Returning to the Workplace:
The Impact of COVID-19 on HVAC Systems

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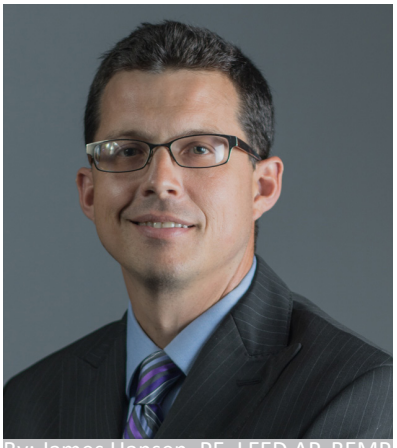
GHT is seeing an increase in requests from members of the commercial building industry to weigh in on how Heating, Ventilation and Air-Conditioning (HVAC) systems can prevent the transmission and/or propagate the SARS-CoV-2 virus (causative agent of COVID-19). Although we are not immunologists, we have been in contact with a number of HVAC equipment suppliers and industry professionals that have been involved in some early stage testing regarding this issue. It is worth noting that our understanding of the virus continues to evolve as more data is collected, and our hope is that this guide can be used as a starting point for discussions on best practices moving forward. The following is a general discussion of the known facts relating to COVID-19 and HVAC systems, possible HVAC mitigation methods and follow up questions and answers.



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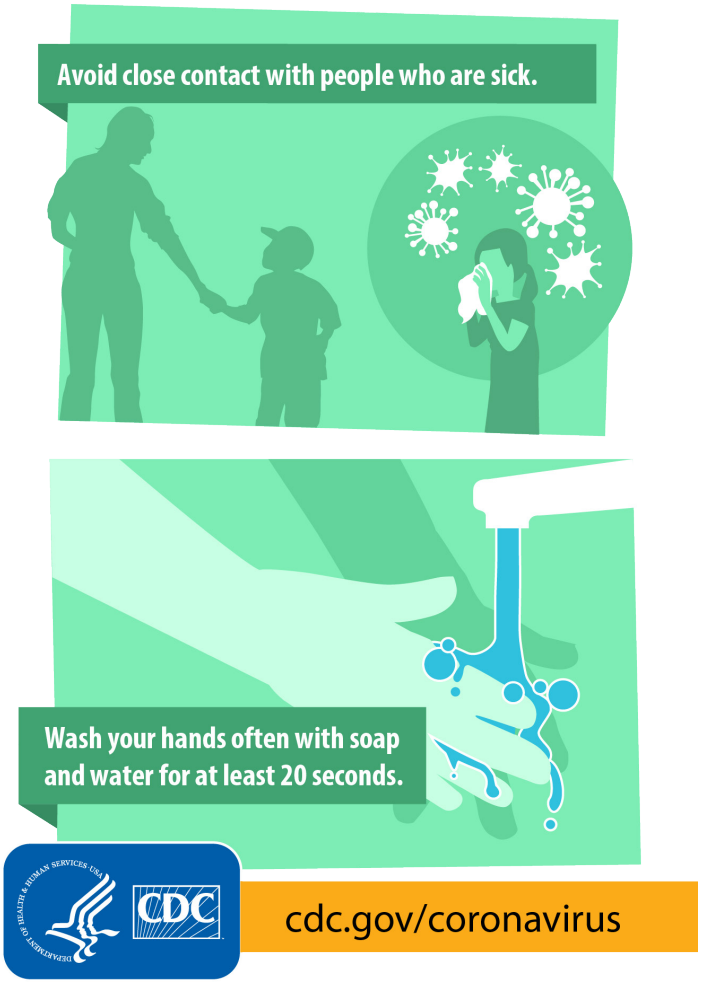
FACT #1

The World Health Organization (WHO) indicates that SARS-CoV-2 is spread primarily from person to person through small droplets from the nose or mouth, which are expelled when a person with COVID-19 coughs, sneezes, or speaks and contact with infected objects (either thru direct touch or indirect contact via air borne sources). The WHO and other experts recommend that social distancing, hand washing, and disinfection will remain the primary ways to avoid transmission.



