COVID-19: Reopening Buildings under Pandemic Conditions

ASHRAE Puget Sound Chapter

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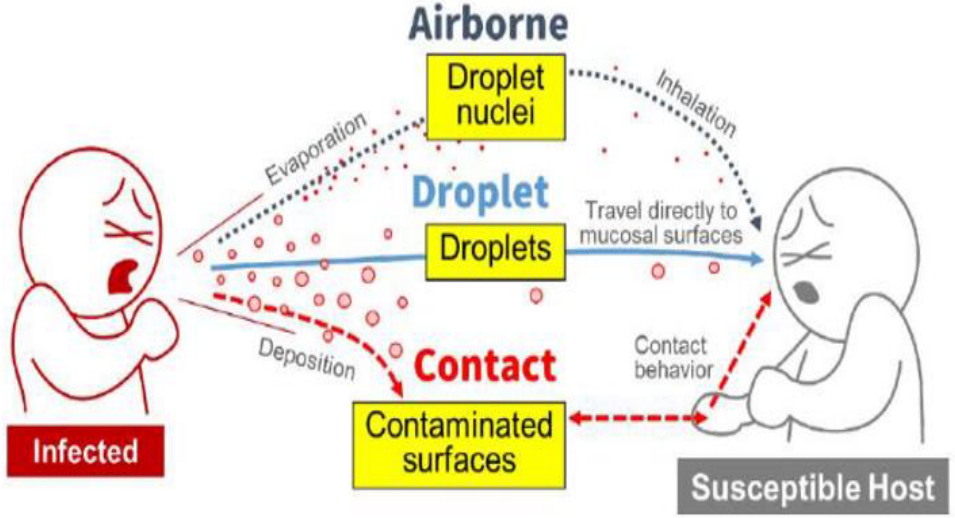
Agenda

1. COVID-19 and SARS-CoV-2 Information
2. HVAC and COVID-19
3. ASHRAE's COVID-19 Guidance
4. Concluding Remarks
5. Q&A Discussion

COVID-19 & SARS-CoV-2

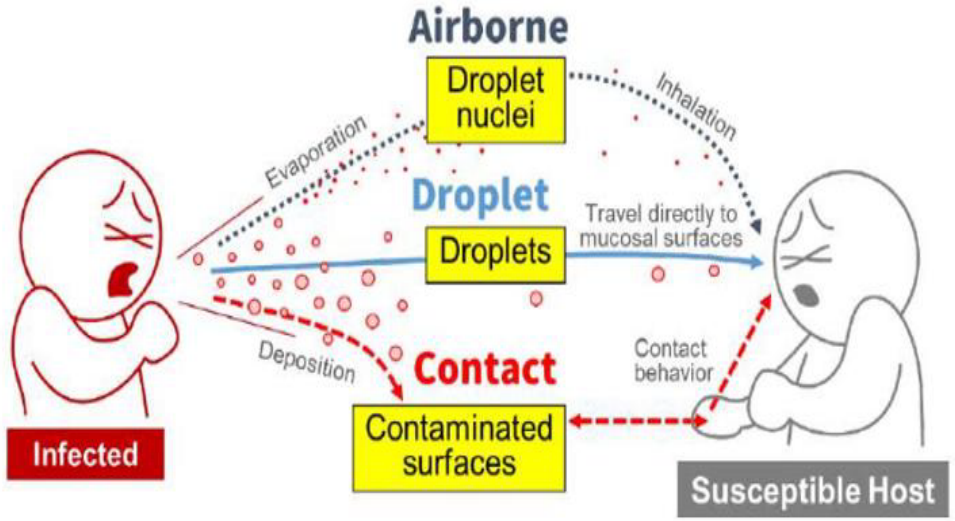
SARS-CoV-2 Transmission Routes



- The coronavirus particle is 80-160 nanometres (1 micron = 1,000 nanometres)
- Inhalation or direct contact through to one's eyes, nose or mouth with "droplets", typically defined as particles larger than 5 microns $(\mu m)^2$. These are relatively heavy particles, so they drop out of the air after traveling a short distance of about 3 to 6 feet.

