ASHRAE Epidemic Task Force Core Recommendations

Reducing Airborne Infectious Aerosol Exposure

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Since beginning its work in late March 2020, the ASHRAE Epidemic Task Force (ETF) has produced a large set of guidance documents totaling hundreds of pages, all of which can be found at the ASHRAE COVID-19 resources web pages (www.ashrae.org/COVID19). This guidance has evolved as scientific understanding has increased and circumstances have changed, necessitating several updates. The initial, one-page "Core Recommendations" document, approved in January 2021, was written to provide a concise summary of the most current task force recommendations for the benefit of the public and to promote consistency between guidance documents developed by different ETF teams. This column includes the Core Recommendations (in bold) with added commentary to provide the rationale for each.

Core Recommendations for Reducing Airborne Infectious Aerosol Exposure

The following recommendations (https://tinyurl.com/2m9bmtd7) are the basis for the detailed guidance issued by the ASHRAE Epidemic Task Force. They are based on the concept that, within limits, ventilation, filtration and air cleaners can be deployed flexibly to achieve exposure reduction goals subject to constraints that may include comfort, energy use and cost. This is done by setting targets for equivalent clean air supply rate and expressing the performance of filters, air cleaners and other removal mechanisms in these terms.

Recommendation 1: Public Health Guidance

Follow all regulatory and statutory requirements and recommendations for social distancing, wearing of masks and other PPE [personal protective equipment], administrative measures, circulation of occupants, reduced occupancy, hygiene and sanitation.

Although ASHRAE's guidance focuses on engineering

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controls for airborne exposure, it is important to recognize that an effective risk mitigation strategy is multilayered. Use of masks, distancing and other measures complement HVAC protections and should not trade off with each other. Wearing of masks in shared indoor spaces is particularly important during high-risk periods because it can significantly reduce both the amount of infectious aerosol emitted by infected persons and the amount inhaled by susceptible ones. Lower emission rates also make the contaminant removal task of the HVAC system easier.

Recommendation 2: Ventilation, Filtration, Air Cleaning

Provide and maintain at least required minimum outdoor airflow rates for ventilation as specified by applicable codes and standards.

Dilution of indoor contaminants of all kinds with outdoor air is a common engineering control for indoor air quality. However, conditioning of outdoor air used for ventilation is one of the largest consumers of energy in a building. Early in the pandemic, guidance from many sources recommended increasing outdoor air as much as possible. That recommendation has been revised to allow flexibility in meeting airborne risk reduction targets by combining multiple control measures as discussed below. This allows setting a minimum outdoor airflow rate at the designed limit for the system. *It should be noted that for non-health-care facilities, code minimum outdoor air may not be sufficient to achieve the desired level of risk reduction in some cases.*

Use combinations of filters and air cleaners that achieve MERV 13 or better levels of performance for air recirculated by HVAC systems.

ETF strongly recommends upgrading filters used in recirculating airstreams from typical MERV 6 to MERV 8 levels to MERV 13 because lower-rated filters have little effect on respiratory aerosol particles smaller than about 5 µm. However, an upgrade to this level may not be possible in some systems. Consequently, the use of multiple lower-MERV filters or filters and air cleaners in series to achieve performance comparable to MERV 13 is an alternative approach for such cases. Note also that some air cleaners do not remove particles from the air, so a filter + air cleaner combination achieves "equivalence" by adding inactivation to removal.

Only use air cleaners for which evidence of effectiveness and safety is clear.

Technologies that clean air (and in some cases, surfaces) may be valuable supplements to ventilation and mechanical filtration. Germicidal ultraviolet light is one technology for which there is strong documentation of effectiveness and safety.[1,2] Many other air cleaning technologies being promoted during the pandemic lack independent, peer-reviewed evidence and standard, application-relevant methods of test to support claims of effectiveness and, for those that introduce reactive species into room air, safety.

Select control options, including stand-alone filters and air cleaners, that provide desired exposure reduction while minimizing associated energy penalties.

