HVAC CONTROL STRATEGIES TO HELP REDUCE THE SPREAD OF COVID-19 WHILE OPTIMIZING ENERGY CONSUMPTION

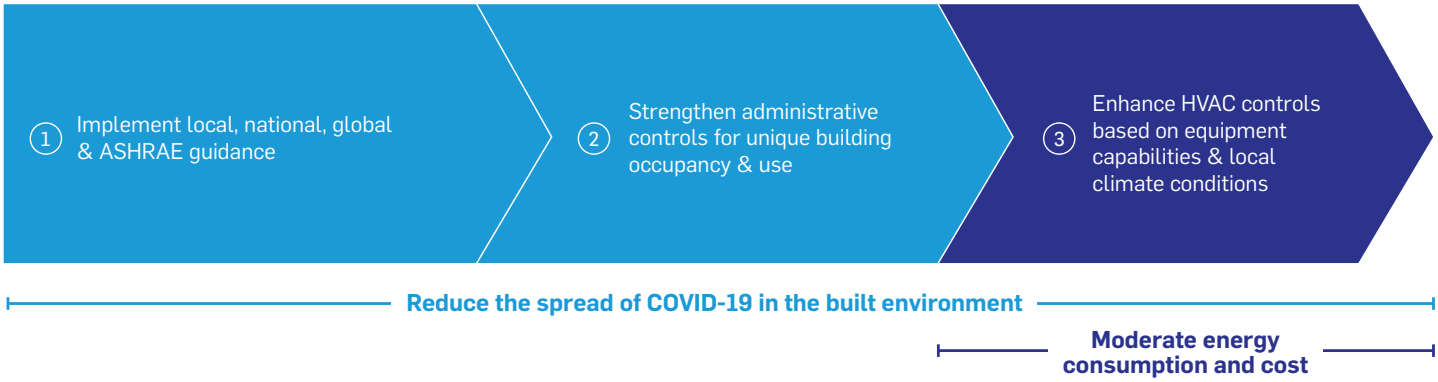
November 2020

As the coronavirus situation has spread, guidelines provided by the Epidemic Task Force of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) have helped building owners and operators to reduce disease transmission in the built environment.[1] Facility managers who adopt ASHRAE's guidance can be confident that they are putting the welfare of their occupants and employees first. They can also be nearly as certain that implementing these new recommendations will drive increased energy consumption.

Fortunately, owners who prioritize a building's health do not sacrifice their ability to optimize energy use and minimize cost.

Many HVAC systems support data gathering, reporting, trending and alarming capabilities. These features allow managers to track the impact and cost of changes made to improve indoor air quality (IAQ) in near real time. However, the age and variety of equipment in airside systems suggest no single solution can minimize energy consumption while meeting ASHRAE guidance.

This white paper provides control strategies that can enable legacy HVAC installations to perform effectively and efficiently while meeting new operating expectations for reducing infection transmission. Enhancing HVAC controls follows logically from steps that many facility managers have already taken, including implementing guidelines from the Centers for Disease Control (CDC) and government authorities and strengthening administrative controls.[2]



Enhancing HVAC controls follows logically from building owners' and operators' steps to meet CDC, governmental and administrative controls. (Source: Carrier)

Staying Current, Being Prepared

Researchers agree that reducing the transmission of COVID-19 requires robust administrative controls, including occupancy planning, social distancing, masks, hand-washing and the adequate cleaning of facilities. HVAC has also emerged as an essential component in minimizing the transmission of COVID-19. ASHRAE has determined that the "transmission of SARS-CoV-2 through the air is sufficiently likely (such) that airborne exposure to the virus should be controlled," adding that HVAC systems "can reduce the airborne concentration of SARS-CoV-2 and thus the risk of transmission through the air."[3] The organization regularly updates its guidance to reflect the continually evolving knowledge of COVID-19 transmission vectors.

