



1

Learning Objectives

- Explain basics of SARS-CoV-2 virus and transmission pathways
- Describe Guidance Document produced by ASHRAE Epidemic Task Force (ETF) Schools Team for reopening schools and universities
- Understand specific suggested strategies to mitigate airborne viral transmission, along with justification for strategies and potential implementation issues
- Review potential updates to guidance and possible changes to design strategies in future

2

Acknowledgements

- ASHRAE Epidemic Task Force (ETF)
 - Bill Bahnfleth, Dennis Knight, Wade Conlan, many other members
- ASHRAE ETF - Schools Team
 - Rick Hermans
- Other ETF Teams and Leads
 - Building Readiness, Residential, Filtration & Disinfection, Healthcare, Commercial, Transportation - More to Come
- ASHRAE Technical Committee 5.5 - Air-to-Air Energy Recovery

3

ASHRAE Resources

Building Readiness: <https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-building-readiness.pdf>

Schools and Universities: <https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-reopening-schools-and-universities-c19-guidance.pdf>

Filtration and Disinfection: <https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-filtration-disinfection-c19-guidance.pdf>

Multifamily: <https://www.ashrae.org/file%20library/technical%20resources/covid-19/covid-19-guidance-for-multifamily-building-owners-managers.pdf>

Healthcare: <https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-healthcare-c19-guidance.pdf>

Commercial: <https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-commercial-c19-guidance-08-17-2020.pdf>

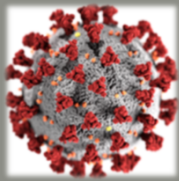
Transportation: <https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-transportation-c19-guidance.pdf>

Coming Soon: Laboratories, Air Cleaner one-page, updates, more...

4

What do we know?

Key information



- SARS-CoV-2 Virus
- Research and Information
 - Significant work being done
 - More available - improving reliability/certainty
- Other key information
 - Initial focus on mitigating transmission
 - still prevalent
 - Social Distancing
 - Cleaning of surfaces
 - PPE
 - Airborne transmission now a focus
 - WHO acknowledged on July 9th
 - CDC acknowledged on October 5th
 - Level of concern varies

5

What don't we know?

A lot.

- Viral Shedding Rate
 - Difference for different activities?
 - Different for different genders or ages?
- Infectious Dose
- Percentage of cases from each transmission pathway
- Where the virus goes when it's airborne
- Best air distribution strategies

6

ASHRAE EPIDEMIC TASK FORCE

Schools Team

- Rick Hermans* (Minnesota)
- Dennis Knight* (South Carolina)
- Raj Sany (Washington DC)
- Keith Hammelman (Illinois)
- Bruce Lindsay (Florida)
- Kyle Hasenkox (British Columbia)
- Julia Keen (Kansas)
- Charles Kovac (New York)
- Itzhak Maar (New Jersey)
- Raj Kapoor (Ohio)
- David Norvell (Florida)
- Frank Mills (United Kingdom)
- Chris Ruch (California)
- Susan Morgan (Minnesota)
- Wade Conlan* (Florida)
- Kathleen Owen* (North Carolina)

7

Important Assumptions*


*Not Necessarily Valid

- Occupant Health/Safety is the Focus
 - *Energy Efficiency is Secondary*
- Social Distancing and PPE Used to Extent Possible (meet requirements of CDC, OSHA, state Public Health Department, etc.)
- Proper Cleaning Protocols in Place (meet applicable recommendations/requirements)
- Buildings have code-required ventilation
 - *Frequently not a valid assumption*
- Means for control exist
 - *Not always a valid assumption*

8

Reopening Schools and Universities Guidance Document

- Online PDF
- Mitigation, not elimination
- Initially posted in early May
- Updates July 17th and October 7th
- Work Started in April – rapid response
- Work Continues
 - New Information
 - Core Principles
 - Shift to Heating (for many areas)
- Focus on Building Systems
 - Refer to other sources for public health guidance



The image shows the cover page of the ASHRAE Epidemic Task Force Schools & Universities Guidance Document. It features the ASHRAE logo at the top left and a colorful illustration of students in a classroom. The document is organized into several sections: Introduction, Background and General Recommendations, Detailed Guidance, References, and a list of Task Force members. The cover page also includes a table of contents and a list of related documents.

