WINDY CITY REPRESENTATIVES
ENGINEERED SYSTEMS

Date: October 16, 2020

Subject: ***Resource Guide*** **- Epidemic Considerations for Facilities v0**

As our industry pursues the mitigation of the current COVID pandemic and prepares our facilities for future epidemics, the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) created the ***ASHRAE Epidemic Task Force (ETF)*** . The ETF references ***key considerations*** that will have a positive impact on; re-opening facilities, reducing the spread of COVID-19 and preparing current and new facilities for future epidemics.

This ***Resource Guide*** summaries how end-users, designers, and builders can translate the key ASHRAE ETF considerations into ***Indoor Environment Strategies*** (practical-product solutions) while accounting for unique facility constraints. Information in this document is provided as a service to the public. While every effort is made to provide accurate and reliable information, this is advisory, is provided for informational purposes only, and may represent only one person's view.

Indoor Environment Strategies: Do you want to?

- ***Increase outside air*** with existing HVAC equipment that uses built-in capabilities by AAON
- Deliver ***100% outside air on-demand*** (uniquely capable packaged HVAC equipment by AAON)
- Provide ***winter humidification*** and add winter humidification to existing HVAC systems with Armstrong
- ***Give occupants their own clean*** air by using underfloor air distribution by AirFixture that limits dilution of outside air for individual occupants
- ***Monitor outside air levels*** for building tenants via outside air flow measuring stations with Accutrol
- ***Increase air cleaning*** with NuCalgon ionization added to recirculated air streams that will enhance air cleaning capacity with no fan system modification
- ***Limit air contamination between spaces*** by integrating room pressurization control to limit cross contamination and infectious disease spreading with Accutrol
- ***Eliminate stagnant hot water*** by using tankless / instantaneous hot water generation that eliminates the potential of standing hot water (a breeding ground for Legionella) with Intellihot
- ***Increase filter MERV ratings*** without the added pressure drop and major fan system modification with BioClimatic
- ***Capture and kill airborne pathogens*** by combining ultraviolet germicidal irradiation (UVGI) and MERV 17 filters to capture and kill airborne viruses with BioClimatic

ASHRAE ETF Facility Considerations:

- Increased Ventilation
- Enhanced Air Treatment
- Humidity Control
- Air Distribution
- Building Pressurization
- Domestic Hot Water Distribution
- System Monitoring (to follow)

Each of the above considerations has a dedicated section answering:

1. What is the ***Consideration's*** impact?
2. What are the design and operational ***implications*** (existing and new facilities)?
3. What are the ***practical-product strategies*** available through Windy City Representatives?

BACK

Facility Considerations

Increased Ventilation

Brief Description and Impact

"ASHRAE's position is that facilities of all types should follow, as a minimum, the latest published standards and guidelines and good engineering practice. ANSI/ASHRAE Standards 62.1 and 62.2 (ASHRAE 2019a, 2019b) include requirements for outdoor air ventilation in most residential and nonresidential spaces, and ANSI/ASHRAE/ASHE Standard 170 (ASHRAE 2017a) covers both outdoor and total air ventilation in healthcare facilities. Based on risk assessments or owner project requirements, designers of new and existing facilities could go beyond the minimum requirements of these standards, using techniques covered in various ASHRAE publications, including the ASHRAE Handbook volumes, Research Project final reports, papers and articles, and design guides, to be even better prepared to control the dissemination of infectious aerosols." (ASHRAE Position Document on Infectious Aerosols 04-14-20, p.1)

"Non-healthcare buildings should have a plan for an emergency response. The following modifications to building HVAC system operation should be considered:

- Increase outdoor air ventilation (disable demand-controlled ventilation and open outdoor air dampers to 100% as indoor and outdoor conditions permit).
- Improve central air and other HVAC filtration to MERV-13 (ASHRAE 2017b) or the highest level achievable.
- Keep systems running longer hours (24/7 if possible).
- Add portable room air cleaners with HEPA or high-MERV filters with due consideration to the clean air delivery rate (AHAM 2015).
- Add duct- or air-handling-unit-mounted, upper room, and/or portable UVGI devices in connection to in-room fans in high-density spaces such as waiting rooms, prisons, and shelters.
- Maintain temperature and humidity as applicable to the infectious aerosol of concern.
- Bypass energy recovery ventilation systems that leak potentially contaminated exhaust air back into the outdoor air supply." (ASHRAE Position Document on Infectious Aerosols 04-14-20, p.10)

"The Building Guidance clearly encourages building operators to increase their systems outdoor air ventilation to reduce the recirculation air back to the space. The guidance indicates that this must be done as much as the system and or space conditions will allow. It is very important that these overall building systems are evaluated by a qualified TAB firm, Cx provider or design professional to ensure that the modifications for pandemic safety do not create additional issues.