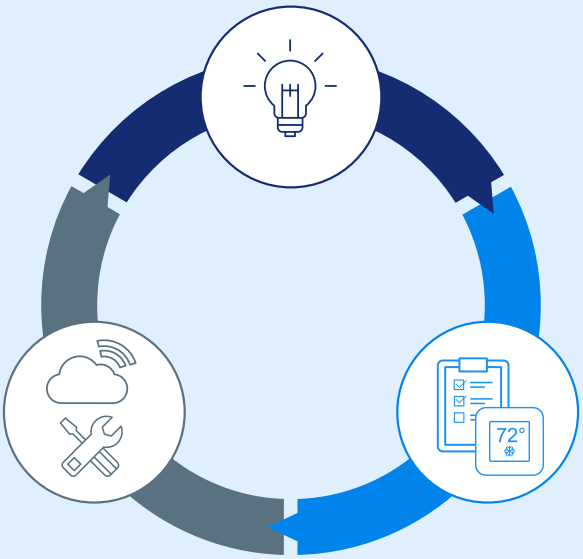
ASHRAE's recommendations assume that owners and operators have completed their preparedness planning. Guidance for this planning can be found on the organization's COVID resource pages and in Carrier's white paper, "Air-Cleaning and Filtration: Addressing the Unseen in the 'New Normal'." Preparedness may include tactical commissioning of a building's HVAC system to ensure its proper operation. Carrier offers a variety of audit programs, from a limited site walk-through to comprehensive assessments that result in IAQ optimization, energy analysis and ROI estimates. These programs are detailed in our white paper, "Improving IAQ in the New Normal: Smart Questions for Building Owners."

As the virus spread ebbs and flows in countries worldwide, owners and operators must adapt their activities to both epidemic and post-epidemic conditions.

Carrier's Approach to Healthy Buildings

EXPERTISE

Leveraging more than 100 years of experience creating optimal indoor environments, partnering with academic researchers and global experts, we build on our expertise to lead the way to a healthier future for all buildings.



OPTIMIZATION

Through advanced controls and digital solutions and services, we optimize buildings to protect the people inside, enabling continuous improvements to air quality and overall health while reducing energy costs.

ASSESSMENT & IMPLEMENTATION

With products that improve ventilation, comfort, air quality and access, we make the solutions that make healthy buildings possible in all types of environments, from new builds to modernizations and retrofits.

Optimization through advanced controls and digital solutions is critical to ensuring a healthy building for employees and occupants.
(Source: Carrier, https://www.corporate.carrier.com/healthybuildings/)

Optimizing Outdoor Air (OA) Ventilation

Under widespread conditions, ASHRAE "encourages building operators to increase their system's outdoor air ventilation to reduce the recirculation air back to the space … as much as the system and or space conditions will allow."[4] In meeting this guidance, facility engineers must factor climate, unit capacity and space requirements for temperature and humidity. Increasing OA will likely incur a substantial energy penalty. ASHRAE provides one example where a rise in OA from 20% to 90% doubles the required chilled water, triples the coil pressure drop and requires just over twice the cooling source from the chiller plant.[5]

Given the anticipated stress on any HVAC system expected to carry such a substantial additional load, Carrier offers the following guidance to maximize outside air ventilation — with the added goal of offsetting as much as practical any associated energy penalty.

- Verify the proper operation of all system fans, economizer dampers and zone dampers.
- Verify that outside air intake and exhaust are free of obstruction.
- Clean cooling coils to recapture potential lost heat transfer from fouling.
- Add updated control logic to adjust the economizer to supply outside air at the greatest rate possible, consistent with the equipment's capacity to maintain acceptable temperature and humidity.
- Consider enhanced freeze protection and/or heating capacity to handle substantial new amounts of OA. The maintenance of humidity levels may also require additional humidification equipment and controls.
- Adjust demand control ventilation systems to maintain minimum ventilation rates at levels equal to or greater than ASHRAE 62.1.
- Place continuously unoccupied areas of the building into setback to reduce energy consumption and allow additional outside air to be delivered to occupied spaces.
- Adjust space temperature setpoints outside the typical comfort conditions.
- Utilize supply air temperature reset to promote greater zone damper openings, typically increasing damper openings and ventilation but reducing energy consumption.

