Nashoba Regional Schools
Nashoba Regional High School
Bolton, MA

2020

HVAC System Evaluation

Prepared For:

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August 28, 2020

HVAC SYSTEM EVALUATION

General

Nashoba Regional School District engaged BLW Engineers to evaluate the Nashoba Regional High School HVAC system relative to its current operating conditions, re-opening to the building to the public and potential considerations relative to COVID-19. BLW performed a site visit as well as reviewed the original construction documents and supporting building documentation provided by the Nashoba Regional School District.

Nashoba Regional High School is located at 12 Green Road in Bolton. The school comprises approximately 194,000 square feet of educational space with an enrollment of approximately 950 students. The building was originally constructed in 1961, underwent a major addition in 1971 and then a renovation and addition in 1999. Most of the HVAC systems and equipment were replaced during the 1999 project.

Nashoba Regional High School Planned Reopening

The Nashoba Regional School District plans on the following school re-opening for the High School:

- School is to be occupied by about 30 special education students and teachers in the hybrid model with 50% occupation Monday/Tuesday; Wednesday disinfection/cleaning; 50% occupation Thursday/Friday; Saturday disinfection/cleaning.
- Classrooms seating will be reorganized to provide recommended social distancing.
- Cafeteria will not be used in normal fashion; students will eat lunches at their desk.
- Gym will not be used in normal fashion.
- Library and Auditorium will not be used in normal fashion; they will be used primarily as classroom space.

Recommendations

Based on applicable guidelines (ASHRAE, State of Massachusetts Re-opening Guidelines, Massachusetts Teachers Association, etc.), the Nashoba Regional High School should consider the following best practice operation of the current HVAC system in an effort to provide an environment to best protect the occupants and visitors to the building during the pandemic:

Tier 1 Recommendations:

1. Create an "Epidemic Mode" Building Management System sequence of operation that can be turned on, shut down or override, if needed, by manual selection of the operator.
2. Replace the unit filters with the best filters available that will not impact the heating capacity of the units and develop a filter replacement plan; the existing rooftop units and air handling units will not be able to accommodate MERV13 filters without significantly impacting system operation, outdoor air delivery to the space and equipment component failures.
3. Filter upgrades will require more frequent changes due to pressure drop of filter and particulates that “dirty” the filters.
4. Continued operation of heating and cooling systems is recommended.

5. Operate toilet exhaust fans 24 hours a day, 7 days a week.; other fans shall operate two hours prior and two hours post occupied hours.
6. Monitor Carbon Dioxide (CO_2) levels in occupied areas of the building.
7. Provide warning signs and consider diverting or rearranging the exhaust air discharge locations so that they would pose no opportunity to cause harm.
8. Operate the building in occupied mode with mechanical ventilation prior and two hours post occupied hours; where mechanical ventilation and exhaust are not currently provided, utilize operable windows.
9. Operate the building in the occupied mode during disinfection and cleaning operations.
10. Operate building air handling equipment with highest percentage of outdoor air possible without adversely affecting the occupied environment; outdoor air percentage will be dependent on outdoor air temperature and allowable indoor air temperatures above/below normal operation.
11. Based on reduced classroom sizes, the classroom current system can provide significantly more ventilation per occupant which exceeds current code requirements (10 CFM per occupant plus 0.12 CFM/SF) and can be supplemented by operable windows.
12. At the commencement of school and until the heating season and when outdoor air temperature conditions allow, the Library and Administration rooftop units can be operated with recirculated air can be run in the "economizer mode" with 100% outdoor air and no recirculation.
13. Reset discharge air setpoint as high as possible for variable air volume systems to encourage variable air volume dampers to maximized outdoor air into the building.
14. Disable any CO_2 demand control ventilation sequences of operation and occupancy setback controls; operate units at maximum outdoor air capacity.
15. Eliminate outdoor air to zones that are not occupied to better use in occupied areas.
16. Relocate occupants from areas that do not have mechanical ventilation or operable windows.
17. Use operable windows when outdoor air conditions allow.
18. Keep conference room doors open as much as possible or open windows when feasible.
19. Increase regular maintenance of all mechanical heating, ventilating and air conditioning equipment.
20. Monitor the heating, ventilating and air conditioning operation of the building on a continual basis.
21. Follow recommendations of holistic view of building recommendations in General Recommendations.