If SARS-CoV-2 continues to be a global threat, there may be impacts on the built environment, particularly for office space. It is reasonable to expect that any of the following may occur:

1. Office re-configuration to ensure minimum 6' separation among the workforce.
2. Increase in frequency and scope for disinfection of surfaces.
3. Finish selection re-prioritized based on ease of disinfection and longevity related to repeated chemical cleaning.
4. More widespread implementation of touch-free devices (e.g. toilet fixtures) and voice commands (e.g. elevator call button commands) in lieu of touch commands.
5. Enhanced air cleaning technologies in high-occupancy environments such as conference rooms, training rooms, auditoriums, etc.
6. Revisions to codes and sustainability rating systems focused on building occupant health.

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FACT #2

There is NOT general consensus that HVAC systems increase or decrease the spread of SARS-CoV-2. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has developed an epidemic task force to investigate and research the issue, and they have approved the following two statements as of April 14, 2020 regarding transmission of SARS-CoV-2:

1. "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."

2. "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."

The first statement echoes some emerging data that indicates that SARS-CoV-2 *may* be transmitted via aerosols. For reference, the virus is approximately 0.1 microns in size. It is already known that it is transmitted via respiratory droplets (> 5 micron in diameter). This size particle typically does not get entrained by an air-handling system because of the effects of gravity, and it remains within 1-2 meters of its source (hence the 6' social distancing guideline). However, if the virus can also be transmitted via aerosols (< 5 micron in diameter), then it is more likely to exist in the air for longer periods of time, and be more easily pulled into an air-handling system as the aerosols can attach to dust particles like PM2.5 and PM10 (Atmospheric Particulate Matter less than 2.5 microns and less than 10 microns, accordingly).

The second statement builds on the first statement and says that *if* the virus can propagate through the air, and is picked up by air-handling systems, those HVAC systems may be capable of limiting the spread under certain conditions and in certain configurations. If, over the next few months, it becomes clearer that aerosol propagation is a real threat, the following are some best practices to help limit the spread of SARS-CoV-2 and other viruses:

1ST LINE OF DEFENSE: FILTRATION

If aerosols carrying SARS-CoV-2 indeed bind with PM particles and end up in air-handling systems, then proper filtration and a filter replacement schedule are in the adjacent table (a summary of ASHRAE 52.2 filter ratings) for limiting spread. As you can see, the MERV rating of a filter has a corresponding particle size that it can efficiently filter. If we are targeting aerosols and bound PM particles, we should be using filters that can effectively filter down to 1 micron and recommend the use of MERV 13 or better filters wherever possible. Note: there may be a need to modify/enhance personal protection during filter replacement.

Table 1: MERV filter ratings versus filtered particle size

MERV Rating (Per ASHRAE Standard 52.2)	Particle Size Ranges
1-4	> 10.0 µm
5-8	3.0 - 10.0 µm
9-12	1.0-3.0 µm
13-16	0.3 - 1.0 µm

NOTE: "MERV" stands for Minimum Efficiency Reporting Value. The method by which filters are tested / rated is slightly complex, but generally involves testing a filter's efficiency with several different ranges of particle sizes (aligning with the ranges above). The efficiency of a particular filter at each range is recorded, and cross referenced with a table that lists minimum efficiency values for a specific MERV rating.

As an example: a MERV 11 filter needs to be 85% efficient in filtering particles between 3 and 10 microns, 65% efficient at filtering particles between 1 and 3 microns, and 20% efficient at filtering particles between 0.3 and 1.0 microns.

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2ND LINE OF DEFENSE ULTRAVIOLET (UV) TREATMENT

Ultraviolet (UV) Treatment. Currently, UV-C lights are the only proven UV-treatment method of de-activating the SARS-CoV-2 virus. However, these systems need to be properly designed and implemented to be effective. UV treatment of cooling coils is a relatively common practice in certain industries, but these installations are intended to eliminate mold by long term exposure to low density light. To effectively de-activate the SARS-CoV-2 virus, a much higher density light needs to be provided so that the virus is exposed to its "kill dose" in a single pass through the lit area. There are multiple manufacturers that provide options for equipment-mounted and duct-mounted UV-C packages.

