OHIO FACILITIES CONSTRUCTION COMMISSION

Ohio Schools and SARS-CoV-2: A Summary of HVAC and Plumbing Industry Guidelines

As school buildings are prepared for reopening, facility staff and administrators may be seeking guidance on actions that should be taken to ensure a safe, healthy environment for occupants. While HVAC plays a role in ensuring indoor air quality, the main mode of transmission for SARS-CoV-2 is through respiratory droplets released by talking, coughing, sneezing, and hand transmission by contaminated surfaces. The primary action taken by schools should be to implement physical distancing, hand hygiene, respiratory etiquette, face coverings, and cleaning and disinfection procedures.

While there is evidence to suggest airborne transmission of infectious aerosols is possible, the risk level of transmitting SARS-CoV-2 through ventilation system ducts is rated as low. This document summarizes the best-practice guidelines for preparing HVAC systems for operation during the SARS-CoV-2 pandemic and for preparing inactive plumbing systems for use by occupants. A high-level list of key actions is below, and each item is described in greater detail in the Summary of Guidelines section.

- Inspect and perform maintenance on HVAC system and equipment.
- Flush all toilets, water taps, and showers prior to occupancy. Ensure all floor drains and u-traps have functioning water seals and are not dry.
- Ensure ventilation system is functioning properly and providing the design level of outside airflow (If design parameters are not available, consult with a professional engineer and use the Ohio Mechanical Code and ASHRAE standard 62.1 or 62.2 to determine the required ventilation rates).
- Implement daily building air flushing procedure by operating HVAC in occupied mode two hours prior to and two hours after occupancy and allowing restroom exhaust to operate 24/7.
- Inspect existing air filtration, upgrade to MERV 13 or 14 if possible.
- Implement monitoring of space temperature, humidity, and CO_2 to help identify indoor air quality issues.
- Consult with a professional engineer on options for system modifications if outside airflow and air filtration are not adequate.

Summary of Guidelines

1. Reopening after Prolonged Shutdown

The first step for building operators is to formulate a plan for re-starting the HVAC system after a prolonged shutdown. There are two checklists at the end of this document that building operators can use to assist in their building start-up procedures. All aspects of the HVAC system should be inspected to ensure that equipment is functioning properly and will be able to meet the heating, cooling, and ventilation requirements.

It is recommended to maintain space temperature between 68°F-78°F and space relative humidity between 40%-60%. Maintaining appropriate temperature, humidity, and ventilation is the first step to ensuring a healthy environment with good indoor air quality. One week prior to occupancy, HVAC systems should be operated in “occupied” mode with outside air dampers open to “flush” the building. When students return to school, the flushing procedure should be repeated daily by allowing the HVAC system to operate in “occupied” mode two hours prior to and two hours after occupancy. Restroom exhaust fans should be set to operate 24/7.

An inspection and flushing of the domestic water system should be performed before the building reopens to prevent any outbreak of waterborne bacteria such as Legionella. All cold water fixtures should be opened simultaneously and flushed for a minimum period of 5 minutes. All hot water fixtures should be opened simultaneously and flushed for a minimum period of 15 minutes. If possible, the temperature of the water at the hot water fixtures should be 120°F during flushing.

It is recommended to maintain the domestic hot water storage temperature at 140°F to prevent bacteria growth, however, mixing valves must be in place to limit the temperature at the service fixtures to the maximum allowed by code to prevent scalding. After flushing is complete, building operators should ensure that mixing valve settings are returned to their original settings. Ohio Plumbing Code section 607.1.2 currently requires water supply to be limited to a maximum of 110°F.

Water-based cooling towers should also be cleaned and disinfected before use to remove any debris or biofilm. The cooling tower should be flushed, treated, and tested to ensure water parameters meet requirements for operation. All floor drains and U-traps should be inspected and filled if the water seal is dry to maintain good indoor air quality and prevent transmission of aerosols through sewer lines. Building operators should refer to the CDC “Guidance for Reopening Buildings After Prolonged Shutdown” and the Ohio EPA “Guidance for Premise Water Service Restoration” for additional measures to ensure the safety of water systems.