Tier 2 Recommendations:

1. Provide additional filtration with portable HEPA filter units or UV filtration units for areas that might have multiple occupants served by units that utilize recirculated air.
2. Install portable humidifiers or retrofit existing heating/ventilating equipment with humidifiers for local humidity control.
3. Add plug-in type supplemental electric heat as required for increased ventilation requirements.
4. Apply and use outdoor air quality sensors or reliable web-based data for outdoor pollution information as part of the new ventilation operation.
5. Consider UV decontamination lights on highly touched surfaces.

Notes:

1. These recommendations are based on guidance provided by applicable agencies and publications for best practices for protection of occupants and visitors to the building but do not provide absolute protection from the pandemic.
2. These recommendations will have a significant impact on the operating and maintenance related costs of the HVAC systems.

HVAC SYSTEM EVALUATION

Existing Conditions

The majority of the building heating is provided through a hydronic system consisting of a two-pipe distribution that is fed from two cast-iron, oil-fired, non-condensing boilers (3,800 MBH each) and variable speed circulation pumps located in the Boiler Room on the first floor. The distribution piping supplies hot water to indoor air handling units (AHU), perimeter zone variable air volume (VAV) terminal units with reheat coils, unit heaters (UH) and various smaller convective heaters throughout the building. Portions of the building are served by the multi-zone, variable flow AHU's with VAV's zoned to serve groups of classrooms or smaller rooms by type and exposure. Larger spaces within the building are served by dedicated AHU's and exhaust systems. The typical AHU consists of a variable speed supply fan, a hot water heating coil, a direct expansion (DX) cooling coil, a variable speed return/exhaust fan, face-bypass damper, filter-mixing box and a corresponding air-cooled condensing unit. Several of the air handling units which serve multiple zones and classrooms include an energy recovery section with enthalpy wheel.

The air handling units AHU-1 and AHU-2 are located in a large Mechanical room on the lower level of the 1971 addition, with corresponding air-cooled condensing units located on the roof. The two units provide ventilation and conditioned supply air through a system of supply and return distribution ductwork to variable air volume terminal units serving the classrooms, lab rooms, offices and corridors on the two stories above. The ventilation air is drawn from a common louver and plenum, is pre-conditioned by the exhaust air through the enthalpy wheel, filtered and then heated or conditioned for supply to the building. The unit supply air set points are established by the control programming to satisfy cooling demand in the worst-case zone on each system, with final tempering of the air being controlled by the individual VAV units. The VAV units modulate supply air flow and where provided the hot water flow through integral reheat coils to maintain zone temperatures based on local thermostat/sensors. Exhaust air is similarly discharged through a common louver in the exterior wall on the rear of the building. The AHU supply fans modulate speed to maintain a constant duct static pressure with the return/exhaust fans tracking the supply fans to maintain positive pressurization of the building. Face and bypass dampers modulate airflows across the coils to optimize unit operation and energy consumption (economizer). The design documents indicate that AHU-1 is a 100% outdoor air unit with a maximum supply air flow of 14,200 CFM and a maximum exhaust air flow of 11,900 CFM. This unit was designed with capacity for 462 MBH of heating and 491 MBH of total cooling, with 30% efficient filters (MERV8). AHU-2 is also a 100% outdoor air unit with a maximum supply air flow of 11,000 CFM and a maximum exhaust air flow of 10,100 CFM. This unit was designed with capacity for 358 MBH of heating and 363 MBH of total cooling, with MERV 8 filters (~30% efficiency). New filters have recently been installed on these units as well as the energy recovery sections and are reported to be MERV 10 (~50% efficiency).

