# Nashoba Regional Schools
# Hale Middle School
# Stow, MA

# 2020

# HVAC System Evaluation

**Prepared For:**

**Nashoba Regional School District**
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# EXECUTIVE SUMMARY

## ***General***

The Nashoba Regional School District engaged BLW Engineers to evaluate the HVAC systems serving these buildings relative to their current operating conditions, re-opening of the building to the public and potential considerations related to Covid-19.

While at the site, BLW Engineers met with the facilities operator who reported the HVAC systems receives regular preventative maintenance which includes filter replacement, grease motors and bearings, replace fan belts and verify damper and valve operation.

The Hale Middle School is located at 55 Hartley Road in Stow. The school comprises approximately 81,000 square feet of educational space with enrollment of approximately 270 students. The building was originally constructed in 1965, with a major renovation around 1996 with most of the current HVAC systems and equipment having been installed at that time.

## Nashoba Regional High School Planned Reopening

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

- School is to be occupied by 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 Hale Middle School is safe to occupy and 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: Tier 1 recommendations are immediate revisions to system operation prior to start of classroom and until the start of the heating season.

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. Should building exhaust exit building through sidewall louvers subject to pedestrian traffic, 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. Operate Classroom unit ventilators with ventilation as originally designed. Based on reduced classroom sizes, the classroom current system can provide more than 30 CFM/occupant which exceeds current code requirements (10 CFM per occupant plus 0.12 CFM/SF) and can be supplemented by operable windows.
12. Operate Classroom heating/ventilating unit (HV-1) with ventilation as originally designed. Based on reduced classroom sizes, the classroom current system can provide more than 30 CFM/occupant which exceeds current code requirements (10 CFM per occupant plus 0.12 CFM/SF) and can be supplemented by operable windows.
13. Operate Gym rooftop units (RTU-1,2) at maximum design air flow; the units have the capability of providing 20/CFM per occupant for 150 occupants.
14. Operate Computer Lab rooftop unit (RTU-3) at maximum design air flow; the unit has the capability of providing 20/CFM per occupant for 25 occupants.
15. Operate Media Center rooftop unit (RTU-4) at maximum design air flow; the unit has the capability of providing 20/CFM per occupant for 25 occupants.
16. Operate Administration rooftop unit (RTU-5) at maximum design air flow; the unit has the capability of providing 20/CFM per occupant for 25 occupants.
17. Operate Auditorium rooftop unit (RTU-6) at maximum design air flow; the unit has the capability of providing 20/CFM per occupant for 310 occupants.
18. Operate Music rooftop unit (RTU-7) at maximum design air flow; the unit has the capability of providing 20/CFM per occupant for 25 occupants.
19. Operate Teacher's Room fan coil units (FC1,2) at maximum design air flow; the unit has the capability of providing 20/CFM per occupant for 15 occupants.
20. Operate Computer Lab air conditioning unit (AC-2) at maximum design air flow; the unit has the capability of providing 20/CFM per occupant for 25 occupants.
21. Operate Cafeteria heating/venting unit (HV3) at maximum design air flow; the unit has the capability of providing 20/CFM per occupant for 150 occupants.
22. At the commencement of school and until the heating season and when outdoor air temperature conditions allow, the air handling equipment can be operated with recirculated air can be run in the "economizer mode" with 100% outdoor air and no recirculation.

23. 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.
24. Disable any CO2 demand control ventilation sequences of operation and occupancy setback controls; operate units at maximum outdoor air capacity.
25. Eliminate outdoor air to zones that are not occupied to better use in occupied areas.
26. Relocate occupants from areas that do not have mechanical ventilation or operable windows.
27. Use operable windows when outdoor air conditions allow.
28. Keep conference room doors open as much as possible or open windows when feasible.
29. Increase regular maintenance of all mechanical heating, ventilating and air conditioning equipment.
30. Monitor the heating, ventilating and air conditioning operation of the building on a continual basis.
31. Follow recommendations of holistic view of building recommendations in General Recommendations.

