HVAC STRATEGIES FOR SAFEGUARDING WELLNESS

Adjusting strategies for diluting and filtering air can help mitigate the risk of spreading COVID-19, while careful scheduling can save the school money.

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PUBLISHED IN NETASSETS IN JUNE 2020

While heating, ventilation and air conditioning (HVAC) performance has long been a barometer of facilities stewardship, it is taking on new importance in the current pandemic environment. In the past we have optimized systems for energy performance and occupant comfort, whereas now we will optimize for comfort and health. Managing the changes to facilities operations in the age of COVID-19 can feel overwhelming. Using guidance from OSHA, the CDC and others, however, we can develop and implement control strategies, including dilution, filtration, and schedule modifications that will support the health and wellness of your school community.

The main source of COVID-19 outbreaks have thus far been the home, workplaces, public transportation, social gatherings and restaurants. While academic campuses have not been named specifically, independent schools have facets of some if not all of the above-named environments – offices, dining halls, transportation, residence halls, etc. Only 0.3% of traced infections have occurred outdoors. Simulating the outdoor environment within our facilities, specifically, through increased ventilation, may significantly reduce the risk of spending time inside.

Dilution

Standards

Nearly 50 years ago, the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) established the Standard for Ventilation for Acceptable Indoor Air Quality, which was revised most recently in 2019. This guideline is a ubiquitous standard on providing outdoor air to occupied spaces.

Since the turn of the new millennium, the LEED rating system has encouraged new and existing buildings to increase mechanical ventilation at 30% above the minimum rate set by ASHRAE. Beyond spacing room occupants at a minimum two meters apart, improved ventilation represents an excellent infection control strategy.

The Old and the New

Note how ASHRAE's Standard for Ventilation for Acceptable Indoor Air Quality delineates "acceptable" air quality. It is the code-requirement for the bare minimum of fresh air. As sustainable design and operation of facilities continues to evolve, we need to look beyond acceptable to improve indoor air quality. ASHRAE is currently developing development a method to benchmark occupant health in a post-pandemic world, which may be released as early as next year.

Buildings constructed prior to code adoption (the year of which varies by state) often lack mechanical ventilation or use residential style furnaces, functioning on return air alone. It is possible to retrofit vintage systems by adding ductwork and dampers to bring outside air in.

Strategies

When conditions outside are mild, rely heavily on air handling units to bring increased amounts of fresh air into buildings. In traditional air handling units, increased outdoor air will reduce return air, replacing much of the air in the built environment. The concept of air changes per hour (ACH) is helpful to understanding how to effectively dilute air in an indoor space. A space's ACH is the total air provided to the space in one hour, divided by the space volume:

total air provided to space in one hour / space volume = air changes per hour (ACH)

Higher ACH in a space is preferable, as it effectively washes the room of stagnant air. Consider also the direction of the high-volume airflow within the space. Non-aspirating diffusers in the ceiling grid can provide high volumes of low-velocity airflow to occupied spaces.

	Room 1, Before	Room 1, After
Square Footage	800	800
Room Height	8	8
Occupants	12	10
Minimum Outside Air	216 CFM	432 CFM
ACH of Outside Air	2	4
Total Airflow	1080 CFM	1080 CFM
Outside Air Per Occupant	18 CFM	43 CFM

Doubling the outside air quantity doubles the air changes per hour of fresh air. It should also be noted that we can effectively increase outside air per person by limiting space density.

It's ideal to change the quantity of outdoor air to occupied spaces using your facility's building automation system (BAS), with time-stamped records of such changes kept in the operator's logbook (if they are not already logged in the BMS).

The caveat to these changes is that more thermal energy is required to temper outside air prior to reaching the occupied space. Dilution's increased energy requirement translates to increased utility costs, though implementing the strategy does not require any start-up investments and can be implemented right away.

When determining the spaces on which to focus resources, consider how much the project will cost divided by how many people will occupy the space. This will help determine which areas have highest priority for increased ventilation. If implementation costs for a multipurpose space and an office are identical, for example, and the multipurpose space can have 30 occupants, but the office only six, the multipurpose project will have a lower unit cost and most likely should be prioritized.