The air handling units AHU-3, AHU-4, AHU-5 and AHU-6 are located in an attic Mechanical room above a portion of the original 1960 construction, with corresponding air-cooled condensing units located on the neighboring, flat roof. The four units provide ventilation and conditioned supply air through a system of supply and return distribution ductwork to variable air volume terminal units serving the classrooms, offices and corridors on the two stories below. The ventilation air is drawn from two common, louvered hoods on the pitched roof, is pre-conditioned by the exhaust air through the enthalpy wheel, filtered and then heated or conditioned for supply to the building. The unit supply air set points are established by the control programming to satisfy cooling demand in the worst-case zone on each system, with final tempering of the air being controlled by the individual VAV units. The VAV units modulate supply air flow to maintain zone temperatures based on local thermostat/sensors. Exhaust air is discharged through two common, louvered hoods on the roof. The AHU supply fans modulate speed to maintain a constant duct static pressure with the return/exhaust fans tracking the supply fans to maintain positive pressurization of the building. Face and bypass dampers modulate airflows across the coils to optimize unit operation and energy consumption (economizer). The design documents indicate that AHU-3 is a 100% outdoor air unit with a maximum supply air flow of 8,400 CFM and a maximum exhaust air flow of 7,600 CFM. This unit was designed with capacity for 274 MBH of heating and 285 MBH of total cooling, with 30% efficient filters (MERV8). AHU-4 is also a 100% outdoor air unit with a maximum supply air flow of 5,500 CFM and a maximum exhaust air flow of 4,900 CFM. This unit was designed with capacity for 179 MBH of heating and 170 MBH of total cooling, with MERV 8 filters (~30% efficiency). AHU-5 is also a 100% outdoor air unit with a maximum supply air flow of 6,400 CFM and a maximum exhaust air flow of 6,100 CFM. This unit was designed with capacity for 209 MBH of heating and 214 MBH of total cooling, with MERV 8 filters (~30% efficiency). AHU-6 is also a 100% outdoor air unit with a maximum supply air flow of 5,600 CFM and a maximum exhaust air flow of 4,100 CFM. This unit was designed with capacity for 153 MBH of heating and 174 MBH of total cooling, with MERV 8 filters (~30% efficiency). New filters have recently been installed on these units as well as the energy recovery sections and are reported to be MERV 10 (~50% efficiency).

The air handling units AHU-7, AHU-8 and AHU-10 are located in a Mechanical room above the cafeteria, with corresponding air-cooled condensing units located on the neighboring, flat roof. AHU-7 provides ventilation and conditioned supply air through a system of supply and return distribution ductwork to variable air volume terminal units serving the administration offices, meeting rooms and corridors on the two stories below. The unit supply air set points are established by the control programming to satisfy cooling demand in the worst-case zone on the system, with final tempering of the air being controlled by the individual VAV units. The VAV units modulate supply air flow and hot water flow through integral reheat coils to maintain zone temperatures based on local thermostat/sensors. AHU-8 provides ventilation and tempered supply air through a system of supply and return distribution ductwork to the old Gymnasium. The unit is heating only, draws ventilation air from a common wall louver through ductwork to the unit where it mixes with return air from the space, is filtered and then heated for supply to the building. Excess return air or exhaust air is discharged through a louvered hood on the roof. The supply fan and return/exhaust fans have single, constant speed motors which operate at a set differential to maintain space pressurization. Face and bypass dampers modulate airflows across the heating coil to optimize unit operation and energy consumption (economizer). AHU-10 provides ventilation and conditioned supply air through a system of supply and return distribution ductwork to the cafeteria and to office services areas on the first floor. The unit draw ventilation air from a common louver and plenum, through ductwork where it mixes with return air from the corresponding spaces served, is filtered and then heated or conditioned for supply to the building. Excess return air or exhaust air is discharged through ductwork from the unit to a louvered roof hood. The AHU-7 supply fan modulates speed to maintain a constant duct static pressure with the return/exhaust fan tracking the supply fan to maintain positive pressurization of the building. The AHU-8 and AHU-10 supply and exhaust/return fans have single, constant speed motors. Face and bypass dampers modulate airflows across the coils to optimize unit operation and energy consumption (economizer). The design documents indicate that AHU-7 is 25% outdoor air with a maximum supply air flow of 8,000 CFM, corresponding maximum ventilation air flow of 2,000 CFM and a maximum return air flow of 7,200 CFM. This unit was designed with capacity for 86.4 MBH of heating and 242 MBH of total cooling, with 30% efficient filters (MERV8). AHU-8 is 25% outdoor air with a maximum supply air flow of 9,100 CFM, corresponding maximum ventilation air flow of 2,275 CFM and maximum return air flow of 9,000 CFM. This unit was designed with capacity for 345.4 MBH of heating and 30% efficient filters (MERV8). AHU-10 is 58% outdoor air with a maximum supply air flow of 8,300 CFM, corresponding maximum ventilation air flow of 4,800 CFM and a maximum return air flow of 7,500 CFM. This unit was designed with capacity for 495.1 MBH of heating and 359.2 MBH of total cooling, with MERV 8 filters (~30% efficiency). New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency).