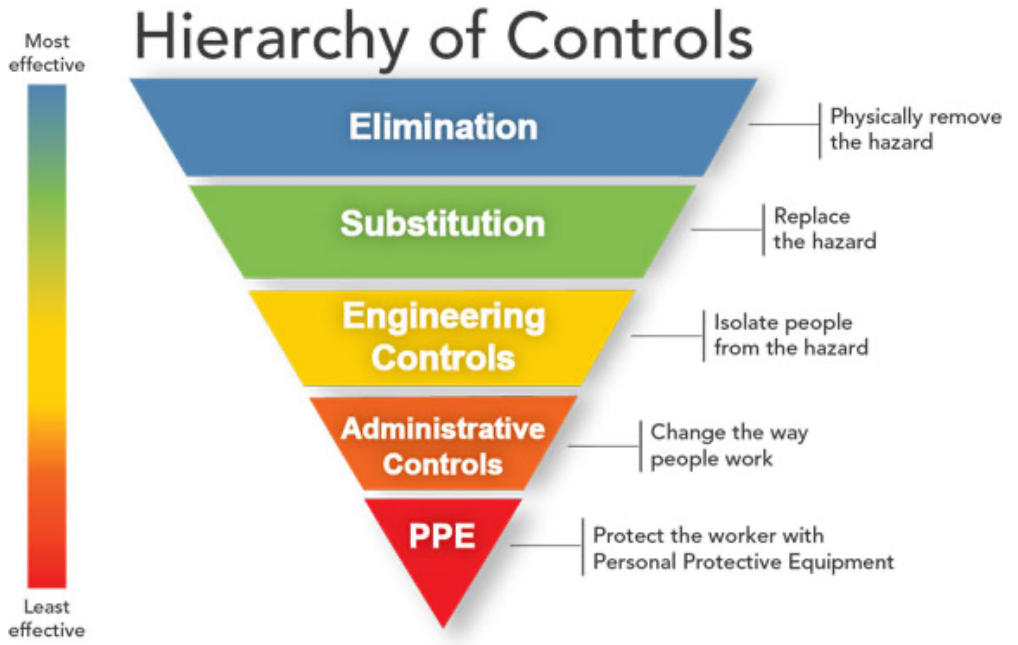
https://www.infectiousdiseaseadvisor.com/home/topics/covid19/respiratory-transmission-of-covid19-coronavirus/

SARS-CoV-2 Transmission Routes



- Indirect contact through droplets that contaminate surfaces (called fomites) then are transmitted to one's eyes, nose or mouth typically by touching with one's hands.
- Inhaled aerosols or droplet nuclei, defined as particles smaller than about 5 μm^2. These particles are light enough that they can stay suspended in the air for longer periods of time and over long distances.

SARS-CoV-2 Primary Mitigation



- The NIOSH Hierarchy of Controls can be helpful in evaluating the effectiveness of measures under consideration.
- This hierarchy begins with the most effective measures and descends to measures with lower effectiveness.
- HVAC mitigation strategies would be engineering controls

SARS-CoV-2 Primary Mitigation

- Have people work remote if possible
- Maintain social distancing of at least 6 feet
- Face masks can reduce droplet transmission where more than one person gathers.
  - A single breath releases 50 - 5000 droplets
  - A single cough releases about 3,000 droplets and droplets travels at 50 miles per hour
  - A single sneeze releases about 30,000 droplets, with droplets traveling at up to 200 miles per hour
- People with symptoms or known to be exposed should stay home

Note that a recent study of an infected cruise ship showed that 81% of people who tested positive were asymptomatic.

