AIVC Webinar, 11/20/2020
COVID-19 Ventilation Related Guidance by ASHRAE and REHVA

ASHRAE's Ventilation Recommendations for COVID-19 Risk Mitigation

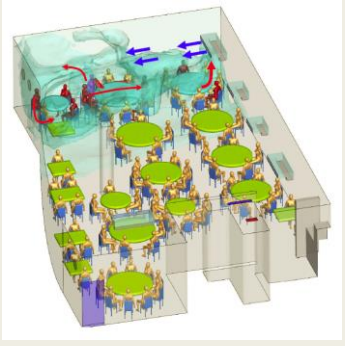
William P. Bahnfleth, PhD, PE, FASHRAE, FASME, FISIAQ
Professor, The Pennsylvania State University, USA
Chair, ASHRAE Epidemic Task Force

ASHRAE
PennState College of Engineering
ARCHITECTURAL ENGINEERING

1

Covid-19 Transmission Characteristics

- Covid-19 transmission
  - *Can be transmitted by airborne route indoors*
  - *Super-spreading incidents with observed or suspected low outdoor air exchange rates*
  - *Evidence of impact on transmission by in-room recirculation when outdoor air exchange is inadequate*
  - *No clear evidence of room to room transmission through ventilation systems (system level recirculation)*



2

Scope of ASHRAE Guidance

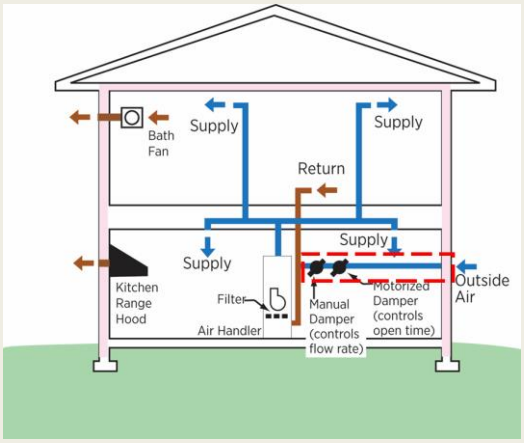
(Some still under development)

- Residential (Detached, Multi-unit)
- Commercial/Retail
- Schools (K-12, Universities)
- Communities of Faith
- Laboratories
- Healthcare (Hospitals/Clinics, Alternate Care Facilities, Nursing homes)
- Transportation

- Intended to be adaptable to any system type
- Not climate zone-specific
  - *Members in more than 130 countries*
  - *More than 20% of members outside North America*
  - *US includes 8 of 9 climate zones*

Typical Residential Forced Air System

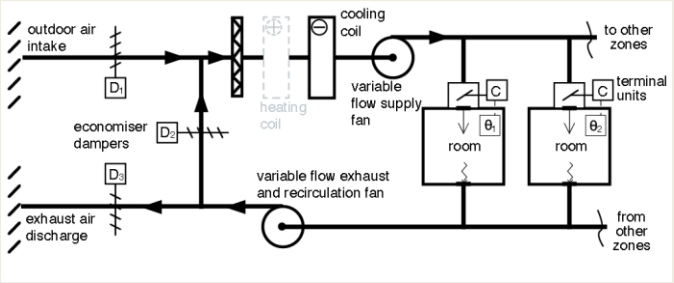
- Constant volume recirculating system
- Furnace/DX air conditioner or heat pump
- Older homes likely to have no outdoor air supply
- Newer homes may have energy recovery ventilators



https://www.energy.gov/eere/buildings/downloads/building-america-top-innovations-hall-fame-profile-low-cost-ventilation

Typical Variable Air Volume (VAV) System

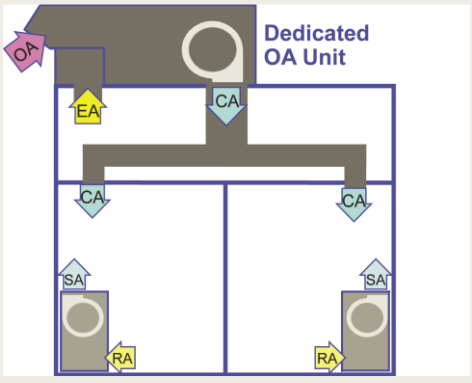
- Most air supply is recirculated
- Economizer controls permit up to 100% outdoor air to save energy
- Maximum possible outdoor air depends on weather
- Filters normally located in central supply air path
- More outdoor air → less recirculation through filters



https://www.cibsejournal.com/cpd/modules/2019-04-vav/

Typical Dedicated Outdoor Air (DOAS) System

- 100% outdoor air system with energy recovery
- Normally sized for no more than ventilation requirement
- Limited or no ability to increase outdoor air flow rate
- Often serve spaces without operable windows.
- Filters in DOAS do not clean indoor air



Core Principles for Ventilation and Air Distribution

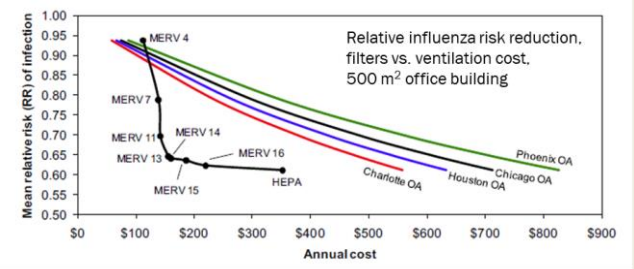
- Provide a*t least* design minimum outdoor air when building is occupied (e.g., compliant with ASHRAE Standard 62.1)
- Provide filter and air cleaner performance equivalent to *at least* MERV 13 (~ePM1 50%) for recirculated air streams (MERV 13 filters if possible)
- Operate system for a time required to achieve three equivalent air changes of outdoor air before first daily occupancy and between occupied periods, if needed
- Prefer mixing without strong air currents that could increase direct person to person transmission
- Use combinations of outdoor air, filters, and air cleaners that provide desired exposure control while minimizing energy penalties

Why minimum required outdoor air and not as much as possible?

