GEAUGA MECHANICAL

COVID-19 HVAC BEST PRACTICES FOR SCHOOLS

April 28, 2020

The HVAC systems in most non-medical buildings play only a small role in infectious disease transmission, including SARS-CoV-2 (Coronavirus, COVID-19). However, 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.

HVAC filters, along with other strategies, help to reduce virus transmission while removing other air contaminants that may have health effects.

Source: "ASHRAE Issues Statements on Relationship Between COVID-19 and HVAC in Buildings"
https://www.ashrae.org/about/news/2020/ashrae-issues-statements-on-relationship-between-covid-19-and-hvac-in-buildings

HOW SARS-VOC-2 SPREADS

According to the WHO (World Health Organization), "The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes…." Talking and breathing can also release droplets and particles. Droplets generally fall to the ground or other surfaces in about 1 m (3 ft), while particles (aka aerosols), behave more like a gas and can travel through the air for longer distances, where they can transmit to people and also settle on surfaces. The virus can be picked up by hands that touch contaminated surfaces (called fomite transmission) or be re-entrained into the air when disturbed on surfaces.

SARS infected people over long distances in 2003, SARS-CoV-2 has been detected as an aerosol in hospitals, and there is evidence that at least some strains of it remain suspended and infectious for 3 hours, suggesting the possibility of aerosol transmission. However, other mechanisms of virus dissemination are likely to be more significant, namely,

- direct person to person contact
- indirect contact through inanimate objects like doorknobs
- through the hands to mucous membranes such as those in the nose, mouth and eyes
- droplets and possibly particles spread between people in close proximity

For this reason, basic principles of social distancing (1 to 2 m or 3 to 6.5 ft), surface cleaning and disinfection, handwashing and other strategies of good hygiene are far more important than anything related to the HVAC system.

Source: "Guidance for Building Operations During the COVID-19 Pandemic", Lawrence J. Schoen, P.E., Fellow/Life Member ASHRAE
https://www.ashrae.org/news/ashraejournal/guidance-for-building-operations-during-the-covid-19-pandemic

NON-HVAC RECOMMENED ACTIONS

For those buildings that remain open, in addition to the policies described above, recommended non-HVAC actions include:

- Increase disinfection of frequently touched surfaces.
- Install more hand sanitation dispensers, assuming they can be procured.
- Supervise or shut down food preparation and warming areas, including the office pantry and coffee station.
- Close or post warning signs at water fountains in favor of bottle filling stations and sinks, or even better, encourage employees and students to bring their water from home.

Source: "Guidance for Building Operations During the COVID-19 Pandemic", Lawrence J. Schoen, P.E., Fellow/Life Member ASHRAE
https://www.ashrae.org/news/ashraejournal/guidance-for-building-operations-during-the-covid-19-pandemic

GENERAL HVAC RECOMMENED ACTIONS

Once the Non-HVAC recommended actions have been implemented, a few actions related to HVAC systems are suggested, in case some spread of the virus can be affected:

- Increase outdoor air ventilation (use caution in highly polluted areas); with a lower population in the building, this increases the effective dilution ventilation per person.
- Disable demand-controlled ventilation (DCV).
- Further open minimum outdoor air dampers, as high as 100%, thus eliminating recirculation (in the mild weather season, this need not affect thermal comfort or humidity, but clearly becomes more difficult in extreme weather).
- Improve central air filtration to the MERV-13 or the highest compatible with the filter rack, and seal edges of the filter to limit bypass.
- Keep systems running longer hours, if possible 24/7, to enhance the two actions above.
- Consider portable room air cleaners with HEPA filters.
- Consider UVGI (ultraviolet germicidal irradiation), protecting occupants from radiation,13 particularly in high-risk spaces such as waiting rooms, prisons and shelters.

Source: "Guidance for Building Operations During the COVID-19 Pandemic", Lawrence J. Schoen, P.E., Fellow/Life Member ASHRAE
https://www.ashrae.org/news/ashraejournal/guidance-for-building-operations-during-the-covid-19-pandemic

ASHRAE HVAC BEST PRACTICES SUMMARY – SCHOOL BUILDINGS

A full list of Best Practices for School Buildings can be found on ASHRAE's website (https://www.ashrae.org/technical-resources/resources). The following is a summary of Best Practices for Commercial and School Buildings that we feel are the most applicable to our customers' buildings.