COVID-19 Unknown/Incompletely Known

- Source strength and infectious dose of SARS-CoV-2
  - Limits ability to make quantifiable control requirements, define conditions under which airborne or aerosol transmission are likely and assess risk
- Survival time of SARS-CoV-2 in the environment
  - Affects decisions about measures needed to reoccupy buildings, requirements for after-hours operation when reoccupied
- Ability of SARS-CoV-2 to transmit through HVAC systems

COVID-19 Unknown/Incompletely Known

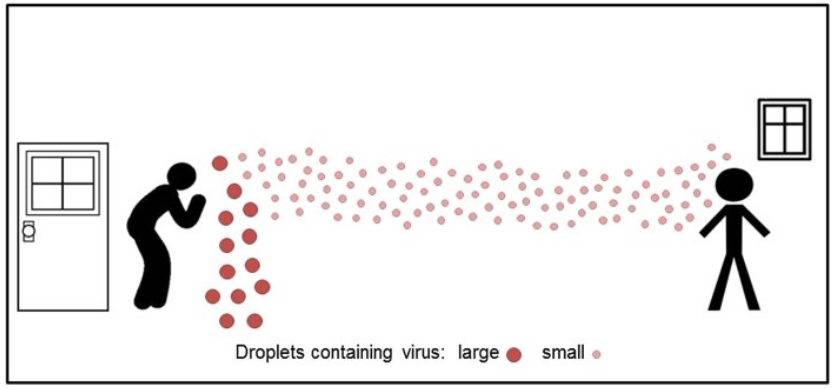
- Role of ambient particulate matter in COVID-19 transmission
- Which investments in protection now will meet objectives to mitigate transmission and provide the greatest benefits post-pandemic without compromising energy and environmental goals

HVAC & COVID-19

HVAC and COVID-19

- Infection occurs when a susceptible person receives a sufficient dose of virions
- WHO, CDC, and other health authorities believe transmission of COVID-19 is mainly by short-range/large droplet mode
- Some community spread/super-spreading events suggest possibility for airborne/aerosol transmission under some circumstances