2. Ventilation

The most important role of HVAC in mitigating the spread of SARS-CoV-2 is providing adequate levels of fresh outside air to the occupied spaces. The transmission of aerosols has been shown to increase when a space has poor ventilation and be nearly eliminated when the air change rate is sufficiently high. Facility maintenance staff should inspect all systems that provide outside air to the buildings. This includes ensuring that outside air dampers open and modulate properly, air-handling units (AHU) have functioning supply fans, and ductwork and supply diffusers are free of any blockage.

If the AHUs include outside airflow monitoring, the sensors should be calibrated by a qualified Testing and Balancing (TAB) contractor. Outside airflow setpoints, if adjustable, should be set to the values listed on the engineering drawings. If there is no airflow monitoring, the outside airflow should be measured by a TAB contractor and the outside air damper setpoints should be set to provide the design level of outside air.

Some HVAC systems may have control sequences which modulate the outside airflow based on duct or space CO_2 sensors, known as demand-controlled ventilation (DCV). The outside airflow setpoints for DCV should match the values listed on the engineering drawings and the CO_2 setpoints should be set to 800 ppm minimum and 1000 ppm maximum. Building operators may also choose to temporarily disable DCV to allow the system to run at design ventilation regardless of occupancy.

Outside airflow setpoints should not be set above the design values listed on the engineering drawings. The outside airflow is an important factor in determining the heating and cooling capacity of an AHU; thermal comfort and humidity issues will result if the design outside airflow is exceeded. If design parameters are not available, consult with a professional engineer and consult the Ohio Mechanical Code and ASHRAE standard 62.1 or 62.2 to determine the required ventilation rates.

3. Air Quality Monitoring

Building operators should implement monitoring and trending of space temperature, humidity, and CO_2 to identify air quality issues quickly. This is best accomplished by using a building automation system (BAS) however a manual review of handheld or wall mounted sensors can be completed if the space is not tied to a BAS. Temperature, humidity, and CO_2 should be monitored in the occupied space.

If the HVAC system uses sensors mounted in the ductwork, consider adding zone level sensors, especially if the sensors are in central return or supply ductwork that serves multiple spaces. CO_2 sensors are the best indicator of whether adequate ventilation is being supplied. An alarm sequence for space CO_2 should be set up to provide a warning at 800 ppm and an alarm at 1000 ppm that triggers action to resolve the issue and achieve sufficient ventilation.

4. Air Filtration

After ensuring adequate levels of ventilation are maintained, the filtration in AHUs should be investigated. Air filters with a minimum efficiency reporting value (MERV) greater than or equal to 13 are efficient at capturing airborne viruses. MERV 13 is a recommended minimum filter level, and MERV 14 filters are preferred. Building staff should create a list of equipment identifying the MERV rating, filter dimensions, filter rack depth, quantity of filters, unit design airflow and type of motor and VFD installed to assist in identifying opportunities to upgrade the filtration.

The ability for an AHU to support higher efficiency filters depends on whether the unit can meet the required airflow, heating, and cooling requirements when the additional pressure drop of a more efficient filter is added to the system. If existing AHUs do not currently have MERV 13 filters or better, consult with a licensed professional before upgrading the filtration to determine if the existing equipment can handle more efficient filters.

During a local outbreak, air filters may capture particles contaminated with SARS-CoV-2. Gloves and masks should be worn by maintenance staff when changing filters, and filters should be placed in sealed bags for disposal to avoid spreading the virus.

If the design level of outside airflow cannot be achieved or if air filtration cannot be upgraded to at least MERV 13, building operators should consult with a licensed professional to determine a solution. The options that may be explored could include increasing or adding supplemental heating and cooling capacity to increase outside air supply, changing fans and motors to allow greater pressure drop with higher efficiency filters, or air treatment methods such as in-room portable HEPA filter units, duct-mounted UV/C lamps (ultraviolet) and bi-polar ionization.

UV/C lamps and bi-polar ionization are both air treatment technologies that can be installed in duct systems to neutralize infectious aerosols in the air stream. Ions released by a bi-polar ionization system can also bond to particles in the air, allowing them to be more easily captured in an air filter. The design or selection of a UV/C or bi-polar ionization system should be completed by a professional engineer to ensure that the system will be effective.