Maintenance Recommendations

- It is important to maintain HVAC and Building Service Systems in safe and healthy conditions. Standard preventative maintenance tasks should be continued.
- Disinfect high touch areas of the HVAC system, such as on/off switches, thermostats, and Building Automation System panels and computers.
- If you suspect that an HVAC system may be contaminated with a virus, maintain personal protection while cleaning, replacing filters and moving or using other equipment.
- When feasible, filters can be disinfected with a 10% bleach solution or another appropriate disinfectant, approved for use against SARS-CoV-2, before removal. Filters (disinfected or not) can be bagged and disposed of in regular trash.

Operational Recommendations

- Continued operation of all systems is recommended.
- Maintain a relative humidity level of 40% to 60% (if possible).
- Outside air for ventilation be increased to as much as the HVAC system can accommodate and still maintain acceptable indoor conditions during occupied hours.
- For HVAC systems that use Demand-controlled ventilation sequences we recommend disabling this feature for the duration of the crisis.
- In buildings with operable windows, when outside air thermal and humidity conditions and outdoor air quality are acceptable, open windows where appropriate during occupied hours. Please keep in mind, Exposure to seasonal and other outdoor allergens (pollen and mold spores) may occur with windows opened.
- Keep heating water systems circulating and maintain temperatures above 140°F to avoid microbial incursion. Do not let water temperature to drop below 120°F.
- Exhaust system for toilets should run 24/7. Do not open operable windows in toilets.
- Maintain slightly positive pressure as compared to outside in both single story and multistory buildings. Shut off return air to the central air conditioning systems in the spaces where infected people may be present and use exhaust fans discharging air directly to the outside away from outdoor public gathering spaces, outdoor air intakes and operable windows. Consider HEPA filter, or, UVGI lamps with exhaust fan if exhaust can cause harm to public.

Indoor Air Quality Recommendations

- Maintain indoor carbon dioxide (CO_2) between 800 and 1,000 parts per million (ppm).
- Install both fresh air supply and exhaust ventilation systems in occupied areas.
- Avoid recirculating previously exhausted contaminants when ventilating.
- Ensure adequate make-up air in boilers to minimize backfires and carbon monoxide contamination.
- Maintain indoor air relative humidity (RH) below 70 percent.
- Maintain indoor air temperature at comfortable levels (68-72°F when the room is being heated and 70-78°F when the room is being cooled).
- Change filters and clean drip pans according to manufacturer's instructions. (Filters in high-pollution areas may require more frequent service.)
- Ventilate occupied areas at a minimum rate of 15 cubic feet per minute per person (cfm/p).

Variable Air Volume System Recommendations

If your building is served by a Variable Air Volume (VAV) system, we recommend the following additional actions:

- For VAV systems that have the capacity to operate with 100% outside air, such as an economizer cycle, close return air dampers and open outdoor air dampers to 100% or to the maximum setting that the HVAC system can accommodate and still maintain acceptable indoor conditions.
- Prioritize increasing outside air over controlling humidity.
- Consider changing the unit's discharge air setpoint to the maximum (typically no higher than 60ºF). This will cause the VAV terminal units (boxes) to open and try to satisfy space cooling loads which will increase the number of air changes in the space being served.

Filtration and Disinfection

- Where modifications to existing HVAC system are not possible due to physical or capacity limitations, install portable filtration and air cleaning devices such as UVGI (Ultraviolet Germicidal Irradiation), especially if seniors or anyone with other health issues or compromised immune systems may be located, or, in mission critical areas where required.
- Consider adding air treatment and cleaning devices such as. UVGI (ultraviolet germicidal irradiation) in duct, plenums and air handling units and on the face of cooling coils. See "Filtration and Disinfection" section below.
- Update or replace existing HVAC air filtration to a minimum of MERV 13 (MERV 14 preferred) or the highest compatible with the filter rack, and seal edges of the filter to limit bypass. Make sure the air handling systems and fans can overcome the additional pressure drop of the new filters and still maintain air flow at acceptable levels.
- Cooling coils, heating coils, condensate drain pans, and humidifiers inside air handling equipment can become contaminated. Therefore, consider adding UVGI for coil surface and drain pan disinfection are encouraged as it will reduce the needs and frequency for in-person coil surface disinfection.