Tier 2 Recommendations: Tier 2 recommendations are supplemental revisions/additions to the existing systems that may be required for the heating season when systems will need to utilize recirculated air to maintain space temperature setpoints.

1. Provide additional filtration with portable HEPA filter units or UV filtration units for areas that might have multiple occupants served by units (unit ventilators, rooftop units, heating/ventilating units, fan coil units, air conditioning 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. While there is ventilation air and return air associated with each classroom unit ventilator, the units only recirculate air within each classroom and do not recirculate air between classrooms. The ventilation and exhaust systems for the typical classroom is continuous and separate.
2. While there is ventilation air and return air associated with Gym, Computer Lab, Media Center and Auditorium rooftop units, the units only recirculate air within each space and do not recirculate air between other spaces.
3. While there is ventilation air and return air associated with Cafeteria heating/ventilating unit, the unit only recirculate air within each space and do not recirculate air between other spaces.
4. While there is ventilation air and return air associated with Teacher's Room fan coil units, the unit only recirculate air within each space and do not recirculate air between other spaces.
5. While there is ventilation air and return air associated with Computer Lab air conditioning unit, the unit only recirculate air within each space and do not recirculate air between other spaces.

6. 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.
7. 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 heating for the buildings is provided through a hydronic system consisting of a two-pipe distribution that is fed from two oil-fired, non-condensing boilers and constant speed circulation pumps. The distribution piping supplies unit ventilators (UV), indoor air handling units (AHU), rooftop units (RTU), heating ventilation units (HV), duct heating coils (HC) , unit heaters (UH) and various smaller convective heaters throughout the building. Cooling is provided to the Media Labs, Computer Labs, Auditorium and Administrative offices through packed, direct expansion (DX) cooling systems integral to the roof top units or through split DX condensers paired with cooling coils in the air handling unit. Cooling is provided in the Classrooms through a multi-zone heat pump system with fan coils in each room and heat pump unit on the roof.

The classrooms, art rooms and science rooms in this building are served by floor mounted unit ventilators which provide constant ventilation throughout the spaces during occupied hours. The science and art classrooms are provided with constant air exchange through general exhaust fans, most classrooms are noted to have wall exhausters integral to the unit ventilators. The design drawings do not contain information related to the wall exhaust capacity. All classrooms do appear to have operable windows. The UV's draw ventilation air through a directly connected wall louver, the air is mixed with return air from the space, is filtered then heated to maintain space temperature. The UV's are designed for a total supply airflow of 1,250 CFM and ventilation air flow of 500 CFM, with capacity of 90 MBH heating. The UV's are controlled through the building energy management system and are reportedly capable of operating with 100% ventilation air under appropriate weather conditions. Most classrooms are also provided with cooling through a multi-zone, split DX heat pump system with ceiling mounted cassette style fan coils in each class interconnected through refrigerant piping to a central, roof mounted heat pump. The typical classroom is approximately 850 SF, provided a ventilation airflow of 500 CFM and appears to be continuously exhausted. The original ventilation design appears to meet current code requirements, which would be 400 CFM for such a classroom size (Ventilation = 10 CFM x 30 Occupants + 0.12 CFM x 850 SF). The typical art room is approximately 1050 SF, provided a ventilation airflow of 500 CFM and is continuously exhausted. The original ventilation design appears to meet current code requirements, which would be 415 CFM (Ventilation = 10 CFM x 21 Occupants + 0.12 CFM x 1050 SF). The typical science room is approximately 1000 SF, provided a ventilation airflow of 500 CFM and is continuously exhausted. The original ventilation design appears to meet current code requirements, which would be 450 CFM (Ventilation = 10 CFM x 25 Occupants + 0.12 CFM x 1000 SF).