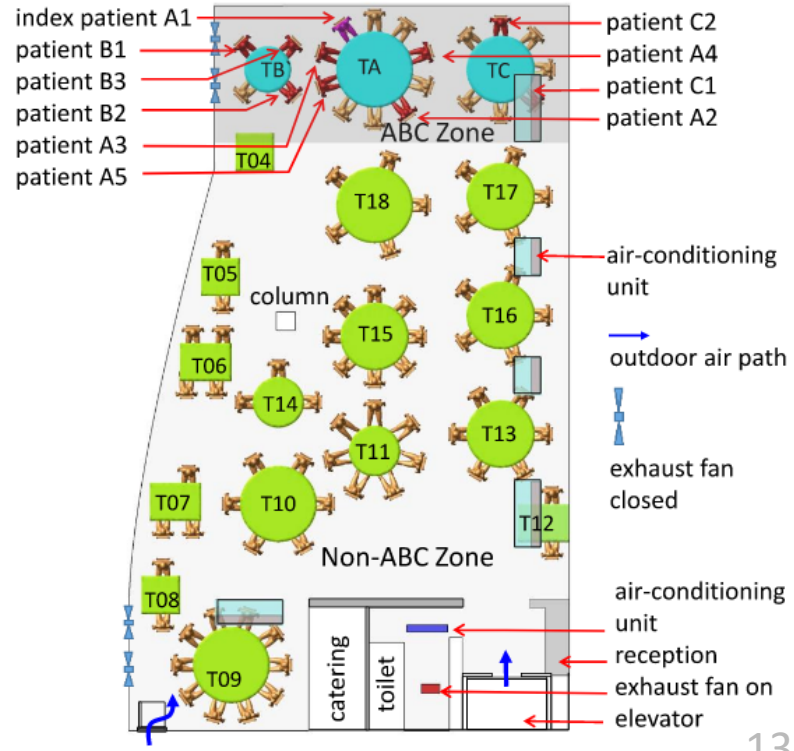
HVAC and COVID-19

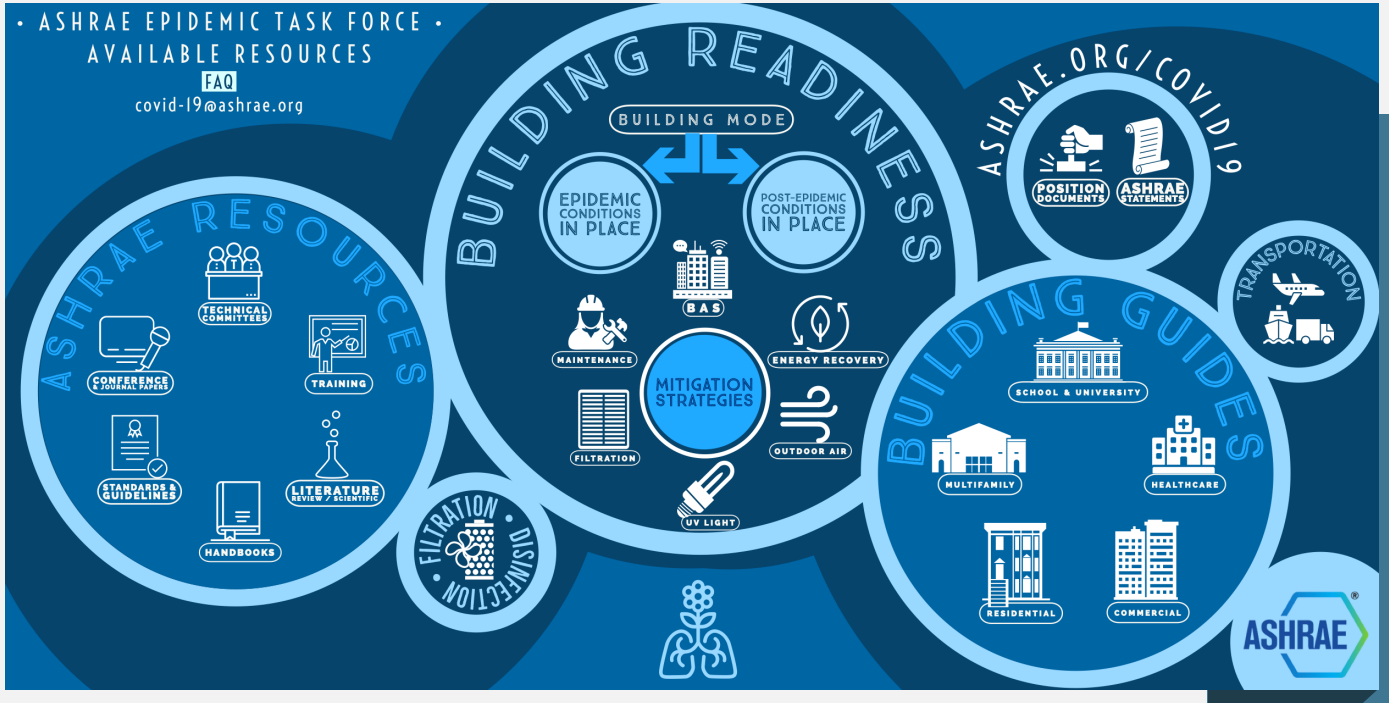


- The WHO recently acknowledged that short-range aerosol transmission, particularly in specific indoor locations, such as crowded and inadequately ventilated spaces over a prolonged period of time with infected persons cannot be ruled out.
- A recent study showed the presence of SARS-CoV-2 RNA present in approximately 25% of air handler filter samples taken from multiple hospital air handling systems.
- Risk of HVAC airborne/aerosol transmission can be reduced by reducing airborne concentration – ventilation, air management, filtration, and air cleaning all apply.

