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U.S. DEPARTMENT OF ENERGY

Fact Sheet

# OPERATING HVAC SYSTEMS IN COMMERCIAL OFFICE SPACES TO REDUCE RISKS OF AIRBORNE INFECTIOUS DISEASE TRANSMISSION

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), Center for Disease Control (CDC), and the Federation of European Heating, Ventilation and Air Conditioning Associations (RHEVA) have each released guidance related to operational changes in buildings for reducing disease transmission. Some of the general ASHRAE guidance might have different effects depending on the pressure configuration of the building. Separate from the heating, ventilation, and air conditioning (HVAC) changes, there will also likely need to be operational changes to limit a building's occupancy because of possible staff physical distancing requirements.

ASHRAE guidance recommends maximum outside air (OA) ventilation (whenever possible). Potential increase of outdoor air ventilation could result in:

- Increased moisture being introduced into the building as a side effect. Consider the climate of the building and the moisture in the outside air.
- Increased dust and pollens being introduced into the building as a side effect. Consider the impacts to HVAC filter loading and occupants.
- Increased cold air being introduced into the building as a side effect. Consider the impacts to HVAC system performance during cold weather.
- Increased hot air being introduced into the building as a side effect. Consider the impacts to HVAC system performance during hot weather.
- Stressed system causing component failure. Consider ramping up to 100% outside air to confirm system capabilities.
- High humidity can lead to occupant discomfort and unwanted microbial growth.

Use the list below to mitigate the potential side effects of operational changes mentioned above:

- **Moisture Control:** Air-handling unit (AHU) or roof top unit (RTU) may not be able to remove excess moisture at cooling coils beyond original building design.
  - Cooling coils are designed with drain pans that provide a path for condensation to drain. Verify drain pans and piping are adequately designed and maintained (no blockages) to ensure that water is flowing to the designed drain connection – not down the ductwork, reintroduced into the airstream, or overflowing onto the mechanical room floor, etc.
- **Economizer:** 100% OA can be achieved via properly working economizer dampers.
  - Check economizer dampers – if failed, may limit the 100% outside air ventilation capabilities.
  - Increased exhaust (or relief) air needs to be considered along with increased outside air. An equal amount of air needs to be removed from the building. Most offices are designed with the bulk of the air going back to the return.
- Operating ventilation systems with 100% OA during extreme weather may drive primary systems beyond their capacity. This could result in chilled water or hot water heating plants being unable to maintain adequate temperatures for comfort cooling and comfort heating. Consider the following strategies:

- **Internal Load Control:** Communicate with occupants and see if the zone temperatures can be slightly increased or decreased without affecting acceptable comfort. Consider reducing internal loads that do not affect essential building functions, such as temporarily shutting down less frequently used vending machines, water fountains, refrigerators (if empty; if full notify users), dimming hallway lights, and unplugging office equipment that is not in use.
- **External Load Control:** The introduction of 100% outdoor air for dilution will drive cooling and possibly dehumidification loads higher than original design considerations. Chilled water plants that provide comfort cooling and serve process loads simultaneously may be forced to starve comfort cooling loads in order to maintain process loads (data centers, IT closets, elevator machine rooms, etc.) during extremely warm outdoor conditions. Consider installing automated shading devices to reduce heat gains during cooling season and allow the sun to warm office spaces during heating season.
- **Hot Water Reconfiguration:** Hot water plants with the following characteristics may encounter unique challenges that need to be addressed if 100% outside air is being maintained:
  - Hot water loops that serve process heating loads (snow melt systems, etc.) may need to be reduced during cold weather to account for higher heating loads at the AHUs.
  - Hot water that is derived from heat pump chillers may result in heating loads beyond their original design parameters – resulting in cold spaces or the need to revert operations to gas-fired boilers (if they exist).
  - Hot water boilers that normally operate in a lower temperature region for efficiency may need to be configured to operate at higher temperatures.

- If there is an energy-recovery device, ASHRAE notes that some devices (i.e., energy wheels) have the potential of cross contamination between intake and exhaust air (ASHRAE 2020). This may necessitate the energy wheel being bypassed (if the energy wheel has bypass dampers) unless there is proper filtration downstream of the energy wheel.
- ASHRAE guidance includes HVAC air filtration based on "Minimum Efficiency Report Value" (MERV). The higher the MERV value, the more efficient air filtration. ASHRAE recommends a minimum of MERV-13, but MERV-14 is preferred. ASHRAE recommends considering using a high-efficiency particulate air (HEPA) filters, which has a MERV rating of 17+, for supply-side filtration.
  - **Air Velocity Control:** Filtration can result in increased resistance or static pressure which reduces airflow to the HVAC equipment and building space. For a direct expansion (DX) cooling system, if air velocity is too low, the cooling coil could freeze because of low airflows.
    - Large AHUs may increase the speed of the fan to overcome the increased static pressure drop. Some AHUs or RTUs may not have the capability to automatically increase the speed of the fan (if not configured with a variable frequency drive or VFD).
    - Instead of more efficient filtration (which might result in other mitigation steps), consider increased outside air change rates, meaning the proportion of outside air, not necessarily increasing the total circulating airflow.
    - Typically, the AHU or RTU comes with the ability to increase the fan speed by changing the mechanical sheave and pulley, which results in increased speed (and increased power consumption at the fan motor). This can only occur if the motor is oversized and is not already operating at its maximum power rating.
    - Variable air volume (VAV) boxes serving the spaces will ramp to maximum cubic feet per minute (CFM) setpoint, resulting in maximum airflow rates in the spaces to ensure maximum airflows.
  - **Filter Maintenance:** Filters will become dirty from use.
    - Before installing a more efficient filter than you are currently using, verify that your system can accommodate it (or plan on more frequent filter changes).