The rooftop air handling units RTU-1 and RTU-2 are located on the lower roof beside the gymnasium, providing ventilation and tempered supply air through supply and return distribution ductwork to the Gymnasium. The air handling unit operates at a constant air volume and discharge temperature is controlled to maintain space temperature based on local thermostat/sensor. The design documents indicate that RTU-1 and RTU-2 are 25% outdoor air, each with a maximum supply air flow of 6,000 CFM and corresponding maximum ventilation air flow of 1,500 CFM. The units were each designed with capacity for 259 MBH of heating, an external static pressure capacity of 1.5" w.c. through the supply fan and 0.75 w.c. through the return fan. New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency). The required ventilation air flow to the Gymnasium will vary based on the proportioning of play area and spectator area but does appear to meet current code requirements corresponding to an approximate total floor area of 7,000 SF.

The Girl's and Boy's Locker Rooms are exhaust continuously through a roof mounted exhaust fan and each served by a dedicated unit ventilator. UV-1 serving the Girl's Locker Room providing ventilation and tempered supply air through a system of supply and return distribution ductwork, the ventilation air is drawn through a roof intake to the unit where it mixes with return air from the space, is filtered and then heated for supply to the space. UV-2 serving the Boy's Locker Room providing ventilation and tempered supply air through a system of supply and return distribution ductwork, the ventilation air is drawn through a roof intake to the unit where it mixes with return air from the space, is filtered and then heated for supply to the space. Exhaust air is drawn at a rate of 400 CFM from the locker rooms through registers and ductwork to the exhaust fan and discharged. The design documents indicate that UV-1 and UV-2 each have a maximum supply air flow of 750 CFM and a ventilation air flow of 300 CFM, with 40 MBH heating capacity.

The rooftop air handling unit RTU-3 is located on the lower roof above the Computer Lab, providing ventilation and conditioned supply air through a system of supply and return distribution ductwork and duct mounted hydronic heating coil to the Computer. The air handling unit operates at a constant air volume and discharge temperature is controlled to maintain space temperature based on local thermostat/sensor. The design documents indicate a maximum supply air flow of 2,000 CFM, a ventilation airflow of 500 CFM with an external static pressure capacity of 0.75" w.c. through the supply fan. The unit has a total cooling capacity of 86 MBH and the associated duct heating coil has a capacity of 92 MBH. New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency). The design ventilation does appear to meet current code requirements for the Computer Lab which would be 320 CFM (Ventilation = 10 CFM x 21 Occupants + 0.12 CFM x SF) for the approximate total floor area of 850 SF.

The rooftop air handling unit RTU-4 is located on the lower roof above the Media Center, providing ventilation and conditioned supply air through a system of supply and return distribution ductwork and duct mounted hydronic heating coil to the Media Center and adjacent office. The air handling unit operates at a constant air volume and discharge temperature is controlled to maintain space temperature based on local thermostat/sensor. The design documents indicate a maximum supply air flow of 2,850 CFM, a ventilation airflow of 500 CFM with an external static pressure capacity of 0.75" w.c. through the supply fan and 0.5" w.c. through the return fan. The unit has a total cooling capacity of 62 MBH and the associated duct heating coil has a heating capacity of 123 MBH. New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency). The design ventilation does not appear to meet current code requirement for ventilation air flow to the Media Center which would be 625 CFM based on default occupancy (Ventilation = 10 CFM x 40 Occupants + 0.12 CFM x SF) for the approximate total floor area of 1600 SF.

The rooftop air handling unit RTU-5 is located on the lower roof over the main building entry, providing ventilation and heated supply air through a system of supply and return distribution ductwork and duct mounted hydronic heating coil to the various Administrative offices on the first floor. The air handling unit operates at a constant air volume and discharge temperature, the associated heating coil is controlled to maintain space temperature based on local thermostat/sensor in the Principal's Office. The design documents indicate a maximum supply air flow of 2,825 CFM, a ventilation airflow of 500 CFM with an external static pressure capacity of 1.5" w.c. through the supply fan and 0.5" w.c. through the return fan. The unit has a total cooling capacity of 92 MBH and the associated duct heating coil has a heating capacity of 122 MBH. New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency). The design ventilation does appear to meet the current code requirement for the offices which would be 150 CFM (Ventilation = 10 CFM x 21 Occupants + 0.12 CFM x SF) for the approximate total floor area of 1,700 SF.