From an abundance of caution, initial guidance from ETF and others focused on maximizing ventilation, which could have very negative consequences for energy use of buildings. While risk reduction must be the primary concern, it is appropriate to seek combinations of controls that will not significantly increase energy use and that are as affordable as possible. This can be done by setting targets for equivalent clean air delivery based on a risk analysis and meeting them by combining outdoor air, mechanically filtered air and air treated by air cleaners. In particular, during the pandemic, use of in-room filters and air cleaners may be a cost-effective and energy-efficient approach. ETF is currently working to finalize guidance on additional ventilation to support application of this recommendation.

Recommendation 3: Air Distribution

Where directional airflow is not specifically required, or not recommended as the result of a risk assessment, promote mixing of space air without causing strong air currents that increase direct transmission from person to person.

Air distribution is a complex and important factor impacting airborne exposure. The Core Recommendations do not contemplate major revisions of air distribution in existing buildings during the pandemic, but some basic guidelines are provided to help reduce risk. Directional airflow in the breathing zone may be beneficial when the location of contaminant sources is known. However, in most spaces the location of infectors is not known.

Strong drafts capable of moving concentrated aerosol clouds long distances have been implicated in disease outbreaks, e.g., Kwon, et al.[3] Research has shown[4] that stratified air distribution may keep the cloud of

droplets produced by a cough or sneeze concentrated and trapped in the breathing zone, raising exposure for anyone who might encounter it. The promotion of mixing, perhaps by use of existing ceiling fans operating at reduced speed, can help achieve a more uniform, lower concentration in the breathing zone and disperse concentrated aerosol clouds without creating high speed horizontal airflows.

Recommendation 4: HVAC System Operation

Maintain temperature and humidity design setpoints.

Although evidence exists[5] that survival time of SARS-CoV-2 virus is higher at low temperature and humidity, it is not clear that manipulation of either temperature or humidity as risk mitigation measures will have a major impact compared to other controls. While ASHRAE guidance recommends[6] maintaining humidity within a 30% to 60% relative humidity range, installation of humidification systems in buildings that are not humidified is costly and potentially harmful to the building, its occupants and its systems as a result of moisture damage and mold growth, hence the recommendation to maintain as-designed conditions.

Maintain equivalent clean air supply required for design occupancy whenever anyone is present in the space served by a system.

This recommendation addresses two disparate concerns. Early guidance for building operation recommended 24/7 operation of HVAC systems, which creates the potential to increase energy use substantially. On the other hand, some buildings may disable ventilation outside of normal business hours, but when custodial or maintenance personnel still may be present. Current guidance is that while systems need not run when no one is present, they should run at their full-occupancy levels whenever anyone is in the building.

When necessary to flush spaces between occupied periods, operate systems for a time required to achieve three air changes of equivalent clean air supply.

The purpose of flushing spaces between occupancy periods is to clear the air of residual infectious aerosol. The initial amount of contaminant in the air of a well-mixed space falls by 95% after three air changes of clean air are supplied. Initial ETF guidance recommended a two-hour flush at the beginning and end of the day. The current recommendation prescribes only one flush per occupied period and only if it is determined to be necessary, e.g., between class periods in an academic building. Flushing can take credit for air recirculated through filters or the operation of air cleaners, so the time to achieve three air changes in some buildings or spaces may be less than 30 minutes.

Limit reentry of contaminated air that may reenter the building from energy recovery devices, outdoor air intakes and other sources to acceptable levels.

While reentry concern initially focused mainly on energy recovery wheels and outdoor air intakes, other possible routes for reentry exist. Recent studies of COVID-19 outbreaks in South Korea concluded that in one case infectious fecal aerosol flowed from one apartment to another through sanitary plumbing via dry traps[7] and in another that the pathway was reentry from a natural ventilation shaft due to stack effect.[8] Similar incidents occurred during the 2003 SARS epidemic in Hong Kong, including suspected building-to-building transmission at the Amoy Gardens apartment complex.[9]

Recommendation 5: System Commissioning

Verify that HVAC systems are functioning as designed.

Sadly, it is well known that HVAC systems in many buildings are not meeting their design intent. For the recommended infection control measures to be effective, it is important that the HVAC system provide the intended flow of outdoor air, have properly installed filters and have controls that operate as intended. A 2020 report by the U.S. General Accountability Office found that roughly one-third of HVAC systems in U.S. schools need repair or replacement.[10]

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