"One major concern is the ability to maintain space conditions. Hot and humid climates could struggle to keep the space below acceptable temperature and relative humidity for comfort. Cold climates could struggle to keep the space above acceptable space temperature and relative humidity for comfort. It is important to note that research indicates that maintaining the space relative humidity between 40% and 60% decreases the bio-burden of infectious particles in the space and decreases the infectivity of many viruses in the air. The team should consider adjusting the space comfort setpoints to increase the system's ability to use more outside air." (Building Readiness, 08-19-20 p. 15)

"Post-Epidemic Conditions in Place, the ventilation should be returned to normal quantity and duration prior to the epidemic.

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Refer to ventilation modification notes to determine required adjustments to the system to achieve initial operating conditions." (Building Readiness, 08-19-20 p. 111)

Mitigation Objective

Reduce the risk of infection of SARS-CoV2 through airborne transmission in built environments

Existing System / Facility Implications

"Many buildings are fully or partially naturally ventilated. They may use operable windows and rely on intentional and unintentional openings in the building envelope. These strategies create different risks and benefits. Obviously, the airflow in these buildings is variable and unpredictable, as are the resulting air distribution patterns, so the ability to actively manage risk in such buildings is much reduced. However, naturally ventilated buildings can go beyond random opening of windows and be engineered intentionally to achieve ventilation strategies and thereby reduce risk from infectious aerosols. Generally speaking, designs that achieve higher ventilation rates will reduce risk. However, such buildings will be more affected by local outdoor air quality, including the level of allergens and pollutants within the outdoor air, varying temperature and humidity conditions, and flying insects. The World Health Organization has published guidelines for naturally ventilated buildings that should be consulted in such projects (Atkinson et al. 2009). (ASHRAE Position Document on Infectious Aerosols 04-14-20, p.6)

"Pre-and Post-Flushing Strategy:
The intent is to ensure that while the building is operating, your ventilation schedule should assist in removing bioburden during, pre-, and post-occupancy of the building. Flush the building for a duration sufficient to reduce concentration of airborne infectious particles by 95%. For a well-mixed space, this would require 3 air changes of outside air (or 3 equivalent air changes including the effect of filtration and air cleaners) as detailed in the calculation methodology.

In lieu of calculating the air change rate, pre-and post-occupancy flushing periods of 2 hours (for a total of 4 hours) may be used since this should be sufficient for most systems meeting minimum ventilation standards.

So for each mode, the control would be as follows:
•Occupied: bring in the most outside air that the systems can accommodate as described above
•Pre-and Post-: The general method is to operate the systems in Occupied Mode for "x" hours prior to, and after, daily occupancy. Use the calculation to determine "x"." (Building Readiness, 08-19-20 p. 19)

New System / Facility Implications

"ASHRAE's position is that facilities of all types should follow, as a minimum, the latest published standards and guidelines and good engineering practice. ANSI/ASHRAE Standards 62.1 and 62.2 (ASHRAE 2019a, 2019b) include requirements for outdoor air ventilation in most residential and nonresidential spaces, and ANSI/ASHRAE/ASHE Standard 170 (ASHRAE 2017a) covers both outdoor and total air ventilation in healthcare facilities. Based on risk assessments or owner project requirements, designers of new and existing facilities could go beyond the minimum requirements of these standards, using techniques covered in various ASHRAE publications, including the ASHRAE Handbook volumes, Research Project final reports, papers and articles, and design guides, to be even better prepared to control the dissemination of infectious aerosols." (ASHRAE Position Document on Infectious Aerosols 04-14-20, p.1)
BACK

“Mitigation of infectious aerosol dissemination should be a consideration in the design of all facilities, and in those identified as high-risk facilities the appropriate mitigation design should be incorporated.” (ASHRAE Position Document on Infectious Aerosols 04-14-20, p.9)

“Consider taking steps to improve ventilation in the building, in consultation with an HVAC professional, based on local environmental conditions (temperature/humidity) and ongoing community transmission in the area:

- Increase the percentage of outdoor air, (e.g., using economizer modes of HVAC operations) potentially as high as 100% (first verify compatibility with HVAC system capabilities for both temperature and humidity control as well as compatibility with outdoor/indoor air quality considerations).
- Increase total airflow supply to occupied spaces, if possible.
- Disable demand-control ventilation (DCV) controls that reduce air supply based on temperature or occupancy.
- Consider using natural ventilation (i.e., opening windows if possible and safe to do so) to increase outdoor air dilution of indoor air when environmental conditions and building requirements allow.” (CDC: COVID-19 Employer Information for Office Buildings)

Mitigation Solutions (near term and long term)

The design and operation of HVAC systems can affect infectious aerosol transport, but they are only one part of an infection control bundle. The following HVAC strategies have the potential to reduce the risks of infectious aerosol dissemination: air distribution patterns, differential room pressurization, personalized ventilation, source capture ventilation, filtration (central or local), and controlling temperature and relative humidity. While UVGI is well researched and validated, many new technologies are not (ASHRAE 2018). (Evidence Level B)

Ventilation with effective airflow patterns (Pantelic and Tham 2013) is a primary infectious disease control strategy through dilution of room air around a source and removal of infectious agents (CDC 2005). However, it remains unclear by how much infectious particle loads must be reduced to achieve a measurable reduction in disease transmissions (infectious doses vary widely among different pathogens) and whether these reductions warrant the associated costs (Pantelic and Tham 2011; Pantelic and Tham 2012).” (Evidence Level B) (ASHRAE Position Document on Infectious Aerosols 04-14-20, pp.6-7)

“Personalized ventilation systems that provide local exhaust source control and/or supply 100% outdoor, highly filtered, or UV-disinfected air directly to the occupant’s breathing zone (Cermak et al. 2006; Bolashikov et al., 2009; Pantelic et al. 2009, 2015; Licina et al. 2015a, 2015b) may offer protection against exposure to contaminated air. Personalized ventilation maybe effective against aerosols that travel both long distances as well as short ranges (Li 2011).