ALTERNATE TECHNOLOGIES

There are a number of air cleaning technologies on the market that have a proven track record of eliminating everything from E. Coli, to Staph, to MRSA, to Legionella. One such technology is bipolar ionization, which creates positively and negatively charged ions. These ions are delivered to the conditioned area where they neutralize things like bacteria, viruses, mold, and VOCs, and can also bind to additional pollutants so that filters can more effectively trap them. There have been published studies demonstrating their effectiveness at de-activating viruses, but many of the manufacturers are concerned about plant-wide exposure to the SARS- CoV-2 virus and testing may be delayed until there is a vaccine available. In addition, there is not a standard in place to test performance of these system relative to other filtration techniques. This should change in the near future and we hope to see positive results. These systems have a variety of configurations, including side-stream filtration, duct- mounting, and personal protection/point-of-use.

EFFECT OF OUTDOOR AIR

Code required ventilation rates were derived to ensure that building contaminants are removed at a reasonable rate using "fresh" outdoor air. Does this mean that increasing the amount of outdoor air delivered to your building will help flush out the SARS-CoV-2 virus? YES and NO. If the outdoor air is properly filtered and dehumidified, presumably the additional outdoor air will allow a greater air change rate which will reduce the viral load within the building. However, note the following:

1. Studies have shown that the virus may bind with PM particles – in areas with high pollution or high ambient PM levels, an increase in outdoor air delivered to the building may result in an increase in indoor PM levels if the air is not properly filtered.

2. Studies have also shown that in general, viruses are less viable if the ambient humidity in the space is between 40% and 60%. An increase in outdoor air without proper dehumidification and/or humidification may make it more difficult for the HVAC system to maintain 50% relative humidity, thereby increasing the risk of transmission.

TO SUMMARIZE

Implement the WHO guidelines. Focus on proper filtration and filter replacement. Standby for industry updates on alternative technologies as they become available. Feel free to reach out to your MEP engineer for coordinating any substantial changes to building operations (such as increased outdoor airflow rates or the implementation of UV filters). Note that the impact of humidity on the SARS-CoV-2 virus, specifically, is still being studied.

QUESTIONS + ANSWERS

Should I turn my HVAC system off?

No, the accepted industry agreement is that a functioning HVAC system allows for filtration of any air-borne infected particles and keeps the building at a relative humidity that is less conducive for transmission.

Do I need to change the thermostat settings in my facility to help combat the spread of SARS-CoV-2?

No, there is currently no data that shows that setting back temperatures has an impact on a reduction in viral transmission. On the contrary, doing this may disturb the space relative humidity which appears to have a larger impact on viability.

Should I go around my facility and replace all filters with new MERV 13 versions?

If the equipment was designed to support MERV 13 filters, absolutely. If the equipment was not specifically designed to support high efficiency filters (think fan coil units, fan-powered VAV boxes, etc), reach out to an engineer or equipment vendor to determine if that equipment can support MERV 13 filters. A higher efficiency filter on equipment not designed to support it may cause premature equipment failure. When upgrading filters is not an option, in-room filtration strategies may be beneficial.

If someone in my office tested positive for COVID-19, what is the likelihood that I will have been exposed via the HVAC system?

The current thinking is that you would be much more likely to be infected from direct or indirect contact with that person than from air-borne transmission via the HVAC system. The research is still not conclusive on whether SARS-CoV-2 can be transmitted through aerosols, but even if it can, a properly designed and maintained HVAC system may limit transmission of the virus through filtration.

If COVID-19 can be transmitted via aerosols, are certain HVAC systems better than others at limiting spread?

Probably. If the scientific community determines that aerosol-based transmission is prevalent, then those systems with a higher zone-level filtration capacity will presumably limit the spread better than those without. As an example: a fan-powered VAV system with fan motors sized to accommodate MERV 13 filters may effectively filter more of the virus than a more traditionally static system like chilled beams. However, for those developers and building owners currently making decisions on mechanical systems: we strongly advise waiting for more conclusive scientific studies related to aerosol transmission of SARS-CoV-2.

As the pandemic continues, the scientific community is continuing to research, study, and learn more about this virus. As new information becomes available we will provide updates on HVAC strategies to limit transmission of COVID-19.