9

Key Concepts

HVAC System Verification and Operation

- Checklists
- Verify HVAC System Design
 - Do systems provide code-required ventilation (ASHRAE Standard 62.1)
 - Do systems maintain acceptable conditions
 - What are system capacities
- Ensure Building Systems Operate as Intended
 - Trending with controls
 - Testing and Balancing
 - Review Air Distribution/Mixing
 - Retrocommissioning*
 - Calibration of sensors*
 - Check IAQ trouble spots
 - Check leakage at energy recovery devices*

10

Key Concepts

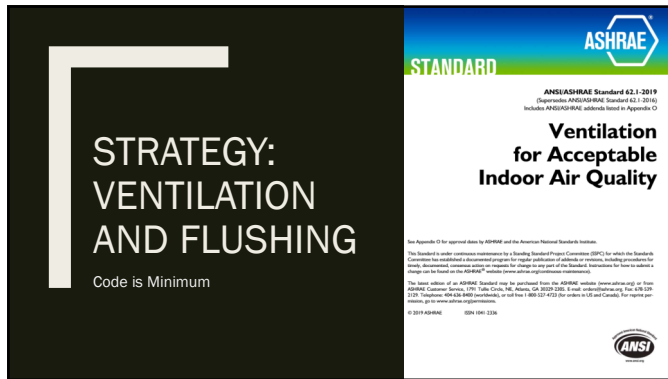
Short-term System Modifications/Improvements

- Ventilation and Flushing
- Increase Filter Efficiency (MERV Rating) Where Possible
- Make Minor Modifications to Control Sequences
 - Building Flushing Between Occupancy
 - Demand-Controlled Ventilation (DCV) Changes
- Other Possible 'Improvements'
 - Portable HEPA Filtration Units
 - Humidification
 - Other Treatment Technologies

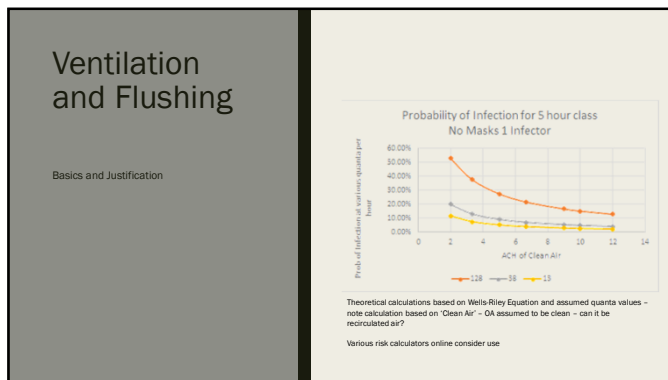
11

DETAILED STRATEGIES

12



13



14

**Ventilation
and Flushing**

Daily Flush Between Occupancy

- HVAC System Operated with Peak Ventilation Rates
 - Intent is to remove contaminants
 - General recommendation is 2-hours in schools guidance
 - Building Readiness guidance recommends 3 air changes of outdoor air, or 2-hours
 - Many buildings may need less than 2-hours
- Likely to require control sequence modifications
- System capabilities need to be reviewed

15

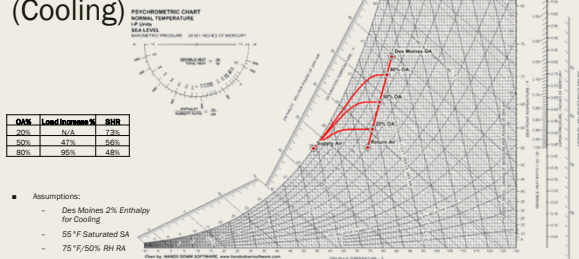
Ventilation and Flushing

Increased Ventilation

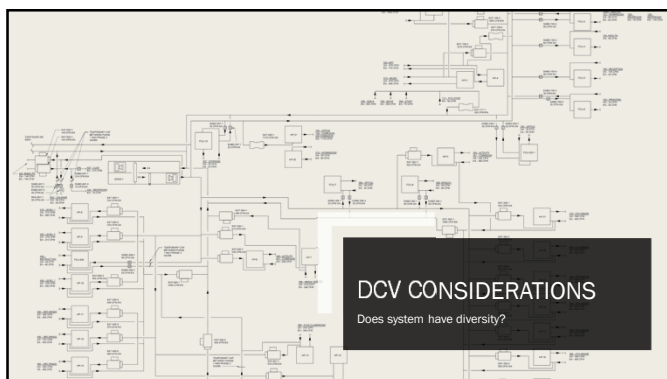
- Goal is to Dilute Contaminants Using Outdoor Air
 - Code is *minimum* – increases may be appropriate
 - System Capacities (cooling/heating) must be considered
 - Limit increase to maintain IAQ
- Disable DCV
 - Should ensure spaces receive adequate ventilation
 - Verify system design and strategy for implementation

16

Additional Ventilation (Cooling)



17



18

STRATEGY: AIR DISTRIBUTION AND FLOW RATE

Clean Air Change Rate and Removal Effectiveness

19

Air Distribution and Flow Rate

Best guesses for now - work being done

- Best Distribution Strategy
 - Various suggestions/recommendations
 - Target is good mixing without creating drafts between occupants
- Reduced Air Flow Rates
 - VAV at reduced flow - reduced dilution?