Personalized ventilation systems, when coupled with localized or personalized exhaust devices, further enhance the overall ability to mitigate exposure in breathing zones, as seen from both experimental and computational fluid dynamics (CFD) studies in healthcare settings (Yang etal. 2013, 2014, 2015a, 2015b; Bolashikov et al. 2015; Bivolarova et al. 2016). However, there are no known epidemiological studies that demonstrate a reduction in infectious disease transmission.
(Evidence Level B)” (ASHRAE Position Document on Infectious Aerosols 04-14-20, pp.7-8)
BACK

“Infectious aerosols can be disseminated through buildings by pathways that include air distribution systems and interzone airflows. Various strategies have been found to be effective at controlling transmission, including optimized airflow patterns, directional airflow, zone pressurization, dilution ventilation, in-room air-cleaning systems, general exhaust ventilation, personalized ventilation, local exhaust ventilation at the source, central system filtration, UVGI, and controlling indoor temperature and relative humidity. Design engineers can make an essential contribution to reducing infectious aerosol transmission through the application of these strategies. Research on the role of airborne dissemination and resuspension from surfaces in pathogen transmission is rapidly evolving. Managing indoor air to control distribution of infectious aerosols is an effective intervention which adds another strategy to medical treatments and behavioral interventions in disease prevention.” (ASHRAE Position Document on Infectious Aerosols 04-14-20, pp.9)

WCR Offerings (analysis and product)

AAON

- Increased OA potential with high degree of DX cooling and heating modulation (digital scroll, high turndown gas modulation, SCR EH, HW, etc.)
- Potential to increase OA beyond selection point while maintaining space conditions
- General Exhaust Fan instead of Return Fan (reduced contamination potential)
- Paragon AFMS (OA opening, or possibly supply)
- Piezometer AFMS (fan inlet)
- ERW Bypass Damper
- Orion (Wattmaster) VCCX High OA Control
- Orion (Wattmaster) MAU Control with MHGR

MILLER-PICKING

- Increased OA potential with high degree of chilled water cooling and heating modulation (chilled water hydronic valve, hot water hydronic valve, integral face and bypass hot water or steam heating, high turndown gas modulation, SCR EH, etc.)
- General Exhaust Fan instead of Return Fan (reduced contamination potential)
- Paragon AFMS
- Piezometer AFMS (fan inlet)
- ERW Bypass Damper

TMI CLIMATE SOLUTIONS

- Increased OA potential with high degree of chilled water cooling and heating modulation (chilled water hydronic valve, hot water hydronic valve, integral face and bypass hot water or steam heating, high turndown gas modulation, SCR EH, etc.)
- General Exhaust Fan instead of Return Fan (reduced contamination potential)
- Paragon AFMS
- Piezometer AFMS (fan inlet)
- ERW Bypass Damper

ACCUTROL

- Supply Air AFMS
- Outdoor Air AFMS
- Exhaust Air AFMS
- Lower System Pressure Requirement than Venturi-type Air Valves
- Possible to retrofit into existing conventional medium pressure systems
- Economic, flexible, and forgiving systems available pressure isolation areas

BACK

PARAGON

- Supply Air AFMS
- Outdoor Air AFMS
- Exhaust Air AFMS

List References

(ASHRAE Building Readiness, August 2020)
(ASHRAE Responds to Pandemic - ASHRAE Journal, May 2020)
(Guidance for Building Operations During the COVID-19 Pandemic - ASHRAE Journal, May 2020)
(ASHRAE Position Document on Infectious Aerosols, April 2020)
(Guidance for Building Operations During the COVID-19 Pandemic - ASHRAE Journal, May 2020)
(Epidemic Task Force Chair Talks Best Practices, FAQs - ASHRAE Journal, July 2020)
(CDC: COVID-19 Employer Information for Office Buildings, Updated July 9, 2020)

Enhanced Air Treatment

Description:
Based on growing evidence regarding the transmission of SARS-CoV-2, the World Health Organization (WHO) has included airborne transmission as a suspected modes of viral transmission. Airborne transmission is defined as the spread of an infectious agent caused by the dissemination of droplet nuclei (aerosols) that remain infectious when suspended in air over long distances and time. The revelation of likely airborne transmission underscores the importance of maintaining healthy indoor air quality (IAQ) in indoor spaces. Healthy IAQ can best be accomplished by means of diluting a viral load within a space by effective air cleaning and/or ventilation.