HVAC and COVID-19

- Poorly ventilated spaces have been cited as primary concerns in the following community spread events
  - Restaurant in Guangzhou, China where 9 of 73 people where infected
  - Conference Center in China where 15 of 30 people where infected
  - Skagit Valley Chorale rehearsal where 53 of 61 people where infected





ASHRAE's COVID-19 Guidance

ASHRAE Position Statements

- Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning systems, can reduce airborne exposures.
- 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. In general, disabling of heating, ventilating, and air-conditioning systems is not a recommended measure to reduce the transmission of the virus.

Building Readiness Plan

- This is a document that should be created to document the mitigation strategies that the facility is going to utilize, whether temporary or permanent modifications, for the facility operators and occupants to understand the plan.
- This should include the non-HVAC strategies as well as the HVAC mitigation strategies that are discussed in this document.
- Non-HVAC strategies could include, but not be limited to, the following items:
  - Building occupancy levels allowed
  - Face mask requirement or recommendation
  - Social distancing between desks, breakrooms, conference rooms, elevator, etc.
  - Directional flow for office space
  - Personal hygiene
  - Cleaning requirements

Building Readiness Plan

- HVAC strategies could include, but not limited to, the following items:
  - Improved Filtration
  - Increased Ventilation
  - Air cleaning devices (such as UVGI and other newer technologies)
- Each HVAC system needs to be analyzed for the appropriate engineering controls to utilize to improve its potential to reduce virus transmission in the building.
- Owners should consider evaluating their building systems to check that they are properly operating (per design conditions or current operational strategies), are capable of being modified to align with HVAC mitigation strategies, and to identify deficiencies that should be repaired.

HVAC Mitigation Strategies

- Inspection and Maintenance
  - Assess the condition of existing systems and making necessary repairs
  - Maintain HVAC and building service systems in safe and healthy conditions
  - All building owners and service professionals should follow ASHRAE Standard 180-2018 “Standard Practice for the Inspection and Maintenance of Commercial HVAC Systems.”
  - Consider PPE for building operators when maintaining ventilation materials including filters

HVAC Mitigation Strategies

- Outside Air Ventilation
  - A good supply of outside air, in accordance with ASHRAE Standard 62.1-2019, to dilute indoor contaminants is a first line of defense against aerosol transmission of SARS-CoV-2
- Consider Pre-Occupancy Purge with Outside Air
  - Intent is to remove infectious aerosol if present
  - Normally three air changes of OSA is required to reduce concentration of airborne infectious particles by 95% for a well-mixed space
- Disable demand control ventilation

HVAC Mitigation Strategies

- Improve Filtration
  - Use minimum MERV 13 filters if it does not adversely impact system operation
  - Seal edges of the filter to limit by-pass
  - Consider portable HEPA air cleaners if MERV 13 filters cannot be used or if there is no mechanical ventilation
  - Open windows where appropriate during occupied hours

Table 12-1 Minimum Efficiency Reporting Value (MERV) Parameters

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
8	N/A	$20 \le E_2$	$70 \le E_3$
9	N/A	$35 \le E_2$	$75 \le E_3$
10	N/A	$50 \le E_2$	$80 \le E_3$
11	$20 \le E_1$	$65 \le E_2$	$85 \le E_3$
12	$35 \le E_1$	$80 \le E_2$	$90 \le E_3$
13	$50 \le E_1$	$85 \le E_2$	$90 \le E_3$
14	$75 \le E_1$	$90 \le E_2$	$95 \le E_3$
15	$85 \le E_1$	$90 \le E_2$	$95 \le E_3$
16	$95 \le E_1$	$95 \le E_2$	$95 \le E_3$

HVAC Mitigation Strategies

- Unitary Fans
  - For ceiling fans, if possible, reverse the flow direction to blow upward
  - For pedestal and horizontal fans, beware of the nature of air flow and avoid prolonged cascades of air flow from the face of a person onto others
  - If there is good ventilation air or good filtration efficiency and poor air mixing, then run the fans to promote good mixing
  - If fans are the only HVAC in the room then either open a window, provide portable air cleaner with HEPA filter units or avoid using the room