The air handling unit AHU-9 is located in a Mechanical room beside the Kitchen area, providing ventilation and tempered supply air through a system of supply distribution ductwork to the Kitchen. The unit is heating only, draws ventilation air from a louvered hood on the roof above through ductwork to the unit where it is filtered and then heated for supply to the building. The supply fan has a single, constant speed motor which is interlocked with and only energizes with the companion kitchen hood exhaust fan. Face and bypass dampers modulate airflows across the heating coil to optimize unit operation and energy consumption (economizer). The design documents indicate that AHU-9 is 100% outdoor air with a maximum supply air flow of 9,100 CFM. This unit was designed with capacity for 720 MBH of heating and 30% efficient filters (MERV8). New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency).

The air handling unit AHU-11 is located in a Mechanical room on the first floor with associated air-cooled condensing unit on the roof above, providing ventilation and conditioned supply air through a system of supply and return distribution ductwork to the printing and service areas on the first floor. The unit draws ventilation air from a wall louver, through ductwork to the unit where it mixes with return air from the corresponding spaces served, is filtered and then heated or conditioned for supply to the building. Excess return air or exhaust air is discharged through ductwork from each unit to a louvered roof hood. The AHU-11 supply fan modulates speed to maintain positive pressurization of the building. Face and bypass dampers modulate airflows across the coils to optimize unit operation and energy consumption (economizer). The design documents indicate that AHU-11 is 56% outdoor air with a maximum supply air flow of 1,800 CFM, corresponding maximum ventilation air flow of 1,000 CFM and a maximum exhaust air flow of 940 CFM. This unit was designed with capacity for 139 MBH of heating and 71.8 MBH of total cooling, with MERV 8 filters (~30% efficiency). New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency).

The air handling units AHU-13 and AHU-12 are located in a Mechanical room between the Wood Shop and the Metal Shop, with a corresponding air-cooled condensing unit for AHU-12 located on the roof. AHU-13 is heating only, providing ventilation and tempered supply air through a system of supply and return distribution ductwork to the Wood Shop. The ventilation air is drawn from a louvered roof hood through ductwork to the unit where it mixes with return air from the space, is filtered and then heated for supply to the space. AHU-12 provides ventilation and conditioned supply air through a system of supply and return distribution ductwork to the Metal Shop. The ventilation air is drawn from a wall louver and plenum through ductwork to the unit where it mixes with return air from the space, is filtered and then heated or conditioned for supply to the space. Exhaust air is discharged through the roof by exhaust fans serving each space separately. The AHU supply fans have single speed motors set to maintain constant air flow. Face and bypass dampers modulate airflows across the coils to optimize unit operation and energy consumption (economizer). The design documents indicate that AHU-13 is 50% outdoor air unit with a maximum supply air flow of 2,400 CFM, corresponding maximum ventilation air flow of 1,200 CFM and a maximum exhaust air flow of 2,000 CFM. This unit was designed with capacity for 260 MBH of heating and with 30% efficient filters (MERV8). AHU-12 is a 50% outdoor air unit with a maximum supply air flow of 2,000 CFM, corresponding maximum ventilation air flow of 1,000 CFM and a maximum exhaust air flow of 2,000 CFM. This unit was designed with capacity for 139 MBH of heating and 71.8 MBH of total cooling, with MERV 8 filters (~30% efficiency). New filters have recently been installed on these units are reported to be MERV 10 (~50% efficiency).