The rooftop air handling unit RTU-6 is located on the lower roof adjacent to the auditorium with the associated air-cooled condensing unit. This RTU provides ventilation and conditioned supply air through a system of supply and return distribution ductwork to the Auditorium. The air handling unit operates at a constant air volume and discharge temperature controlled to maintain space temperature based on local thermostat/sensor. The design documents indicate a maximum supply air flow of 15,000 CFM, a ventilation airflow of 6,200 CFM with an external static pressure capacity of 1.75" w.c. through the supply fan and 0.75" w.c. through the return fan. The unit has a total cooling capacity of 480 MBH and a heating capacity of 810 MBH. New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency). The design ventilation does appear to meet and exceed the current code requirement for the Auditorium which would be 4,400 CFM (Ventilation = 5 CFM x 810 Occupants + 0.06 CFM x SF) for the approximate total floor area of 5,400 SF.

The rooftop air handling unit RTU-7 is located on the lower roof above the Music Room, providing ventilation and heated supply air through a system of supply and return distribution ductwork to the Music Room, adjacent practice and storage rooms on the first floor. The air handling unit operates at a constant air volume and discharge temperature is controlled to maintain space temperature based on local thermostat/sensor. The design documents a maximum supply air flow of 1,950 CFM, a maximum ventilation air flow of 500 CFM an external static pressure capacity of 1.0" w.c. through the supply fan and a heating capacity of 84 MBH. New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency). The design ventilation air flow does appear to meet the current code requirement for the Music Room and associated interior rooms which would be 490 CFM (Ventilation = 10 CFM x 40 Occupants + 0.06 CFM x SF) for the approximate total floor area of 1,500.

The Teacher's Rooms on the first and second floors are served by fan coil units FCU-2 and FCU-1 respectively. The fan coils are mounted above the ceilings, providing ventilation and heated supply air through a system of supply and return distribution ductwork both rooms. The units operate at constant air volume and discharge temperature is controlled to maintain space temperature based on local thermostat/sensor. The design documents indicate a maximum supply air flow of 800 CFM, maximum ventilation airflow of 150 CFM with an external static pressure capacity of 0.3" w.c. through the supply fan and a heating capacity of 50 MBH for FCU-2. The maximum supply air flow of 400 CFM, maximum ventilation airflow of 100 CFM with an external static pressure capacity of 0.3" w.c. through the supply fan and a heating capacity of 26 MBH for FCU-1. The design ventilation air flow appears to meet current code requirements for these spaces, which would be 150 CFM and 50 CFM respectively for the approximate floor areas of 700 SF and 250 SF (Ventilation = 5 CFM x # Occupants + 0.06 CFM x SF).

The heating ventilation unit (HV-1) as well as duct heating coils (HC-1 & 2) are located in the Mechanical crawl space on the second floor. These units provide ventilation and tempered supply air through a system of supply and return distribution ductwork to Technology classroom and the Consumer Science class room. The unit operates at a constant air volume and is controlled to maintain discharge temperature. The duct heating coils are controlled to maintain space temperature based on local thermostat/sensor. The design documents indicate a maximum supply air flow of 3,000 CFM, a maximum ventilation air flow of 1,000 CFM, with an external static pressure capacity of 1.25" w.c. through the supply fan. HV-1 has a heating capacity of 129 MBH, HC-1 has a capacity of 64 MBH and HC-2 has a capacity of 64 MBH. New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency). The design ventilation air flow appears to meet the current code requirement for these classrooms which would be 500 CFM for the approximate floor areas of 1,350 SF and 1,200 SF respectively.