Conclusion

Proper maintenance and operation of HVAC and plumbing systems should be primary components of any plan to reopen schools. Building operators should ensure all repairs and preventative maintenance have been performed, plumbing and air systems have been flushed prior to occupancy, verify that ventilation systems are functioning properly and providing the design level of outside air, inspect air filters and upgrade filtration if possible, and set up monitoring of space temperature, humidity and CO_2.

After the HVAC system is functioning properly and providing design ventilation, building operators may choose to consult with a professional engineer to explore additional options to improve indoor air quality.

Principal author: Daniel Nigon-Kirgis, PE
Peer reviewed by the OFCC Energy Program Team
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[11] Cooling Tower Institute Resources (also refer to “Building Readiness” [2] above)
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ASHRAE Checklist No. 1: Summer Checklist for Fall Start of Classes				
Item No.	**Task**	**Date Checked**	**Corrective Action Required?**	**Date Corrective Action Performed**
1	Review diffusers, return grilles, exhaust grilles and air registers to confirm no blockage and adequate airflow.			
2	Review existing Indoor Air Quality issues, if any, and record status of issue and identify corrective action.			
3	Inspect all spaces for any water leaks or mold growth.			
4	Check all lavatories and sinks to confirm proper operation and ensure soap dispensers are full and functional.			
5	Coordinate with local utilities to identify when buildings will be restarted and identify demands that may increase.			
6	Clean and disinfect building surfaces, focusing on high touch services.			
7	Review HVAC systems and building control sequences to verify systems are operating to maintain required ventilation, temperature, and humidity conditions.			

ASHRAE Checklist No. 2: Startup Checklist for HVAC Systems Prior to Occupancy				
Item No.	**Task**	**Date Checked**	**Corrective Action Required?**	**Date Corrective Action Performed**
1	Adjust BAS setpoints to maintain an indoor temperature range of 68°F-78°F and indoor humidity 40%-60% RH. Consider consulting with a professional engineer to determine the appropriate temperature and humidity levels based on local climate, type of construction, age of building and space use.			
2	Set up trend data in the BAS to monitor space temperature, humidity, and CO_2. Implement BAS alarms to notify building operators when temperature, humidity, and CO_2 are outside the limits.			
3	Verify proper separation between outdoor intakes and exhaust discharge outlets to prevent/limit re-entrainment of exhaust air (generally minimum 10 ft separation required - check local code)			
4	Consider measurement and balancing of airflows and building pressurization by a qualified Testing, Adjusting and Balancing (TAB) contractor.			
5	Consider having airflows and system capacities reviewed by design professionals to determine if additional ventilation can be provided without adversely impacting equipment performance and building indoor air quality.			
6	Maintain positive building pressure relative to the outdoors through space pressure setpoints on the BAS and/or ensuring that system airflows are set to design levels.			
7	Verify that air handling unit and terminal unit airflow setpoints and discharge air temperature setpoints are set to the design values.			
8	Review outdoor airflow rates and ensure they are set to the design values.			

Item No.	Task	Date Checked	Corrective Action Required?	Date Corrective Action Performed
9	Verify that all filters are installed correctly.			
10	Develop standards for frequency of filter replacement and type of filters to be utilized.			
11	Select filtration levels (MERV ratings) that are maximized for equipment capabilities. Use MERV 13 filters as a minimum final filter level if equipment allows, while assuring the pressure drop is less than the unit fan capacity.			
12	If the air systems use CO2 sensors to adjust outside air levels (demand-controlled ventilation), set CO2 concentration setpoints to 800 ppm -1000 ppm.			
13	Trend and monitor CO2 and outside airflow if possible.			
14	Consider operating at the maximum design outside air setpoint or disabling demand-controlled ventilation if it will not adversely impact operation of overall system.			
15	Verify that outside air dampers are functioning properly.			
16	Operate all mechanical systems in occupied mode for a minimum of one week prior to students returning.			
17	Domestic cold water flush: Open all fixtures on each branch of piping simultaneously for a minimum period of 5 minutes. If possible, all building fixtures should be open at the same time, otherwise ensure flow rate is adequate to flush piping mains and branch lines.			
18	Domestic hot water flush: Open all fixtures on each branch of piping simultaneously for a minimum period of 15 minutes. If possible, all building fixtures should be open at the same time, otherwise ensure flow rate is adequate to flush piping mains and branch lines.			