20

STRATEGY: FILTRATION

Capture Viral Particles

21

Filtration

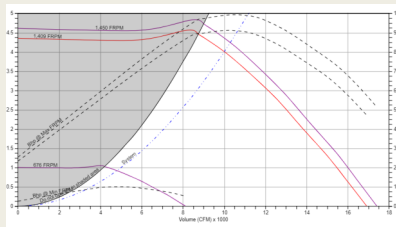
Improved Filtration

- Goal of MERV 13 or better
- Considerations
 - Which units need it (DOAS?)
 - Filter rack configuration and condition
 - Additional pressure drop - does system have capacity
 - Filter type (mechanical, charged, etc.)
 - Terminal equipment

25

FILTRATION

- Detailed Considerations - Fan Capacity
 - Don't sacrifice airflow for filtration



26

Filtration

Detailed Considerations

- Filter Type
 - MERV (might be enhanced - charged)
 - MERV-A (mechanical only)
 - ISO, HEPA, etc. (too much for equipment?)
- Terminal Equipment
 - What filters are available?
 - What is replacement frequency?
 - What is system configuration?
 - May consider adding portable HEPA units to space

27

Filtration

Room Air Cleaners

- Guidance coming from ASHRAE ETF
 - HEPA or high MERV (13 or better)
 - Clean Air Flow Rate
 - Considerations on Sound and Placement
- Other Resources:
 - [Harvard-CU Boulder Portable Air Cleaner Calculator](#)
- Other Key Considerations:
 - Filter type/availability
 - Consistency for maintenance

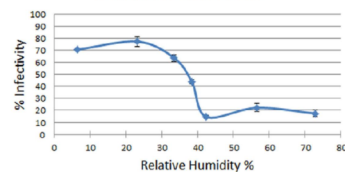
28

STRATEGY: HUMIDIFICATION

Reduce Transmission Potential

29

A Total Aerosol Fractions



Humidification

Studies Based on Influenza A
 *Higher RH results in droplet stability

ASHRAE Tech Hour from
 Stephanie Taylor, M.D.,
 M.Arch. - ETF Member:
<https://youtu.be/4Cj-mIkVQ>

* Nott, John D., et al. "High humidity leads to loss of infectious Influenza virus from simulated coughs." *PLoS one* 8.2 (2013).
 * Wen Yang and Lindsey Marie, "Mechanisms by Which Ambient Humidity May Affect Viruses in Aerosols", 2012 Oct.

30

Humidification

Options and Considerations

- Central Humidification
 - AHUs or duct-mounted
- Portable Humidifiers
 - Small temporary units
- Key Considerations
 - Water treatment
 - Potential for condensation

31

PSYCHROMETRIC CHART
HUMIDITY RATIO (lb/lb OF DRY AIR)
DRY-BULB TEMPERATURE (°F)
WET-BULB TEMPERATURE (°F)
SATURATED VAPOR PRESSURE (in. Hg)
SATURATED VAPOR PRESSURE (mm. Hg)
SATURATED VAPOR DENSITY (lb./cu. ft.)
SATURATED VAPOR DENSITY (g./cu. m.)
SATURATED VAPOR MASS (lb./lb. OF DRY AIR)
SATURATED VAPOR MASS (g./g. OF DRY AIR)
SATURATED VAPOR VOLUME (cu. ft./lb.)
SATURATED VAPOR VOLUME (cu. m./kg.)
SATURATED VAPOR ENTHALPY (Btu/lb.)
SATURATED VAPOR ENTHALPY (kJ/kg.)
SATURATED VAPOR ENTROPY (Btu/lb.-°R)
SATURATED VAPOR ENTROPY (kJ/kg.-°K)

Condensation will occur when indoor air comes in contact with surfaces below the Dew Point Temperature

Humidification Challenges

- Condensation in Building Envelope

32

STRATEGY: OTHER AIR TREATMENT

Many Options – What Works

33

Other Air Treatment

Multiple Options and Objectives



- Multiple Technologies
- Generally aim to deactivate viral particles
- Some may cause particles to agglomerate
- Consider claims, independent testing, standards, etc.
 - *Do not reduce ventilation air*

34

Summary

Many variables – most out of our control

- Information is changing rapidly
- Airborne Transmission is Possible
- Systems need to work as intended
- Ventilation and filtration can reduce viral particle concentrations
 - *Application needs to be considered*
- Humidification and air treatment may help further
 - *Application needs to be carefully considered*

35

QUESTIONS?

Corey B. Metzger, PE
corey.metzger@resourcece.com

36