Because wholesale increases in ventilation rates are often impractical or impossible in existing systems, and prohibitively expensive in new systems, improving the air cleaning strategy for a space is often the most practical means of improving IAQ.

For the purpose of this technical brief, air cleaning will be defined as the treatment or filtration of return air (or a mixture of return and outside air) with the intent of removing particulates and contaminants, including but not limited to, SARS-CoV-2.

Mitigation Objective:
As part of a broader IAQ strategy that may include ventilation, pressurization and humidification, utilize air cleaning technologies to dilute viral contaminant concentration within a defined indoor space. Air cleaning technologies to be considered include the following:

- Utilize high efficiency filters in terminal HVAC units, central station air handling units, or spot air cleaning units to remove airborne contaminants from the air before being recirculated to the space.
- Utilize germicidal UV-C lights in terminal HVAC units, distribution ductwork, central station air handling units, or spot air cleaning units to deactivate airborne contaminants through ultraviolet exposure.
- **BACK**

- Utilize ionization technology in terminal HVAC units, distribution ductwork, central station air handling units, or spot air cleaning units to agglomerate small or hard to capture contaminants, and to damage surface proteins of viral particles in order to deactivate them.

Existing System / Facility Implications:
Certain applications notwithstanding, the many existing HVAC installations use a basic filtration strategy that may include a low-resistance and low-efficiency throwaway filter (i.e. MERV4) or a slightly more efficient MERV8 pleated filter. Recent emphasis on IAQ for the purpose of LEED certification for buildings has increased the prevalence of higher efficiency MERV11 and MERV13 filters, but most projects do not employ these higher-grade filters. Because of the prevalence of lower efficiency filters, many existing HVAC units are not directly adaptable to these improved air cleaning strategies. Some challenges facing retrofit applications of air cleaning technologies will include:

- Increased air pressure drop of high efficiency filters cannot be overcome (while still delivering a suitable volume of air) by the existing air handling equipment.
- Air tunnel length or cross-sectional area in existing air handling equipment may not be available to accommodate deeper or larger filter media or UV-C light fixtures.
- Power connections for electro-dependent air cleaning strategies
- Access to, or space to modify existing duct sections to accommodate air cleaning media or devices.

New System / Facility Implications:

The broad long-term impact of the COVID-19 pandemic on building systems design will not become clear for some time, however, COVID-contemporary projects will likely see an increased emphasis on IAQ to assuage uncertainty around the future of this pandemic and other potential pandemics in the future.

Building owners and their respective design teams should weigh the trade-offs in different air cleaning strategies for new construction projects. For example, the design/ownership team should determine the priority of pandemic-era occupant safety vs. first cost, as well as the adaptability and sustainability of the air cleaning strategy in the long term. For example, filter media replacement and the associated energy consumption of high efficiency filters can be a costly on-going operating and maintenance expenditure for a building owner so evaluating the post-pandemic need for the improved IAQ measures, and the adaptability of the HVAC systems to removing or scaling back some of these measures is a worthwhile exercise during initial design.

Mitigation Solutions (near and long term):

<u>BiPolar Ionization</u>

- A relatively low-cost solution with a small footprint and limited electrical demand, needlepoint bipolar ionization (NBPI) is a useful air cleaning strategy for both retrofit and new construction systems.
- Relative to retrofit applications, because the NBPI devices are low resistance, the technology can be easily applied to existing air handling systems without driving BHP/motor HP increases on the supply fans.
- Due to the small spatial footprint, NBPI can be applied to new construction air handling systems without driving significant air tunnel growth (length).
- NBPI is viewed by ASHRAE and the CDC as an emergent technology for COVID-19 deactivation and therefore defers to manufacturer data on product efficacy without making a recommendation or endorsement regarding the technology.
    - Emergent test data suggests NBPI as an effective technology for SARS-CoV-2 deactivation over time.

- Because NBPI is not arresting particulates in a filter as part of air recirculation in the space, the technology relies on multi-pass treatment of space air to improve viral deactivation.
- Users are cautioned to ensure product compliance with UL2998, demonstrating zero-ozone production.

Filter Efficiency improvement

- Filter MERV ratings are indicating of the tested performance/effectiveness of a given filter media, within a specific air flow or velocity range, at removing particulates of a certain size. Higher MERV ratings imply better efficacy at removing smaller particles.
- HEPA filters (>MERV17) stand as the best performing filters, but have the lowest face velocity requirements, highest air pressure drop, highest media replacement cost, and most labor-intensive replacement process. While useful and necessary in many healthcare and process environments, HEPA filters may not be the best air cleaning strategy for all applications.
- ASHRAE suggests improving central station air handling filtration to at least MERV13.
- Increasing filter efficiency in retrofit applications can prove challenging due to the increased air pressure drop of higher-grade filter media.