Along with these enhanced ventilation strategies, facility managers should maximize the use of energy-saving features of their building automation systems to improve energy efficiency during pandemic-related sequencing.

Owners and operators should make changes incrementally, document effects carefully and seek input from occupants. Adjusting building and space pressurization is one such example. When increasing OA without adjusting exhaust and relief air systems, doors may not close and occupants may experience excessive noise at entrances and between adjacent spaces. Changes in building pressurization can also affect vertical transportation systems and areas intended to be negatively pressurized, such as commercial kitchens, bathrooms, process areas and custodial areas.

Other Control System Options

Air Flushing. Prior to or following scheduled occupancy, ASHRAE recommends that facility managers initiate a purge cycle "sufficient to reduce concentration of airborne infectious particles by 95%." For well-maintained space, this would require three changes of building volume using outside air, or a flush period of about four hours.[6] Virtually all Carrier air source controllers have built-in pre-occupancy purge cycle logic. Carrier's EcoEnergy Insights provides a set of recommendations that involve scheduled purge cycles, cyclic equipment health checks and control recommendations for building startup and regular operations.[7]

For occupied buildings, air changes per hour (ACH) is a critical indicator in determining how effectively space is being ventilated. Note that in most cases, but especially in multizone systems, additional instrumentation and smart building controls are required to measure and control ACH as part of a healthy building strategy.

Nighttime Free Cooling (NTFC). Another standard feature of many Carrier controllers, NTFC can supplement or replace a purge cycle by pre-cooling space with outside air. However, control system logic may prevent NTFC functions when external conditions are unfavorable.

Zone Occupancy Strategies. When buildings return to partial occupancy, operators can set their HVAC control systems to create a temporary but continuous unoccupied mode. This modification may make more outside air available to occupied zones while ensuring optimal IAQ in occupied areas and reducing energy consumption.

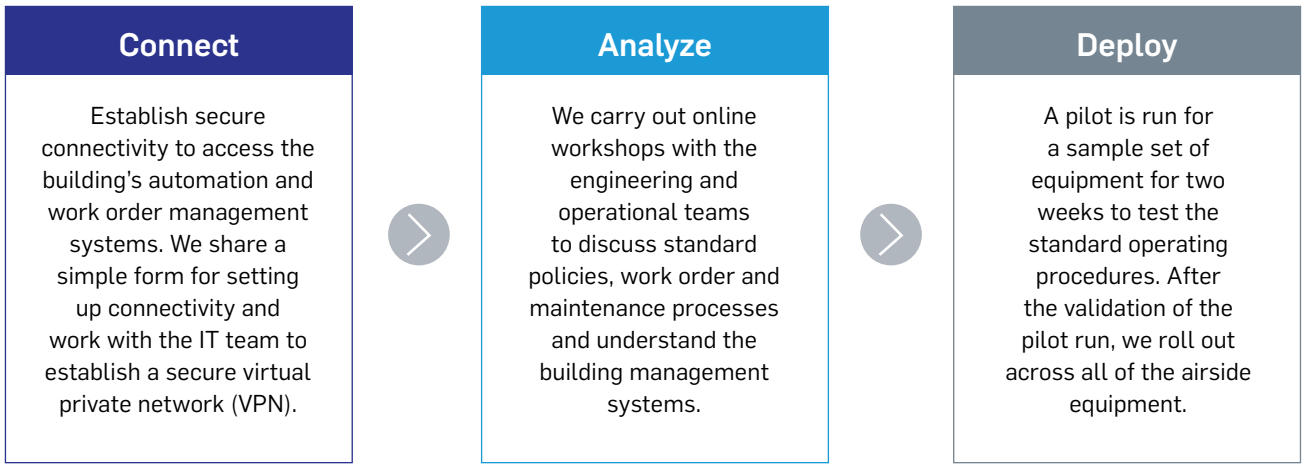
Filtration. Building owners and operators should consider upgrading to higher MERV-rated filters consistent with ASHRAE guidance and their individual systems' capabilities. These upgrades may require adjustments to fan speeds, airflow setpoints and differential pressure switches, more frequent filter replacement, and the possible addition of a filter status switch if not currently present on the equipment. Most Carrier-installed air source controllers, and all field-installed programmable controllers, allow for the addition of a filter status switch. Owners can use Carrier's NSA-DBL or NSB-ZPS line of pressure sensors with Carrier or non-Carrier equipment.