- Minimum outdoor air *by itself* is not sufficient, but “as much has possible” has inconsistent, sometimes adverse consequences
  - *DOAS – does not change operation or reduce risk*
  - *VAV or other all-air system*
    - Possibly large risk reduction
    - Large energy use increase
    - Potential operational problems
    - Reduces filter effectiveness
- Minimum outdoor air + upgraded filters can achieve similar outcome with lower energy use and cost

Why MERV 13 filters and not HEPA for HVAC equipment?

- Existing air handling units and some terminal units *may* accept MERV 13, but definitely not HEPA
- Lack of room to room transmission suggests near 100% single pass efficiency is not essential
- Removal rate and not single pass efficiency is most important – high flow with moderate efficiency



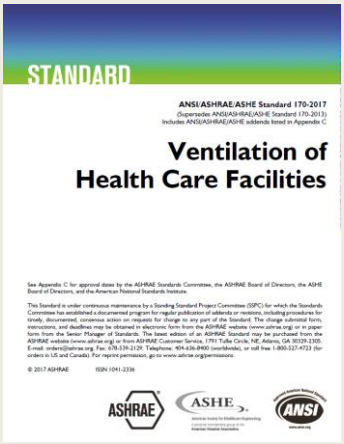
Azimi and Stephens, Building and Environment 70 (2013) 150-160

Why is recirculation not a concern?

- It ***is*** a concern within spaces when there is poor ventilation and filtration
- It ***is*** a concern for energy wheels, which should be checked
- Within systems, lack of space-to-space infection transmission evidence suggests dilution makes risk low
- Eliminating recirculation in all-air systems like typical VAV trades off with central filtration performance
- High recirculation rates through efficient filters is the basic approach to infection control in healthcare facilities

ASHRAE Standard 170-2017 Infection control is an objective

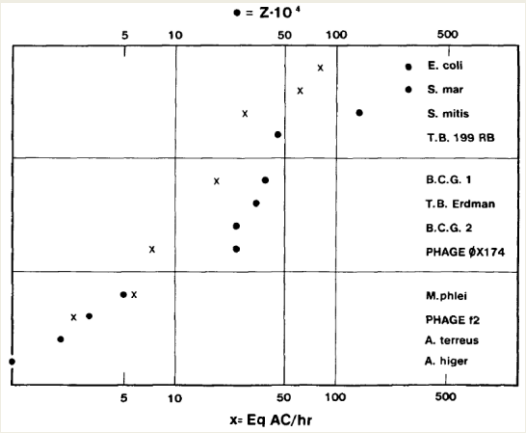
- Patient room minimum, requirements
  - *Outdoor air: 2 ACH*
  - *Total supply air: 4 ACH*
  - *Pre-filter: MERV 7*
  - *Final filter: MERV 14*
  - *Exhaust all room air outdoors - no*
- Protective environment
  - *Outdoor air: 2 ACH*
  - *Total supply air: 12 ACH*
  - *Pre-filter: MERV 7*
  - *Final filter: HEPA*
  - *Exhaust all room air outdoors - yes*



What is the role of air cleaners?

- Supplement outdoor air and mechanical filtration to achieve exposure targets
- May be central or in-room
- Recommended
  - *Standalone HEPA filtration*
  - *Germicidal ultraviolet*
    - Upper room most effective
    - Air-handler/in-duct may be lower cost, but less effective
- Others
  - *Mostly technologies that produce reactive species*
  - *Caveat emptor!*

Upper Room UVGI Equivalent Air Changes



Riley, R. and Nardell, E., 1989. Clearing the air. *Am Rev Respir Dis*, *139*, pp.1286-94.

Why prefer mixing when stratification is "known" to give better IAQ?

"…the general air distribution system in many cases creates a fully mixed concentration, which to some extent protects people from a high exposure from the source person."

Nielsen, P., et al. 2008. ASHRAE Transactions 114: 632.

"Based on the available data and our understanding at present, … we do not recommend the use of displacement ventilation…for control of exhaled substances or any harmful infectious aerosols."

Li, Y, et al. 2011 *ASHRAE Journal*, *53*(6), pp.86-89.

In most existing buildings, revision of air distribution in the short term is not an option

What is "desired exposure control"

- Targets for exposure control
  - *Growing acceptance and use of "equivalent clean air supply" approaches to Covid-19 risk management*
  - *Typically based on Wells-Riley model analysis*
  - *ASHRAE has not made recommendations, but others have*
  - *Multiple risk estimating tools are available*
- This approach allows optimization of with respect to cost and operational constraints
- Results are somewhat comparable to healthcare ventilation requirements

Summary

- ASHRAE recommendations provide a minimum baseline that may require supplementation
- Emphasis is on feasibility of implementation with some consideration for energy use
- Allowance of multiple controls and use of equivalent clean air approach allows owner/operator to tailor effective strategies to local conditions
- Better understanding of total air exchange requirements is needed

Thank you!

Bill Bahnfleth
wbahnfleth@psu.edu

ASHRAE Covid-19 resources
ashrae.org/covid19

ASHRAE

PennState College of Engineering | ARCHITECTURAL ENGINEERING