UV-C Lights

- UV-C light, also referred to as UVGI (ultraviolet germicidal irradiation) uses shortwave ultraviolet energy to deactivate viral, germicidal, and fungal particles moving through an airstream or on an active coil or air handling surface.
- UV-C is well established as an effective air cleaning strategy for deactivating airborne viral contaminants. ASHRAE recommends that UV-C, for the purpose of in-air viral contaminant deactivation, be paired with filtration to enact an effective "Capture and Kill" air cleaning strategy.

Electrostatic Filters

- Electrostatic filters apply an electrical charge to a low-resistance filter media to encourage smaller particles to cluster together in order to be captured by the media, without the restrictive sieve media required for traditional high MERV filters.
- In existing HVAC systems, electrostatic filters serve as a useful retrofit technology due to the opportunity for high (up to MERV15) filter efficiency with low air pressure drop relative to traditional filter media of the same rating. Because of the low air pressure drop, there is little impact on fan power requirements.
- In new construction HVAC systems, electrostatic filters provide the best MERV efficiency rating at the lowest air pressure drop yielding favorable energy performance over the life of the building.
- The form factor of electrostatic filters is generally deeper (in the direction of air flow) than traditional filter media of the same efficiency. This requires additional air tunnel length that may not be available in retrofit applications, and in new construction systems, would need to be a consideration for designers as the mechanical footprints would grow as a result.

WCR Offerings:

AAON, based out of Tulsa, OK offers semi-custom rooftop and air handling units available with a wide range of air cleaning options.
https://aaon.com/controls/

TMI Climate Solutions, based out of Holly, MI offers custom and configurable custom air handling units that can flexibly incorporate any style of air cleaning system to fit a specific application.
https://tmiclimatesolutions.com/

Miller Picking, a Johnson Controls Company, offers custom and configurable custom air handling units that can flexibly incorporate any style of air cleaning system to fit a specific application.
http://www.miller-picking.com/

BioClimatic, based out of Delran, NJ offers myriad engineered air cleaning systems and solutions for retrofit, and new construction applications.
http://www.bioclimatic.com/

NuCalgon, offers needlepoint bipolar ionization air cleaning systems for retrofit, and new construction applications.
https://www.nucalgon.com/products/iwave-air-purifiers/

References

https://www.epa.gov/coronavirus/indoor-air-and-coronavirus-covid-19

https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions

https://www.ashrae.org/technical-resources/building-readiness#ecip

https://www.ashrae.org/file%20library/about/position%20documents/pd_infectiousaerosols_2020.pdf

https://globalplasmasolutions.com/pathogen-reduction

Humidity Control

Description:

Humidity control within buildings helps to protect respiratory systems during the winter months in cold dry climates as well as helping to reduce the transmission of infectious agents by bio aerosols.

Objective:

Maintaining a relative humidity between 40% - 60% in the occupied space is ideal for human health as well as mitigating the spread of viruses. Acute respiratory infections typically have a viral origin and are more widespread during the winter season in the cold climate regions because it is the driest season. During this time is when the outdoor humidity ratio and indoor relative humidity levels are at their lowest. Maintaining the correct humidity level in the space helps protect the respiratory system in humans. Maintaining this humidity level also helps to decrease bio aerosols that are exhaled or emitted by coughing or sneezing. Having the correct humidity level helps to reduce the droplet evaporation process, and the transmission efficiency of airborne viruses. Virus transmission efficiency is highest at low relative humidity (less than 35%). Implementing humidification control in occupied spaces will help mitigate these issues.

Existing System / Facility Implications:

Existing systems that do not have humidity control can typically be retrofitted for this. Humidifier manifolds can be installed in existing air handling units or rooftop units. If proper space is not available, then they can be installed in existing ductwork or even directly in the occupied space.

New System / Facility Implications:

New construction or even equipment replacement/upgrades can easily be designed to incorporate proper humidification equipment.

Mitigation Solutions (near and long term):

WCR Offerings:

Windy City Representatives, in partnership with **Armstrong International**, based out of Three Rivers, MI offers a complete line of humidification products for new and existing applications. Armstrong offers everything from conditioned steam to electric/gas steam humidifiers to atomization to evaporative and even custom/specialized steam solutions.
https://www.armstronginternational.com/products-systems/humidification

References

Improving IEQ To Reduce Transmission of Airborne Pathogens in Cold Climates.

https://images.magnetmail.net/images/clients/ASHRAE//attach/AJ_Newsletter/Graef_September_2020.pdf

HVAC and COVID-19

https://images.magnetmail.net/images/clients/ASHRAE//attach/AJ_Newsletter/Light_September_2020.pdf

Armstrong International

Humidification vs Acute Respiratory Infections (Attached)

Humidification vs Bio Aerosols (Attached)

Air Distribution

Description:

HVAC Airflow in spaces generally can be classified by two types: Mixing Systems or Displacement Ventilation.

Mixing Systems – Is a distribution strategy where high velocity turbulent supply air, typically from overhead ductwork (Overhead Air Distribution – OHAD), mixes with room air so that the space air is at the desired temperature and humidity.
Displacement Ventilation – Is an alternative room air distribution strategy where conditioned air is supplied at a low velocity from an underfloor air plenum/raised access floor and extracted above the occupied zone at ceiling height. It is also very commonly referred to as Underfloor Air Distribution (UFAD).