The air handling units AHU-14, AHU-15 and AHU-16 are located in a Mechanical mezzanine over the Auditorium, with corresponding air-cooled condensing units located on the roof above. AHU-15 provides ventilation and conditioned supply air through a system of supply and return distribution ductwork to variable air volume terminal units serving the drama classroom, support spaces and lobby on the first floor. The unit supply air set points are established by the control programming to satisfy cooling demand in the worst-case zone on the system, with final tempering of the air being controlled by the individual VAV units. The VAV units modulate supply air flow and hot water flow through integral reheat coils to maintain zone temperatures based on local thermostat/sensors. AHU-14 and AHU-16 provide ventilation and conditioned supply air through a system of supply and return distribution ductwork to the Music Studio and the Auditorium respectively. The three units draw ventilation air from a common louver and plenum, through ductwork to the individual units where it mixes with return air from the corresponding spaces served, is filtered and then heated or conditioned for supply to the building. Excess return air is discharged from each unit through louvered hoods on the roof above. The AHU supply fans modulate speed to maintain a constant duct static pressure with the return/exhaust fans tracking the supply fans to maintain positive pressurization of the building. Face and bypass dampers modulate airflows across the coils to optimize unit operation and energy consumption (economizer). The design documents indicate that AHU-14 is 26% outdoor air with a maximum supply air flow of 3,800 CFM, corresponding maximum ventilation air flow of 1,000 CFM and a maximum return air flow of 3,100 CFM. This unit was designed with capacity for 223 MBH of heating and 154 MBH of total cooling, with 30% efficient filters (MERV8). AHU-15 is 25% outdoor air with a maximum supply air flow of 5,200 CFM, corresponding maximum ventilation air flow of 1,300 CFM and a maximum return air flow of 3,700 CFM. This unit was designed with capacity for 343 MBH of heating and 268 MBH of total cooling, with MERV 8 filters (~30% efficiency). AHU-16 is 20% outdoor air with a maximum supply air flow of 11,400 CFM, corresponding maximum ventilation air flow of 2,250 CFM and a maximum return air flow of 11,000 CFM. This unit was designed with capacity for 1171 MBH of heating and 553 MBH of total cooling, with MERV 8 filters (~30% efficiency). New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency).

The air handling units AHU-17 and AHU-18 are located in a Mechanical room on the lower level below the Gymnasium, providing ventilation and tempered supply air through a system of supply and return distribution ductwork to the Girl's and the Boy's Locker rooms respectively. The units are heating only, relying on transfer air from wall grilles in the Gymnasium for ventilation air drawn through ductwork to the unit where it mixes with return air from the interior corridors, is filtered and then heated for supply to the building. Exhaust air is drawn from the locker rooms through registers and ductwork to dedicated in-line fans within the Mechanical room and discharged through the roof. The supply fans and exhaust fans have single, constant speed motors which operate at a set differential to maintain negative pressurization in the locker rooms. The design documents indicate that AHU-17 is 30% outdoor air with a maximum supply air flow of 3,600 CFM and maximum exhaust air flow of 3,800 CFM. This unit was designed with capacity for 217 MBH of heating and 30% efficient filters (MERV8). AHU-18 is also 30% outdoor air with a maximum supply air flow of 4,200 CFM and maximum exhaust air flow of 4,350 CFM. This unit was designed with capacity for 217 MBH of heating and 30% efficient filters (MERV8). The use of transfer air for ventilation to the locker rooms does not comply with current mechanical code requirements and the arrangement should be corrected to provide a direct connection to the outdoors. New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency).

The air handling units AHU-19 and AHU-20 are suspended below the roof in the Gymnasium, providing ventilation and tempered supply air through a system of supply and return distribution ductwork to the Gymnasium. The units are heating only, drawing ventilation air from louvered hoods on the roof through ductwork to the unit where it mixes with return air from the space, is filtered and then heated for supply to the building. Exhaust air is drawn from the space through registers and ductwork to discharge at roof mounted fans. The supply fans and exhaust fans have single, constant speed motors which operate at a set differential to maintain positive pressurization in the Gymnasium. The design documents indicate that AHU-19 is 60% outdoor air with a maximum supply air flow of 6,500 CFM, corresponding maximum ventilation air flow of 3,900 CFM and maximum exhaust air flow of 2,660 CFM. This unit was designed with capacity for approximately 360 MBH of heating and 30% efficient filters (MERV8). AHU-20 is 60% outdoor air with a maximum supply air flow of 6,500 CFM, corresponding maximum ventilation air flow of 3,400 CFM and maximum exhaust air flow of 2,660 CFM. This unit was designed with capacity for approximately 360 MBH of heating and 30% efficient filters (MERV8. New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency).

Miscellaneous spaces have been provided with hot water terminal equipment interconnected with the hot water distribution piping system. Some small spaces, corridors and offices are provided with dedicated electric heating units.

Bathrooms, Janitor's Closets, Storage, etc. are exhausted through registers and ductwork connected to roof mounted exhaust fans. Bathrooms are provided with hot water heating terminal equipment.

Specialty exhaust systems have been provided for the Science Rooms, Wood Shop, Metal Shop, Printing Room, Art Room/Kiln and Storage.