Recommendations for Specific Space Types

- **Conference Rooms and Classrooms** - Keep doors to be opened to promote good ventilation where possible. If doors must be closed, consider local air filtration and cleaning devices and appliances such as portable air filters, or provide local exhaust fans discharging directly to the outside to improve ventilation.
- **Pantries/Storage Rooms** - Provide local exhaust, or portable air filtration and cleaning appliances, especially if refrigerators, or similar appliances, are presented.
- **Large Assembly Spaces** - Where there can be a large assembly of people, consider air treatment, e.g. upper-room UVGI lamps.

Temporary or Special Exhaust Systems

- Consider installing temporary and special exhaust systems if there are rooms that may accommodate infected people or have the opportunity generate and entrain harmful particulates in the air. Particulates or aerosols should be captured and filtered or disinfected as close to the source as possible. Particulates can possibly be a means where the virus can adhere to become aerosol.

Source: "ASHRAE Technical Resources: COVID-19 (Coronavirus) Preparedness Resources"
https://www.ashrae.org/technical-resources/resources

ASHRAE FILTRATION AND DISINFECTION - BEST PRACTICES SUMMARY

A full list of Best Practices for Filtration and Disinfection can be found on ASHRAE's website (https://www.ashrae.org/technical-resources/resources). The following is a summary of Best Practices for that we feel are the most applicable to our customers' buildings.

Mechanical Air Filters

- Consist of media with porous structures of fibers or stretched membrane material to remove particles from airstreams.
- Some filters have a static electrical charge applied to the media to increase particle removal.
- The fraction of particles removed from air passing through a filter is termed "filter efficiency" and is provided by the Minimum Efficiency Reporting Value (MERV) under standard conditions.
    - MERV ranges from 1 to 16; higher MERV = higher efficiency
    - MERV ≥13 (or ISO equivalent) are efficient at capturing airborne viruses
    - MERV 14 (or ISO equivalent) filters are preferred
- Generally, particles with an aerodynamic diameter around 0.3 µm are most penetrating; efficiency increases above and below this particle size.
- Overall effectiveness of reducing particle concentrations depends on several factors:
    - Filter efficiency
    - Airflow rate through the filter
    - Size of the particles
    - Location of the filter in the HVAC system or room air cleaner

HEPA Filters

- By definition, HEPA filters are at least 99.97% efficient at filtering 0.3 µm particles in standard tests.
- Efficiency is better than MERV 16.
- Filters are often delicate and require careful handling to preserve performance.
- HEPA filters can be located in HVAC systems or in:
    - Portable HEPA Machines
    - Pre-Assembled Systems
    - Ad Hoc Assemblies

Ultraviolet Energy (UV-C)

- Ultraviolet energy inactivates viral, bacterial, and fungal organisms so they are unable to replicate and potentially cause disease.
- The entire UV spectrum is capable of inactivating microorganisms, but UV-C energy (wavelengths of 100 – 280 nm) provides the most germicidal effect, with 265 nm being the optimum wavelength.
- The majority of modern UVGI lamps create UV-C energy with an electrical discharge through a low-pressure gas (including mercury vapor) enclosed in a quartz tube, similar to fluorescent lamps.
- Roughly 95% of the energy produced by these lamps is radiated at a near-optimal wavelength of 253.7 nm.
- UV-C light-emitting diodes (LEDs) are emerging for use.
- Types of disinfection systems using UV-C energy:
    - In-duct air disinfection
    - Upper-air disinfection
    - In-duct surface disinfection
    - Portable room decontamination
- Requires special PPE to prevent damage to eyes and/or skin from overexposure.