Consideration Objective:

Airflow patterns determine the flow path of airborne contaminants. Thorough ventilation with effective airflow patterns is a strategy used to reduce the risk and mitigate infectious aerosol transmission of airborne pathogens.

Control of the airflow rate, velocity, and direction of the air being discharged by the air handling device needs to be considered. The objective is to have uniform distribution of temperature in the room and to avoid air velocities above 40 fpm in the occupied spaces, in order to avoid drafts and risk of carrying contaminants from one area of the space to another.

The location of the supply diffusers, the orientation of the discharge air, and the air velocity tend to determine the airflow patterns in the room. The more supply air that is blown directly to an occupied area, the more we will have a direct effect and the worse the air distribution will be. Conversely, ideal distribution is achieved by:

- Ensuring that air has the possibility to travel and expand before reaching the occupied space.
- Locating the air outlet in a position that ensures good airflow, but does not directly blow air into the occupied space

Mitigation Solutions (near and long term):

Using UFAD as a mechanical systems air distribution method can have higher ventilation effectiveness than an OHAD. Overall effectiveness is 1.2-1.5 for UFAD vs. 1.0 for OHAD. Since the conditioned air is supplied directly into the occupied space at the floor, and not mixing with contaminated space and return air, the air quality in the occupied zone is generally superior to that achieved with mixing room air distribution.

Existing System / Facility Implications:

Existing systems if they already utilize OHAD and overhead ductwork are oftentimes difficult to retrofit as UFAD requires a raised access floor of minimum of 8". If a space already has a raised access floor, or if the space is undergoing a complete renovation to where a raised access floor could be installed, UFAD can be considered to mitigate Covid-19 and other airborne pathogens.

New System / Facility Implications:

Consideration of UFAD should be given for new systems as it is documented and supported by ASHRAE and others that the Indoor Air Quality (IAQ) of UFAD systems exceeds that of OHAD. Air is introduced in the occupied zone at the floor at higher temperatures and lower velocities than traditional OHAD. This air then rises out of the breathing/occupied zone, carrying contaminants and exhaled particles/aerosols into the ceiling return system. This will no doubt help mitigate infectious aerosol transmission.

Additional benefits include reduced energy due to lower velocity air distribution and higher supply air temperatures extending the economizer cycles and reducing equipment sizes.

WCR Offerings:

Windy City Reps, in partnership with **AirFixture**, based out of Kansas City, KS offers a complete line of air UFAD products, terminal devices, and 20+ years of intellectual capability, engineering resources, and over 80 million ft^2 of successful UFAD installations across the world. WCR and AirFixture will support our clients' needs from the early design/planning stages all the way through the installation and commissioning phase of the project.

https://airfixture.com/

References

- Airflow Patterns and Flow Path of Airborne Contaminants, Kishor Khankari, Ph.D, ASHRAE Distinguished Lecturer
- UFAD Guide and O&M Guide Set: A Practical Guide For Operation and Maintenance of Underfloor Air Distribution Systems – ASHRAE Handbook 2016
- AirFixture Position Document 2020, "UFAD vs. OHAD – Minimize Transfer of Airborne Infectious Pathogens"
- HVAC Overview of Underfloor Air Distribution (UFAD), A. Bhatia https://www.cedengineering.com/userfiles/HVAC%20Overview%20of%20the%20Underfloor%20Air%20Distribution.pdf

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Building Pressurization

Description:

The HVAC systems in most non-medical buildings play only a small role in infectious disease transmission.

Some actions related to HVAC systems are being suggested to help reduce the spread of COVID-19.

- Increase outdoor air ventilation

- Disable demand-controlled ventilation (DCV)
- Improve air filtration to the MERV-13 or the highest compatible with an existing filter rack
- Keep systems running longer hours, if possible 24/7, to enhance the actions above.

In many cases, adjustments to existing facility HVAC systems are being implemented. When making such changes to existing systems, *ALL* HVAC systems associated with facilities need to be evaluated and modified to maintain proper building and space pressurization.

For new construction projects, short and long-term design considerations for HVAC systems are being evaluated.

Mitigation Objective:
Besides providing greater outside air percentage and better filtration, return air and exhaust air systems need to be modified to account for increased outside air volumes. Both space to space and overall building pressure need to be evaluated and proper control devices put in place to ensure the desired air volumes are achieved and maintained.

Healthcare facilities, laboratory and pharmacy clean rooms have stick space pressure requirements and guidelines. Considerations are being discussed on how to carry over these guidelines to other facilities such as office building, schools and other public buildings.

- Generate clean-to-less-clean air movements by re-evaluating the positioning of supply and exhaust air diffusers and/or dampers and adjusting zone supply and exhaust flow rates to establish measurable pressure differentials.
- Ensure exhaust fans in restroom facilities and other dirty environments are functional and operating at full capacity when the building is occupied.
- Add control devices such as supply and return/exhaust air valves, space pressure monitors and outside and exhaust airflow measuring stations. Such devices can control building ventilation systems and maintain desired building and space pressure requirements.