The building is monitored and operated electronically by a system of direct digital controls (DDC).

Building Ventilation

Supply air flow to individual classrooms varies based on type and size, with a typical classroom size of 750 square feet being supplied with 600 CFM of conditioned ventilation air. The original ventilation design appears to meet current code requirements, which would be 360 CFM for such a classroom size (Ventilation = 10 CFM x 27 Occupants + 0.12 CFM x 750 SF). The typical science lab of 1,200 square feet is supplied with 800 CFM of ventilation while requiring 520 CFM (Ventilation = 10 CFM x 30 Occupants + 0.12 CFM x 1,200 SF). The ventilation air flow to various computer labs and the media center also appear to meet or exceed current code requirements (Ventilation = [10 CFM x 0.025 Occupants/SF + 0.12 CFM] x SF). The air handling units with energy recovery were designed for 30% efficient filters and maintain outdoor air volume to the building during variable air volume operation.

The approximate areas of the Wood shop and the Metal Shop (including associated offices, storage, etc.) are 2,500 SF and 3,000 SF respectively. The supply air flow to these spaces appears to meet current code requirements, with 1,200 CFM and 1,000 CFM of ventilation air provided to the respective shop spaces and separate exhaust systems capable of removing up to 2,000 CFM in each area. (Ventilation = [20 CFM x 0.01 Occupants/SF + 0.18 CFM/SF] x SF), Exhaust = 0.5 CFM x SF).

The supply air flow to the Drama Classroom, Auditorium Lobby, Snack Bar and associated spaces corresponds to a ventilation air flow of 1,200 CFM. The requirements vary by space type and size, but appears to meet current code requirements for the approximate each individual space and a total floor area of 4,500 SF.

The supply air flow to the Music Studio, practice rooms, and associated storage spaces corresponds to a ventilation air flow of 1,000 CFM which appears to meet current code requirements for each individual space and the approximate total floor area of 4,000 SF.

The supply air flow to the Auditorium, Mezzanine and Stage corresponds to a ventilation air flow of 2,250 CFM provides ventilation for approximately 342 students in accordance with current code requirements for the approximate total floor area of 9,000 SF (Ventilation = 5 CFM/Occupants + 0.06 CFM/SF).

The supply air flow and corresponding ventilation air flow to the Gymnasium appears to meet current code requirements corresponding to an approximate floor area of 9,000 SF. The required ventilation air flow varies for the spectator areas and the playing areas, however the indicated design ventilation air flow of 7,800 CFM would be consistent with the space being evenly divided and provides current code ventilation for 500 occupants (Ventilation = 7.5 CFM /Occupant + 0.06 CFM/SF).

The original ventilation air design for the administrative offices and support spaces varies based on type and size. The supply air flow to these spaces corresponds to a ventilation air flow of 2,000 CFM which provides current code ventilation for 256 occupants for the approximate total floor area of 12,000 SF and for the individual typical offices (Ventilation = 5.0 CFM /Occupant + 0.06 CFM/SF).

General Publication Recommendations

Operating commercial office buildings under epidemic conditions requires a holistic framework during the crisis and the restoration to potentially a new “normal” after the public health emergency has ended. Considerations include:

- Review of current operational practices

- Holistic view for owner/operator

Review of current operational practices

- Modes of operation of HVAC systems
  - sequences of operations
  - set points
  - schedules
- Verification that equipment and systems are properly functioning and have the enhanced capabilities to address public health considerations, with a focus building air circulating systems.
- Understanding that infected people who are asymptomatic may enter buildings, increasing the likelihood of the spread of virus through air systems to other occupants.

Holistic view for owner/operator

Owners and operators should take a holistic view of their buildings and:

1. Develop a pandemic preparedness plan
2. Review indoor and outdoor environment
3. Review the space types
4. Operate and maintain HVAC
   - Air-Conditioning and Ventilation systems
   - Exhaust systems
5. Check Elevator Control
6. Check BAS and Access Control Systems

Develop a Pandemic Preparedness Plan

Consider these possible goals:

- Reduce the spread of infection among building occupants,
- Maintain HVAC and Building Service Systems in safe and healthy conditions,
- Minimize impact on building occupants and visitors,
- Communicate risks and precautions being taken with occupants transparently
- Implement measures that help make occupants feel secure:
  - Require occupants, visitors and maintenance personnel to wear appropriate PPE per CDC,
  - Screen, monitor and control the circulation of occupants and guests to help avoid transmission of disease,
  - Increase frequency for surface disinfection on frequently touched surfaces, such as door handles, handrails, door bells and elevator buttons.