Zone differential-pressure — that is, controlling airflow between adjacent spaces — could also have an impact on air dilution. It ensures that in the event of a transmissible outbreak, two spaces can be effectively isolated, provided that they are on separate air handling systems. Without appropriate pressure control, airflow can easily spread between zones. More modern air handling units, usually from 2010 onward, can be adjusted to account for this.

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Filtration

High efficiency mechanical filtration should be another a strong consideration. Whereas ventilation dilutes contaminants in the built environment, mechanical filtration selectively removes contaminants from the airstream.

Filter performance is commonly quantified through the Minimum Efficiency Reporting Value (MERV) measurement scale. Developed by ASHRAE, MERV assigns numeric values to filter classes according to their effectiveness. The higher the MERV rating, the better the filtration.

- Standard commercial HVAC applications usually use MERV 8 filters, which are capable of filtering pollen, dust mite debris, carpet fibers and miscellaneous debris.
- MERV 11 filters will filter mold spores and vehicle fumes for example.
- MERV 13 filters are required to filter out viral carriers and bacteria.

Where possible, institutions should pursue MERV 13 filtration or better. High efficiency particulate air (HEPA) filters, which filter 99.97% of particles down to 0.3 microns, should also used in large air handling systems where possible.

Cautions

It is important to keep in mind the operational limitations of higher filtration. Retrofitting equipment to a higher standard filter may mean installing a wider filter tray to accommodate for higher surface area filters. Additional filtration has the potential to stifle airflow, preventing adequate tempered ventilation from reaching occupants, that is the air may be too hot or cold and dilution may be less effective. Review supply fan capacity to ensure the fan motor can compensate for the increased pressure that enhanced filtration requires. A qualified mechanical contractor should review the HVAC unit operation prior to the upgrade.

New Developments: UVGI Cleaning

Electrical air cleaning and specifically ultraviolet germicidal irradiation (UVGI) holds promise as another way of filtering air. There are multiple wavelengths of ultraviolet light, and the UV-C wavelength is known for its germicidal properties; it can render viral and bacterial organisms inactive. Applying UV-C must be done in a manner to safeguard occupants and equipment operators.

Studies show significant reductions in respiratory health issues when UVGI is installed in air handling units, such as fewer respiratory symptoms and work-related sickness in office environments, and better patient outcomes in healthcare environments.

Increased filtration and the maintenance of in-duct UVGI are complementary. Ensuring that UVGI bulbs are clean at all times ensures that UV-C light output is at the appropriate wavelength. Dust and debris built-up on UVGI bulbs will inhibit their effectiveness. In environments where in-duct UV-C bulbs are not possible, upper-room UVGI can also be effective. This is a small, low cost point-of-use UV-C installation that has documented effectiveness. This may be the preferred UVGI option for low-airflow or independent spaces such as bathrooms, nurses stations, reception areas or alternative ingress points.

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Scheduling

During low or no-usage weeks, facilities operators should aggressively reduce run hours via BAS scheduling and adjust unoccupied space temperature.
A highly functional BAS will be critical to implementing and monitoring these changes. Be sure to monitor percent increases in HVAC systems' outdoor air as well as the impact on space temperature and humidity. Monitor fan speed along with filter differential pressure to ensure systems are functioning at the appropriate capacity. The BAS should be able to show if the germicidal UV-C lights are at operating status and how long they have been running. Demand these functions at minimum from your school's BAS. Address any backlogged work-orders related to the proper function of the BAS, and if automation is lacking in any way, this is the ideal time to address the issues.

As institutions reevaluate their programmatic reopening procedures, they should also review HVAC scheduling. During low or no-usage weeks, facilities operators should aggressively reduce run hours via BAS scheduling and adjust unoccupied

space temperature. Likewise, when spaces are in high use, schedule them to be flushed with large volumes of outside air prior to and after use. Severely restrict the use carbon dioxide sensors that limit outdoor air at this time, while institutions prioritize occupant health.

All these occupant health and wellness strategies represent an energy and cost burden on the school. Given that building occupancy represents about 34% of the hours in a year, it is all the more critical to be highly efficient during the other 66% of the year.

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The Stone House Group is a facilities and environmental consulting firm dedicated to strengthening the mission of institutions. Since our foundation in 1999, we have served over 150 educational clients across the United States through Facilities Audits, Space Planning, Commissioning, LEED Administration, and others.