UV-C In Duct Air Disinfection

- Banks of UV-Lamps installed inside HVAC systems or associated ductwork.
- Requires high UV doses to inactivate microorganisms on-the-fly as they pass through the irradiated zone due to limited exposure time.
    - Systems typically designed for 500 fpm moving airstream.
    - Minimum irradiance zone of two feet
    - Minimum UV exposure time of 0.25 second.
- Should always be coupled with mechanical filtration.
    - MERV 8 filter for dust control
    - Highest practical MERV filter recommended
    - Enhanced overall air cleaning with increased filter efficiency

UV-C Upper-Air Disinfection

- UV fixtures mounted in occupied spaces at heights of 7 feet and above.
- Consider when:
    - No mechanical ventilation
    - Limited mechanical ventilation
    - Congregate settings and other high-risk areas
    - Economics/other
- Requires low UV-reflectivity of walls and ceilings
- Ventilation should maximize air mixing
- Use supplemental fans where ventilation is insufficient

UV-C In-Duct Surface Disinfection

- Banks of UV-Lamps installed inside HVAC systems, generally focused on:
    - Cooling coils
    - Drain pans
    - Other wetted surfaces
- UV irradiance can be lower than in-duct air disinfection systems due to long exposure times.
- Even distribution of UV energy across the coil face
- Generally, 12 to 36 inches from the coil face
- Operated 24/7

Chemical Disinfectants

- EPA reviews and registers antimicrobial pesticides, which include disinfectants for use on pathogens like SARS-CoV-2
- Carefully read product labels and use as directed.
- Most products have a required contact or dwell time, which is the amount of time a surface must remain wet to kill a certain pathogen.
- Applying a product in a way that does not align with its intended use may render the product less effective.
- Products on EPA List N have not been tested specifically against SARS-CoV-2, however the EPA expects them to kill the virus because they:
    - Demonstrate effectiveness against a harder-to-kill virus; or
    - Demonstrate efficacy against another type of human coronavirus similar to SARS-CoV-2.
- All surface disinfectants on List N can be used to kill viruses on surfaces such as counters and doorknobs.

- Because SARS-CoV-2 is a new virus, this pathogen is not yet readily available for use in commercial laboratory testing of disinfectant product effectiveness at killing that specific virus.

Source: "ASHRAE Technical Resources: COVID-19 (Coronavirus) Preparedness Resources"
https://www.ashrae.org/technical-resources/resources

CHECKLIST – BEFORE STUDENTS RETURN

A full list of Best Practices for School Buildings can be found on ASHRAE's website (https://www.ashrae.org/technical-resources/resources). The following is a checklist developed by ASHRAE that can be used to prepare for the return of students to a school building.

IAQ ITEM	*NOTES*
Create a Health and Safety Committee that includes all stakeholders, parents.	
Seek out any IAQ complaints. Create a system to log complaints.	
Search for leaks and/or mold problems. Check around each space for musty smells. Check all the lavatories and sinks for correct operation.	If smells occur, ventilate the space with as much air as possible, find the source, and remove it.
Measure temperature and relative humidity (RH) in every space.	Any temperature and RH measuring device can be used as long as it is in good working order and is used consistently. Be careful of RH meters.
Inspect every HVAC filter visually. Replace with MERV 14 if possible (check for air pressure drop capability of the fan)	Record air pressure drop if available, but always visually inspect filter for clogging.
Measure total and outdoor airflow from each air handler. Measure total airflow into each space. Record airflow to each space. Enable full economizer and disable demand control ventilation.	Modify controls to maximize outdoor air flow but check the heating and cooling capacity of the unit. Use floor standing fan/filter units if necessary, for comfort.

ADDITIONAL RESOURCES

The summary of HVAC Best Practices above is taken primarily from ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers). ASHRAE has created a website for COVID-19 (Coronavirus) Preparedness Resources. This site includes helpful resources such as the "ASHRAE Position Document on Infectious Aerosols" and ASHRAE Epidemic Task Force presentations on Filtration & Disinfection, Commercial Building, School Buildings, Healthcare Buildings, and Residential Buildings.

https://www.ashrae.org/technical-resources/resources

CONCLUSION

The HVAC systems in most non-medical buildings, including schools, play only a small role in infectious disease transmission, including COVID-19. However, ventilation and filtration provided by HVAC system can reduce the airborne concentration of SARS-CoV-2 and thus the risk of transmission through the air. The HVAC system adjustments and upgrades outlined in this document may help to reduce the transmission rate of SARS-CoV-2 in your building.

If you have specific questions about how these HVAC Best Practices can be applied to your facility, please reach out to your Geauga Mechanical Service Account Manager. We are here to help!

Sincerely,

Craig Berman
Chief Executive Officer
Geauga Mechanical Company