Ensure continuity of supply chains and have backup plans.

- Identify your critical suppliers, e.g. filters, cleaners, disinfectants, parts, PPE, etc.,
- Identify vendors who could negatively affect your operation if they fail to deliver,

- Review current service provider agreements to see if alternate suppliers can be engaged in the event of a supply disruption, for example, equipment service providers, and understand contract limitations and restrictions on using alternative providers,
- Ask critical suppliers to share their pandemic plans:
  - What does their plan include?
  - Have they tested their plan? When was it updated?
  - Set boundaries with suppliers – ask that they do not send staff who may be showing signs of illness to your property.

Review contract agreements:

- Review contract agreements: Review contracts with service providers, utilities, and suppliers to determine what rights and remedies they have because of disruptions due to unforeseeable circumstances that prevent fulfillment of a contract.

Establish a communication protocol and continuity of operations plan:

- Identify key contacts and publish normal and emergency contact information,
- Document the chain of command and communication requirements, and provide instructions and outline expectations for how all responses are to be documented and what records shall be maintained and distributed.

Provide staff with:

- PPE per CDC and OSHA requirements,
- Training on the proper use and disposal of PPE and waste,
- Training on infection prevention and control measures,
- Cross training to ensure critical building functions are maintained in an emergency, and
- Instruction to staff to stay at home if they are feeling sick.

Check with insurance providers to determine whether there are special measures that can be taken to preserve coverage or lower premiums.

Next Steps:

1. Notify staff, tenants and visitors about the plan
2. Follow all local, state and federal executive orders, statutes, regulations, guidelines, restrictions and limitations on use, occupancy and separation
3. Follow OSHA Guidelines, especially the portion in the guide regarding filter and outside air.
4. Ensure that custodial staff and service providers job descriptions includes performing proper cleaning procedures based EPA and CDC guidance using approved products and methods:
   - Disinfect high touch areas of HVAC and other Building Service systems such as on/off switches, and thermostats;
   - Consider UV light disinfection devices of high touch counters in public spaces.
   - Disinfect interiors of refrigerated devices, such as refrigerators, coolers and vending machines where the virus can survive for potentially long periods of time.

5. Consider installing a thermal camera at building entrances to help screen visitors for elevated body temperatures. Note that that infected individuals may show no signs of being ill, including having no fever, and can be responsible for much of the transmission. In such cases, thermal imaging may not be effective.
6. Provide MERV13 or higher filters for air handling equipment that recirculate air when equipment has the capacity.
7. The fan powered mixing boxes are physical or capacity limited for better filtration and UV decontamination systems in the return airstream, consider installing 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.
8. Provide automatic hand sanitizer dispensers in the high touch areas and other common areas, including spaces where equipment where frequent maintenance is required, and ensure dispensers are serviced often and remain operational.
9. Post signage in prominent locations that contain information and instructions to educate and remind staff about proper procedures to maintain personal protection while cleaning, replacing filters and moving or using other equipment that maybe contaminated
10. Consider providing antimicrobial door mats at high traffic entrances to the building.
11. Institute additional cleaning procedures to ensure proper disinfection of bathrooms, kitchens and common areas. Educate cleaning and maintenance staff on proper personal protection and PPE use including following OSHA worker exposure guidelines.

Review Indoor and Outdoor Environment

- Maintain dry bulb temperatures within the comfort ranges indicated in ANSI/ASHRAE Standard 55-2017
- Maintain relative humidity between 40% and 60% through the use of the air conditioning systems.

In Cold Climates
i. HVAC systems with no humidification may not achieve the minimum humidity indicated, ii. Observe building assemblies and finishes frequently for condensation when indoor dew points rise above the surface temperatures of the assemblies and finishes, iii. Excessive humidity may lead to condensation, indoor mold growth, and degradation of indoor air quality.

Review the space types

Conference Rooms	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.
Public/Large Assembly Spaces	Where there can be a large assembly of people, consider air treatment, e.g. upper-room UVGI lamps.