As with changes in OA, the addition of filters can positively impact IAQ but may also stress a legacy system and raise energy consumption. Consulting with an HVAC engineer about filtration strategies is essential to optimize system performance and minimize cost.

Humidity. ASHRAE's current research indicates that maintaining relative humidity between 40% and 60% decreases the bio-burden of infectious particles and decreases transmission.[8] Results remain inconclusive, however. As a general recommendation, ASHRAE 62.1-2019 advises maximum indoor dewpoints of 60 degrees F if outdoor dewpoint is above 60 degrees F. In all cases, customers should monitor indoor humidity levels to avoid condensation and mold, and stay informed as new recommendations for relative humidity evolve.

Remote Recommissioning. Recommissioning an older HVAC system, or one that has been idle for a lengthy period, will likely require an on-site inspection of mechanical equipment. In situations where equipment is new, has been inactive for a short time and has sophisticated control features, remote recommissioning via the i-Vu® Building Automation System or EcoEnergy Insights' Safe Start Program may be effective and affordable options.

Remote Airside Management. Remote Airside Management, another offering from Carrier's EcoEnergy Insights, leverages a building's automation system to provide a safe and comfortable environment with minimal intervention by local engineering teams. Specifically, the 24x7 Command Center of EcoEnergy Insights provides remote HVAC airside management for a variety of HVAC brands and equipment, including rooftop units, air handlers, variable refrigerant flow (VRF) units, DX/cassette units, variable air volume (VAV) units, fan coil units (FCU), and ventilation and exhaust fans. A centralized pool of data scientists, engineers and analysts remotely assesses IAQ, filters, equipment, sensors, and control system operational health. These experts can schedule exhaust and ventilation equipment requirements such as air purges, ventilation rates and demand-based ventilation through planned assessments, remote diagnostics and remote resolutions.[9]



Remote Airside Management is implemented in three steps.
(Source: Carrier, https://ecoenergyinsights.com/whats-new/resources/brochures/remote-airside-management.pdf)

IAQ Sensor Alarms. Remote sensing allows for the measurement of temperature, relative humidity, carbon dioxide, volatile organic compounds, filter status and occupancy. Specific to enhanced ventilation strategies, CO_2-based IAQ sensors can indicate that a controlled space is being adequately ventilated and can also generate alerts and alarms in cases where it is not, allowing the building operator to take necessary corrective action.

Additional Resources

HVAC control strategies can be practical and affordable, especially when building owners and operators work closely with HVAC engineers to optimize their sensor, instrumentation and data-gathering practices.

Carrier's Healthy Buildings Program provides an expanded suite of advanced solutions to deliver healthier, safer, more efficient and productive indoor environments.[10] Customers may wish to consult Carrier Commercial Controls' online product page for additional options.[11] For example, some HVAC systems and applications will not support increased ventilation. In those situations, Carrier's OptiClean™ is available in a negative air machine configuration to create negative pressure zones in temporary treatment areas, and as an air scrubber to remove particles, then discharge cleaner air back into the room. Both modes include highly efficient HEPA filters.

As suggested previously, customers with the Carrier i-Vu Building Automation System have access to its native support for sophisticated occupancy scheduling strategies, setpoint setback control, setpoint reset and demand limiting (useful for systems that have no impact on ventilation). These systems can be easily updated to add lighting controls and other sequences to further reduce energy consumption. All system features can help reduce the expected growth in energy consumption brought on by an increase in OA ventilation.