Existing System / Facility Implications:
Adjusting existing supply, return and exhaust systems isn't as simple as it sounds. Most often existing fan systems and associated duct infrastructure will not be sized to account for increased static pressure requirements and air volumes.

When increasing outside air volumes to existing building supply systems, overall building pressurization will be impacted unless associated relief and exhaust air systems are also modified. Such implications can be:

- Doors that will not close
- Excessive noise at entrance doors and between adjacent spaces
- Access / egress issues at common hallways or egress points (in extreme conditions)
- Reverse of the intended pressure required for a space and associated fan system

New System / Facility Implications:
When taking into account suggested measures to help reduce the spread of COVID-19, in order to allow for greater outside air volumes and increased filtration, HVAC systems will exceed pre-COVID design practices. Fan, cooling and heating systems will be designed with larger capacities to account for greater outside air percentages and increase fan horsepower to allow for increased static pressure due to more efficient filters. Higher level of controls will also be required to assure new buildings are maintaining design pressure differentials.

Mitigation Solutions (near and long term):

WCR Offerings:
Windy City Reps, in partnership with **Accutrol**, based out of Danbury, CT offers a complete line of innovated airflow technologies such as airflow control valves, room pressure monitors and airflow measuring devices.
https://accutrolllc.com/

Windy City Reps, in partnership with **AAON**, based out of Tulsa, OK offers semi-custom rooftop and air handling units with a wide range of control options suited for controlling building and space pressure.
https://aaon.com/controls/

References

https://ashrae.iwrapper.com/ASHRAE_PREVIEW_ONLY_STANDARDS/STD_62.1_2019

https://www.ashrae.org/technical-resources/building-readiness#uvgi

https://ashrae.iwrapper.com/ASHRAE_PREVIEW_ONLY_STANDARDS/STD_90.1_2019

Domestic Hot Water Distribution

Given the ongoing impact on building occupancy and density due to the COVID-19 pandemic, additional care and consideration should be taken to ensure the safety of the domestic hot water supply to all buildings. With long periods of vacancy due to shelter in place orders, there is a much larger risk of Legionella propagation in domestic hot water systems. Legionella thrives in stagnant water between 77° and 108° F. Traditional tanked hot water systems will be a perfect breeding ground for Legionella.

To help mitigate this in existing facilities, two options are available.

- Increase the standing hot water temperature above 120° F (up to 140° is recommended by most experts) to reduce Legionella in existing storage tanks. Before occupancy, flush all domestic endpoints (faucets, showers, etc.) until each fixture reaches maximum temperature. Then thoroughly sanitize all fixtures. Ensure that all staff are properly protecting themselves during this process, as the fixture will aerosolize the bacteria, and there is risk for those employees.
- Replace tanked hot water systems with an instantaneous hot water system. Sanitize all water fixtures after system is replaced.

There will be additional operating costs associated with raising the holding tank temperature well above the desired fixture temperature, and without a proper mixing valve, there is hot water scalding risk at the fixture as well. The system replacement will drastically reduce operating costs in the facility, but they come with a larger upfront capital expenditure.

In new facilities, we recommend designing and installing instantaneous systems as a new standard. This greatly reduces any risk of Legionella, offers much lower ongoing operating expenses, as you are not paying to store hot water when it isn't needed, and has been shown to be a neutral to net first cost savings upfront compared to an appropriately sized tanked hot water solution.

We at Windy City Representatives can assist you with this process, as we represent Intellihot instantaneous hot water heaters (www.intellihot.com). These commercial grade domestic hot water heaters come in sizes from 250MBH to 3,000MBH in a single cabinet, offer internal redundancy, so there is no need for 100% back-up on site, and simplify the piping and installation of domestic hot water systems.

Multiple case studies can be found on Intellihot's website (https://intellihot.com/resources/case-studies) including several that discuss Legionella mitigation that was achieved by retrofitting existing facilities with an Intellihot solution.

System Monitoring (to follow)

Disclaimers / Clarifications

Resource Guide (Disclaimers / Clarifications)

The following disclaimers are from our referenced industry resources.

"Information in this document is provided as a service to the public. While every effort is made to provide accurate and reliable information, this is advisory, is provided for informational purposes only, and may represent only one person's view." (Building Readiness, 08-19-20 p. 1)

"Designers of mechanical systems should be aware that ventilation is not capable of addressing all aspects of infection control. HVAC systems, however, do impact the distribution and bio-burden of infectious aerosols." (ASHRAE Position Document on Infectious Aerosols 04-14-20, p. 2; ASHRAE Journal May, p. 6)

"Building science professionals must recognize the importance of facility operations and ventilation systems in interrupting disease transmission. Non-HVAC measures for breaking the chain of infection, such as effective surface cleaning, contact and isolation precautions mandated by employee and student policies, and vaccination regimens, are effective strategies that are beyond the scope of this document. Dilution and extraction ventilation, pressurization, airflow distribution and optimization, mechanical filtration, ultraviolet germicidal irradiation (UVGI), and humidity control are effective strategies for reducing the risk of dissemination of infectious aerosols in buildings and transportation environments. (ASHRAE Position Document on Infectious Aerosols 04-14-20, p. 4)"