The air conditioning unit (AC-2) is located in the Mechanical crawl space on the second floor and interconnected through refrigerant piping to the corresponding air-cooled condensing unit (CU-2) located on the roof above. The unit provides ventilation and conditioned supply air through a system of supply and return distribution ductwork to the Computer Lab adjacent to the Technology classroom. The unit operates at a constant air volume and is controlled to maintain space temperature based on local thermostat/sensor. The design documents indicate a maximum supply air flow of 2,000 CFM, a maximum ventilation air flow of 500 CFM, with an external static pressure capacity of 1.0" w.c. through the supply fan. AC-1 has a total cooling capacity of 60 MBH. New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency). The design ventilation appears to meet the current code requirement for ventilation air flow to this room which would be 300 CFM for the approximate floor area of 800 SF (Ventilation = 10 CFM x 20 Occupants + 0.12 CFM x SF).

The heating ventilation unit (HV-2) is located in the Boiler Room, providing ventilation and tempered supply air through a system of supply distribution ductwork to the Boiler Room and for combustion air make-up. The unit operates at a constant air volume and discharge temperature is controlled to maintain space temperature based on local thermostat/sensor. The unit was designed for 100% outdoor air with a maximum supply air flow of 2,500 CFM with an external static pressure capacity of 0.375" w.c. and a heating capacity of 186 MBH.

The heating ventilation unit (HV-3) is located in a mechanical closet on the second floor, providing ventilation and heated supply air through a system of supply distribution ductwork to the Cafeteria. The cafeteria also acts to provide a portion of the make-up air for the exhaust fans serving the adjacent kitchen area. The unit operates at a constant air volume and the heating coil does not appear to have a control valve, allowing for continuous hot water flow through the coil when heating system is in operation. The unit fan is reported to be interlocked with the kitchen hood exhaust fan and a general exhaust fan serving the cafeteria. The design documents indicate a maximum supply air flow of 4,000 CFM, a maximum ventilation air flow of 3,000 CFM with an external static pressure capacity of 1.25" w.c. through the supply fan and a heating capacity of 456 MBH. New filters have recently been installed on these units and are reported to be MERV 10 (~50% efficiency). The adjacent kitchen is served by a ceiling mounted unit ventilator (UV-6) which draws ventilation air through a wall louver, mixes with return air from the space, is filtered then heated to maintain space temperature. The UV is designed for a maximum supply airflow of 2,000 CFM and a maximum ventilation air flow of 2,000 CFM, with 172 MBH of heating capacity. Exhaust air is drawn from the kitchen hood, dishwasher hood and ceiling registers at a total rate of 3,650 CFM and discharges through roof mounted exhaust fans. Exhaust air is drawn from wall registers in the Cafeteria through an exhaust fan in the Mechanical closet and discharges at a wall louver. The original ventilation design of 3,000 CFM appears to exceed current code requirements for the Cafeteria, which would be 1,300 CFM for the approximate total floor area of 1,800 SF (Ventilation = [7.5 CFM x 0.07 Occupants/SF + 0.18 CFM/SF] x SF). The total kitchen exhaust flow is less than the available design ventilation airflow to the kitchen and cafeteria, the general exhaust fan serving the cafeteria appears to be balanced and operate to maintain the kitchen area at a negative pressure relative to the cafeteria and other neighboring spaces during use.

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, Art Room and Storage.

The electric room has been provided with heat dissipation systems including an exhaust fan, a gravity intake with motor operated damper and a temperature sensor to maintain a maximum space temperature.

Miscellaneous spaces have been provided with hot water terminal equipment interconnected with the hot water distribution piping system.

The building is monitored and operated electronically by a system of direct digital controls (DDC), however the heat pump system serving the classrooms is not integrated with the control system and operates simultaneously unless manually disabled.

**GENERAL PUBLICATION RECOMMENDATIONS**

Publications referenced include ASHRAE and State of Massachusetts Re-opening Guidelines for schools.

Operating school 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 HVAC systems that 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** |
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| i. HVAC systems with no humidification may not achieve the minimum humidity indicated,<br><br>ii. Observe building assemblies and finishes frequently for condensation when indoor dew points rise above the surface temperatures of the assemblies and finishes,<br><br>iii. Excessive humidity may lead to condensation, indoor mold growth, and degradation of indoor air quality. |

**Review the space types**

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| **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