Carrier's MyWay™ is a building services platform that enables occupants to control and personalize how they interact with a building, including regulating temperature, opening doors and adjusting lighting. The service is scalable and works with non-Carrier applications.[12]

Carrier's EcoEnergy Insights is a leading provider of AI and IoT-enabled solutions to digitally transform building and equipment operations. Its CORTIX™ platform collects data from multiple sources, analyzes it, acts on defined deviations autonomously and offers actionable predictive insights. Combined with expert human analytics, the platform has been delivering award-winning outcomes in comfort, maintenance and energy efficiency across multiple industries such as retail, hospitality and banking. EcoEnergy Insights is a part of Carrier Global Corporation, a leading provider of innovative HVAC, refrigeration, fire, security and building automation technologies. For more information on EcoEnergy Insights and the CORTIX platform, visit www.ecoenergyinsights.com and www.cortix.ai.

Carrier's Automated Logic provides customers the WebCTRL® Environmental Index™ tool that enables building operators to manage temperature, humidity and CO_2 levels via a live, dynamic dashboard that can identify and address healthy building performance issues.[13]

Carrier's LenelS2 team provides healthy building solutions related to contact tracing, enhanced access control and proactive screen solutions.[14]

Finally, customers may be able to partially offset the cost of system upgrades intended to meet ASHRAE guidance by taking advantage of the 2020 CARES Act, which provides substantial tax benefits for qualified HVAC-related expenditures, retroactive to January 1, 2018. For more information on this program and the federal government's response to COVID-19, see https://home.treasury.gov/fedresponse or speak with a Carrier representative.

References

[1] "ASHRAE Epidemic Task Force, Building Readiness, Updated 10-20-2020," Web October 10, 2020, https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-building-readiness.pdf.

[2] "COVID-19 Employer Information for Office Buildings," Centers for Disease Control and Prevention, September 11, 2020, Web October 20, 2020, https://www.cdc.gov/coronavirus/2019-ncov/community/office-buildings.html.

[3] "Coronavirus (COVID-19) Response Resources from ASHRAE and Others," Web August 24, 2020, https://www.ashrae.org/technical-resources/resources.

[4] "ASHRAE Epidemic Task Force," Web October 27, 2020, 15.

[5] "ASHRAE Epidemic Task Force," 17.

[6] "ASHRAE Epidemic Task Force," 19.

[7] "A Healthy Buildings Guide to Re-open Small Commercial Buildings: Restarting HVAC Systems Post COVID-19 Shutdowns," EcoEnergy Insights, Carrier, 2020, Web October 27, 2020, https://ecoenergyinsights.com/whats-new/resources/brochures/a-healthy-buildings-guide-to-reopen-small-commercial-buildings.pdf.

[8] "ASHRAE Epidemic Task Force," Web August 24, 2020, 17.

[9] "Remote Airside Management," EcoEnergy Insights, Carrier, 2020, Web October 21, 2020, https://ecoenergyinsights.com/whats-new/resources/brochures/remote-airside-management.pdf.

[10] "Carrier Healthy Buildings Program," Carrier, 2020, Web October 20, 2020, https://www.corporate.carrier.com/healthybuildings/.

[11] "Controls," Carrier, 2020, Web October 27, 2020, https://www.carrier.com/commercial/en/us/products/controls/.

[12] "MyWay™: A Distinctive, Mobile Experience Within Intelligent Buildings," Carrier, 2020, Web October 21, 2020, https://www.corporate.carrier.com/Images/Carrier-MyWayApp-052920_tcm558-80401.pdf.

[13] "WebCTR® Environmental Index™ Tool," Automated Logic, Carrier, 2020, Web October 21, 2020, https://www.automatedlogic.com/pages/product-webctrl-envindex.aspx.

[14] "OnGuard Solutions to Support COVID-19 Needs," LenelS2, Carrier, 2020, Web October 21, 2020, https://www.lenel.com/services/advanced-services/onguard-solutions-to-support-covid19-needs.