> "The [ASHRAE] position document says ventilation, filtration and air-distribution systems and disinfection technologies can limit airborne pathogen transmission through the air and possibly break the chain of infection. Other strategies, including dilution and extraction ventilation, pressurization, airflow distribution and optimization, mechanical filtration, ultraviolet germicidal irradiation (UVGI) and humidity control can reduce the risk of dissemination of infectious aerosols in buildings and transportation environments. (ASHRAE Journal May, p. 6)

"Even the most robust HVAC system cannot control all airflows and completely prevent dissemination of an infectious aerosol or disease transmission by droplets or aerosols. An HVAC system's impact will depend on source location, strength of the source, distribution of the released aerosol, droplet size, air distribution, temperature, relative humidity, and filtration. Furthermore, there are multiple modes and circumstances under which disease transmission occurs. Thus, strategies for prevention and risk mitigation require collaboration among designers, owners, operators, industrial hygienists, and infection prevention specialists. (ASHRAE Position Document on Infectious Aerosols 04-14-20, p. 5)"

Bahnfleth: "The biggest misunderstanding is that air conditioning inherently increases the risk of airborne disease transmission and that we are safer with air-conditioning systems off than on." (ASHRAE Journal, July p. 6)

Bahnfleth: "Ventilation with outside air and particulate filtration both reduce infectious aerosol concentrations in the air and reduce risk of infection." (ASHRAE Journal, July p. 6)

Bahnfleth: "As described in the guidance for reopening buildings at ashrae.org/covid19, a first, critically important, task is to evaluate the condition of systems to determine whether they are functioning as designed. Deficiencies should be addressed, and then epidemic response operating modes and system upgrades can be implemented. To do this properly requires a team that includes the owner; facility staff; commissioning provider; testing, adjusting and balancing company; building automation system company and design engineer and architect." (ASHRAE Journal, July p. 7)

Schoen: "Knowledge is emerging about COVID-19, the virus that causes it (SARS-CoV-2), and how the disease spreads. Reasonable, but not certain, inferences about spread can be drawn from the SARS outbreak in 2003 (a virus genetically similar to SARS-CoV-2) and, to a lesser extent, from transmission of other viruses. Preliminary research has been recently released, due to the urgent need for information, but it is likely to take years to reach scientific consensus." (ASHRAE Journal May, p. 72)

Schoen: "Even in the face of incomplete knowledge, it is critically important for all of us, especially those of us in positions of authority and influence, to exercise our collective responsibility to communicate and reinforce how personal choices about social distancing and hygiene affect the spread of this disease and its impact not just on ourselves, but on our societal systems and economy." (ASHRAE Journal May, p. 72)

Schoen: "We all have a role to play to control the spread of this disease. HVAC is part of it and even more significant are social distancing, hygiene and the influence we can have on personal behavior." (ASHRAE Journal May, p. 73)

"Separate from the approval of this position document, ASHRAE's Executive Committee and Epidemic Task Force approved the following statements specific to the ongoing response to the COVID-19 pandemic. The two statements are appended here due to the unique relationship between the statements and the protective design strategies discussed in this position document:

Statement on airborne transmission of SARS-CoV-2: Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning systems, can reduce airborne exposures.

Statement on operation of heating, ventilating, and air-conditioning systems to reduce SARS-CoV-2 transmission: Ventilation and filtration provided by heating, ventilating, and air-conditioning systems can reduce the airborne concentration of SARS-CoV-2 and thus the risk of transmission through the air. Unconditioned spaces can cause thermal stress to people that may be directly life threatening and that may also lower resistance to infection. In general, disabling of heating, ventilating, and air-conditioning systems is not a recommended measure to reduce the transmission of the virus. ." (ASHRAE Position Document on Infectious Aerosols 04-14-20, p.2)

> “Unconditioned spaces can cause thermal stress to people that may be directly life threatening and that may also lower resistance to infection. In general, disabling of heating, ventilating, and air-conditioning systems is not a recommended measure to reduce the transmission of the virus.” (ASHRAE Journal May, p. 6)

“Ensure that ventilation systems in your facility operate properly. For building heating, ventilation, and air conditioning (HVAC) systems that have been shut down or on setback, review new construction startup guidance provided in ASHRAE Standard 180-2018, Standard Practice for the Inspection and Maintenance of Commercial Building HVAC Systems.” (CDC: COVID-19 Employer Information for Office Buildings)

“Increase circulation of outdoor air as much as possible by opening windows and doors if possible, and using fans. Do not open windows and doors if doing so poses a safety or health risk for occupants, including children (e.g., a risk of falling or of breathing outdoor environmental contaminants such as carbon monoxide, molds, or pollens).” (CDC: COVID-19 Employer Information for Office Buildings)

Links:

A: https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-building-readiness.pdf