- As particles accumulate, the AHU might operate outside of the performance range resulting in further air flow reduction. Filter replacement intervals will increase if system operation changes to either accommodate increased outside air recommendations or provide continuous operation of AHUs or RTUs.
    - At a minimum, replace filters if building occupant(s) are diagnosed with COVID-19. Filter replacement will probably occur at least twice as often, but plan for frequent (e.g., weekly, monthly) inspection of the filters because the frequency will vary based on each building.
- Filter end-of-life also needs to be managed (may contain infectious disease particles). Wear personal protective equipment (PPE), protect the surrounding environment in case stray particles leave the filter during extraction, clean and disinfect the surrounding surfaces, and ensure proper disposal of all used filter materials.
- Filters that may reside in the zone systems (fan powered VAV boxes, fan coils, etc.) may also need to be replaced more frequently and likewise be properly disposed of with attention to required cleaning and disinfection of surrounding surfaces.

- **Elevator Ventilation:** ASHRAE guidance suggests the following to reduce risk in elevators:
    - Turn on the cab ventilation fans where possible, allow elevators to run at higher speeds to minimize the time in elevator.
    - Consider local air treatment devices in frequently used elevators.
    - Consider closing elevator lobby vestibule doors, limiting the number of people in the elevator to maintain physical distancing, and encouraging more use of the stairs by occupants.
    - In a building with multiple elevators, consider reprograming the elevators to serve fewer floors than normal operations.
- **Demand Control Ventilation:** ASHRAE recommends that HVAC systems that use demand-controlled ventilation (DCV) be disabled during times when there is a concern about the spread of infectious disease. This may require the control sequences to be evaluated for proper operation without the DCV capability.
- **Operation Schedules:** ASHRAE recommends operating HVAC systems continuously to ensure building air is filtered adequately.
    - Consider operating the AHU or RTU on minimum outside air (if the building is unoccupied during late nights and weekends) while the AHU or RTU is running.
    - If the building has transitioned to multiple work shifts, then the use of 100% OA ventilation is recommended during late nights and weekends (whenever the building is occupied).
    - Depending on the anticipated duration in response to infectious diseases in commercial office spaces, some of these considerations may be handled manually by the operations staff by overriding the building automation system (BAS) or better handled by updating control sequences in the BAS.
    - REHVA guidance suggests virus sustainability can be affected by the application of high heat (56°C for 30 minutes was needed to inactivate the virus).
    - HVAC operations already do this to prevent coils freezing in the winter.
        - HVAC systems that are running will not allow air temperatures to increase this high (unless the entire space being ventilated is this warm – not practical).
        - This will require the hot water boiler systems to be active year-round (which may already occur in buildings that de-humidify).
        - No action suggested related to operating the heating coils year-round, this is just a side benefit if operating the heating coils.

- **Equipment Maintenance:** Because of increased loads and continuous (or possibly extended) operations, equipment may fail prematurely, resulting in emergency repairs and/or replacements. Consider conducting more frequent preventative maintenance and re-commissioning and developing an emergency plan for unexpected equipment failure.
- **HVAC System Operation:** Implementation of HVAC system changes depend on all aspects of a HVAC system operating properly. General recommendations for HVAC operation include:
  - Review the modes of operation of HVAC system:
    - Sequence of operation, schedule, setpoint, which zones served by which type of HVAC system.
  - Check dampers, filter, and economizers seals and frames are intact and clean, functional, and responding to control signals.
  - Check the accuracy of zone temperature, humidity, and carbon dioxide ($CO^2$) sensor, and that air handling systems are providing adequate airflow.
  - Verify that there are no blockages in the duct system (e.g., closed fire/smoke dampers) and that 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 accessible by pedestrians, etc.

## Resources:


- ASHRAE: ASHRAE 2020, ASHRAE Position Document on Infectious Aerosols
- AHAM: 2015. ANSI/AHAM AC-1-2015, Method For Measuring Performance Of Portable Household Electric Room Air Cleaners. Washington, DC: Association of Home Appliance Manufacturers.
- ASHRAE. 2017b. ANSI/ASHRAE Standard 52.2-2017, Method of Testing General Ventilation Air- Cleaning Devices for Removal Efficiency by Particle Size. Atlanta: ASHRAE.


**Notes:**
Developed by the Pacific Northwest National Laboratory. This information is based on recommendations and guidance from ASHRAE and other sources. This is a quickly changing area of research and readers should review for any recent guidance. Each building in each climate type will differ and affect final implementation. Professional engineers who are familiar with each individual building should consider any changes as they impact a specific, unique building.