HVAC Mitigation Strategies

- Exhaust Systems
  - Garage exhaust systems should run 30 minutes before occupancy. It is preferred to run garage exhaust systems continuously during occupied hours.
  - Other exhaust systems should continue to run as normal. Run exhaust systems 2 hours before and after occupied periods.
  - If there are exhaust outlets located in pedestrian areas outside, provide warning signs and consider diverting or rearranging the exhaust air discharge locations so that they would pose no opportunity to cause harm.

HVAC Mitigation Strategies

- Energy Recovery Devices
  - Some energy wheels have the potential of cross contamination between the intake and exhaust air stream.
  - Any ERV within co-located ducts and equipment casings has potential for some leakage between airstreams.
  - Well-designed and well-maintained air-to-air energy recovery systems should remain operating in residences, commercial buildings and medical facilities during the COVID-19 pandemic.
  - ERV systems should be inspected for proper operation and condition and be evaluated for possible contribution of bioburden to the building's supply air.

HVAC Mitigation Strategies

- Ultraviolet Germicidal Irradiation (UVGI)
  - Consider UV-C light as an enhancement where spaces require additional measures, e.g. spaces serve vulnerable occupants, or, MERV-13 filter or 100% outside air are not possible, etc.
  - The effectiveness of germicidal UV light depends on the length of time a microorganism is exposed to UV, as well as the intensity and wavelength of the UV radiation.
  - The Illuminating Engineering Society (IES) in their Germicidal Ultraviolet (GUV) FAQ report states that the most effective UV-C application for disease control is irradiation at the room level, commonly called upper-room or upper-air UV-C.
  - https://www.ashrae.org/technical-resources/filtration-disinfection#uvc

HVAC Mitigation Strategies

- Building Automation and Control
  - Maintain dry bulb temperatures within the ASHRAE Standard 55 comfort ranges
  - Maintain relative humidity between 40% and 60%, where possible, since that can reduce the half-life decay time of the virus
  - Automate the "Epidemic Mode" operation control sequences that can be turned on, shut down or override, if needed, by manual selection of the operator
  - Monitor and trend the HVAC measures and set alerts and notification to provide real time feedback to building operators

Concluding Remarks

Concluding Remarks

- *No one or series of measures in a building can guarantee that SARS-CoV-2 will not spread to others when more than one person is in a space –there is a risk of transmission when allowing people to occupy buildings.*
- Recommendations from many high-level organizations have not been consistent and are subject to change as we learn more.
- This subject is rapidly evolving as efforts to control the pandemic continue.
- There is no known instance of COVID-19 infection from one room to another though a central HVAC system. This would be extremely difficult to prove.
- It is likely, but not yet definitive, that COVID-19 could be spread through HVAC systems.

Concluding Remarks

- Prepare a Building Readiness Plan
- Ensure building systems are operating as intended
- Social distancing and face masks should be required when re-occupying buildings
- MERV 13/14 filters can help
- The HVAC system outside air pre-purge cycle can help
- Local HEPA room air cleaners can be helpful when MERV 13 and proper ventilation cannot be provided in a space.

Questions

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Other Air Cleaning Technologies

- There is limited to no recognized peer-reviewed research showing the effectiveness of the following technologies for reducing SARS-CoV-2 virus bio-burden:
  - Air cleaners using photocatalytic oxidation
  - Ozone-generating air-cleaning devices
  - Plasma air ionization systems
    - Spanish Ministry of Defense Biological Laboratory testing in May 2020 showed good results but was guided and coordinated by the manufacturer
    - The air ionization system reduced bacteriophage MS2 99% after 10 minutes
    - Unable to find testing on mitigation of SARS-CoV-2 virus