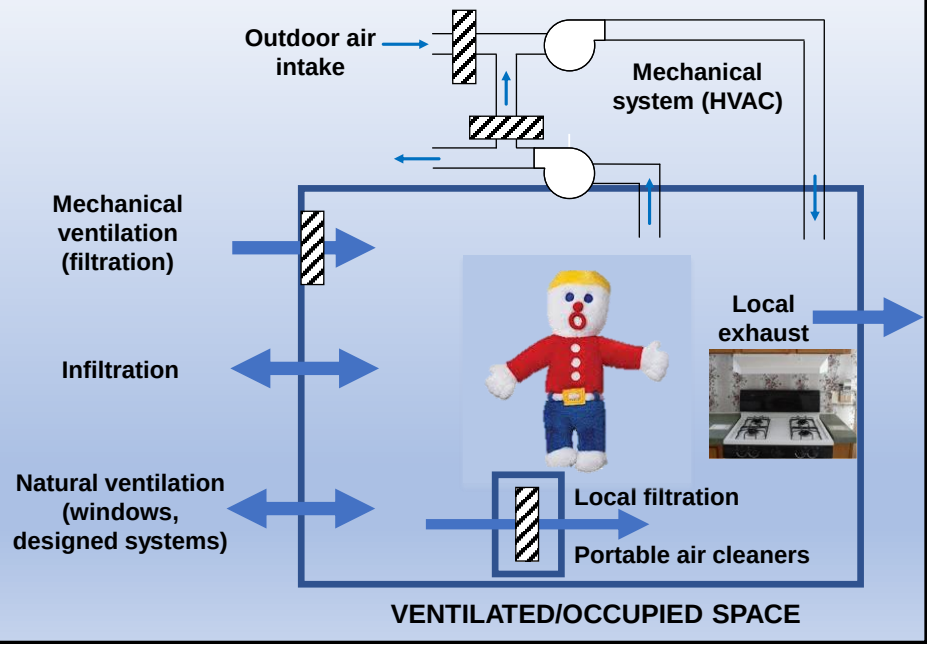
Air moves based on physics, not design intent

Airflow has been studied in very, very few buildings

Outdoor air isn't necessarily fresh air

1 air change per hour does not mean all the air in a building is replaced in 1 hour

Which Airflows



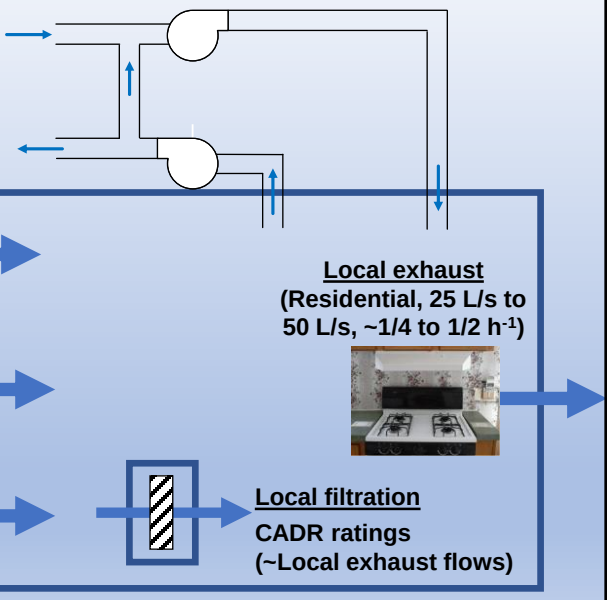
Magnitudes

Mechanical/Commercial
Outdoor air: ~1 h^{-1}, highly variable, up to ~5 h^{-1}
Supply air: ~ 3 to 5 h^{-1}, higher in healthcare

Mechanical/ Residential
OA: ~0.1 to 0.5 h^{-1}

Infiltration
~0.1 to 1.0 h^{-1}
~5 to 1 variation in individual building

Natural ventilation
>1 h^{-1}, hard to measure and predict



Local exhaust
(Residential, 25 L/s to 50 L/s, ~1/4 to 1/2 h^{-1})

Local filtration
CADR ratings
(~Local exhaust flows)

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Interzone airflows

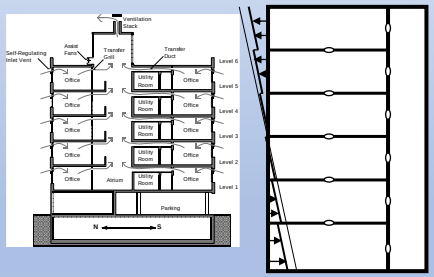
Magnitudes similar to airflows from outdoors

Residential

Crawl spaces, basements, attics, ...

Commercial

Return air plenums, plumbing chases, mechanical rooms, ...



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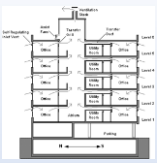

Buildings are diverse
USA: 100 million dwellings; 6 million commercial

Building systems vary and matter
Layout, design & controls, occupant activities, operation & maintenance (O&M), …

Ventilation has been studied in very few buildings
Impacts of HVAC & ventilation on aerosol transport in even less





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Reducing Exposure with Airflow

Build tight, ventilate (filter) right

Overpressure buildings (careful with moisture**)**

Airflow/pressure from clean spaces to dirty

Commissioning, Operations & Maintenance

Ventilation limited for strong, local sources

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Recommendations for Re-Opening Buildings

Ventilation

ASHRAE

REHVA
Federation of European Heating, Ventilation and Air Conditioning Associations

Health & Safety

AIHA
Protecting Worker Health

CDC
Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

UNITED STATES DEPARTMENT OF LABOR
Occupational Safety and Health Administration

Broad issues

National Institute of BUILDING SCIENCES

U.S. DEPARTMENT OF ENERGY

APPA
Leadership in Educational Facilities

BOMA International

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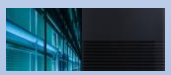
- **Outdoor ventilation**


- **Filtration**


- **Relative humidity**


- **Toilet areas**


- **UV-C and air cleaners**


- **Maintenance personnel**

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Increase outdoor air ventilation
System capacity
Outdoor air quality
Moisture management
Assuming good HVAC control

More efficient filtration
System capacity
Sealing
Maintenance

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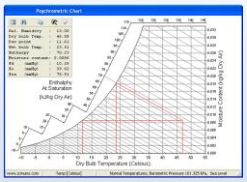
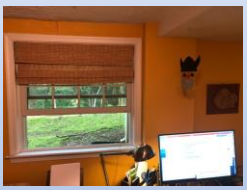
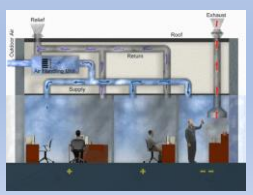
Change relative humidity
Do we know the right number?
System capacity
Condensation potential/microbial growth



Open windows
Outdoor air quality
Moisture, Noise, Security
Direction, magnitude, distribution



Change air distribution
System configuration
Options often limited



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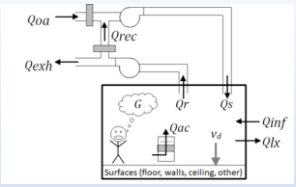
Summary



Do no harm

Good ventilation is good practice

Excellent time to check system, review O&M practice (Schoen 2020 and ASHRAE guidance)
https://www.ashrae.org/technical-resources/resources

NIST on-line tool for comparing impacts of ventilation, filtration, etc. on indoor aerosols
https://www.nist.gov/services-resources/software/fatima

Schoen, L.J. (2020) Guidance for Building Operations During COVID-19 Pandemic, *ASHRAE Journal*, 62 (5), 72-74.