Operate and maintain the HVAC system

Building owners and service professionals should follow the requirements of ASHRAE Standard 180-2018, Standard Practice for the Inspection and Maintenance of Commercial HVAC Systems which has tables to show the typical maintenance required for equipment that has been in operation. Consider PPE when maintaining ventilation materials including filters, condensate. Consult additional guidance before duct cleaning. Check specifically:

- Dampers, filter, and economizers seals and frames are intact and clean, are functional and are responding to control signals. MERV13 or higher filters are required for capture of airborne viruses; however, most existing equipment will not be able to support the associated pressure drop of these filters and equipment should be provided with only the highest MERV rating that does not affect the heating and cooling capacity of the units.
- Zone and air temperature are calibrated and accurately reporting environmental conditions to the BAS or local controllers.
- Exhaust fans are functional and venting to the outdoors.
- Check outside air intake regularly for any potential risk such as exhaust nearby and provide proper clearance if assessible by pedestrians, etc.

Operate and maintain the HVAC system – Air conditioning and ventilation systems

- Continued operation of all systems is recommended.
- For offices with fan coil units, open windows 2 hours before and after occupied periods.

Centralized and floor-by-floor Variable Air Volume (VAV) systems: General information

- For central or floor-by-floor 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.

- If there are heating and cooling coils to temper the air, it can provide comfort and eliminate recirculation (in the mild weather seasons this will have smaller impacts to energy consumption, thermal comfort, or humidity control, however, using 100% outside can be more difficult in extreme weather conditions).
- Considerations also should be given in areas with dry outside air that may lower the relative humidity to below 40%.
- Prioritize increasing outside air over humidity (see concerns about operating at indoor humidity outside the range of 40%-60%).

Centralized and floor-by-floor Variable Air Volume (VAV) systems: Floor-by-floor

- In floor-by-floor VAV systems that have only minimum outside air damper positions or openings, open outside air damper to its maximum position (the same cautions and concerns stated above apply).
- If outside air is supplied centrally from outside air handling units (typically at mechanical levels) to all floors, and there are unoccupied tenant floors, divert the outside air to the occupied floors.
- Consider changing the floor level VAV air handling units' discharge air temperature setpoint the maximum (typically no higher than 60º F).
- This will cause VAV terminal units (boxes) to open to try and satisfy space cooling loads which will increase the number of air changes in the space being served.

Centralized and floor-by-floor Variable Air Volume (VAV) systems: Cooling coils

- Cooling coils, heating coils and condensate drain pans 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.
- These devices and systems should be monitored often and regular and emergency maintenances should continue.
- Provide PPE protection for building operators, maintenance technicians and anyone else who must inspect or come in contact with the device or equipment.

Centralized and floor-by-floor Variable Air Volume (VAV) systems: Operable windows

- 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.
- Disabling the interlock between opening windows and air conditioning system lockout or shut down if this feature is provided for in the Building Automation System.
- Monitor indoor spaces for possible contaminants entering through the windows such as toilets exhaust located nearby or for windows accessible to public and high traffic on adjacent streets and walkways.
- Exposure to seasonal and other outdoor allergens (pollen and mold spores) may occur with windows opened.
- Special ductwork cleaning, or, changing filters more often than normal is not necessary.

Domestic Heating Water systems:

- 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.

Operate and maintain the HVAC system - Exhaust systems

- Exhaust system for toilets should run 24/7. Do not open operable windows in toilets.
- 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.

Elevator Control

1. Turn on elevator cab (lift) ventilation fans, where possible
2. Encourage occupants to take stairs, where possible, especially when elevator lobbies are crowded.
3. Allow elevators to run at high speed to minimize time in elevator.
4. Close elevator lobby vestibule doors, if available.
5. Consider local air treatment devices in frequently used lifts.

Building Automation System and Access Control System Programming

Building Automation Systems:

- Automate the control sequences in this document as a "Epidemic Mode" operation that can be turned on, shut down or override, if needed, by manual selection of the operator.
- Provide remote access to staff and trusted service providers who are responsible for operating and maintain Building Automation Systems, security, access control, information technology, fire alarm and life safety systems. Have written procedures and test remote access and secure access levels and permissions for all individuals prior to an emergency, if possible.

Access Control Systems:

- Post signage and communicate to tenants, and post visitors' procedures for entering and leaving the building that will minimize the time spent in public spaces.
- Use touchless assess control system if available and where possible.
- Require and enforce social distancing within public and shared spaces using signage.
- Ensure that workspaces are situated to accommodate social distancing recommendations