Jacksons Engineering

Reducing the transmission of airborne infectious diseases within buildings

With the right strategies, a building's heating, ventilation, and air conditioning systems (HVAC) can play a role in reducing airborne transmission of infectious diseases such as COVID-19 and its more-infectious Delta variant, which can survive in airborne micro droplets.

Airborne infectious diseases can be transmitted via water droplets and particles released by coughing, sneezing, shouting, and speaking. The smaller aerosolised particles can stay airborne and travel relatively long distances, potentially entering air conditioning units and ventilation systems.

Apart from temperature control, air conditioning systems introduce outdoor air into occupied spaces of buildings, ensuring adequate oxygen for building occupants, diluting, and removing impurities released into the air by furnishings, and removal of odours caused by respiratory functions.

With inadequate outdoor air or overall air movement, the air within an occupied space may not be removed and replaced at a sufficient rate, allowing dust particles or aerosols carrying pathogens to remain present within the space for longer. This increases the chance of contamination by direct contact or inhalation — and increases the likely rate of transmission of airborne infectious diseases.

HVAC based strategies

1. Configure air conditioning systems to 'single pass' full outdoor air

This is a dilution strategy and applies to central plant air handling systems that supply large volumes of conditioned air to multiple building spaces or floors. These systems can be configured to supply full outside air to occupied spaces with no recirculated air, reducing the chances of widespread distribution of contaminated air. The pathogen load is limited to that generated within a space at a given time.

However, this strategy can lead to side effects, including higher energy consumption and uncomfortable internal temperature and humidity levels, due to the increased heating and cooling loads imposed by higher quantities of outdoor air. Reduced comfort levels can lead to complaints and a reduction in staff productivity.

Note that not all central plant air conditioning systems are suited to full outdoor air configuration, especially those utilising direct expansion refrigeration coils to heat or cool incoming air.

System controls or building management systems (BMS) can be used to ensure indoor conditions remain within tolerable limits. However, this can reduce the strategy's effectiveness.

2. Increase outdoor air flowrates to occupied spaces

This is an alternative dilution strategy for central plant air conditioning systems or distributed fan coil units type systems, where the outdoor air is supplied by dedicated systems. By increasing the flow rate of outdoor air to interior spaces, the rate that a contaminant is diluted increases, so helps to reduce the risk of airborne infectious disease transmission.

3. Night purge cycle

This strategy can generally apply to all ventilation systems, other than those that operate 24/7.

By setting outdoor air and any applicable exhaust systems to run continuously or for set periods at night, the systems can replenish the air while the building is unoccupied, and no contaminants are being generated.

Most ventilation systems can be simply configured for this by changing the plant operation schedules within a Building Management System. Plant energy usage may even decrease if heating and cooling functions are disabled or setpoints relaxed during times when the building is unoccupied. However, maintenance requirements will increase as filters require more frequent cleaning and related plant items may require shorter service intervals.

Note that in winter this strategy may result in lower room temperatures in the mornings, impacting occupants and sensitive equipment

4. Clean of all air conditioning unit and ventilation system filters

Regular cleaning or replacement of HVAC system filters helps to maximise air flow through the building. This helps to increase the dilution rate of contaminants and minimises stagnant air pockets, which have been shown to increase the transmission of airborne infectious diseases.

If it is suspected that a person with an airborne infectious disease has been present in an occupied space, replace the filters in the local fan coil indoor units or any other recirculating ventilation systems, then carefully dispose of them by incineration. This also applies to washable media filters, as washing them could expose maintenance staff to live bacteria and viruses.

All maintenance staff should use disposable nitrile gloves and suitable face/respiratory protection when changing potentially infected filters. A high level of personal hygiene and job specific hazard analysis is required.

5. Retrofitting HEPA filtration in ventilation systems

High Efficiency Particulate Arrestance (HEPA) filters are designed to capture very small particles, including water droplets and aerosols. However, While HEPA filters are effective at capturing bacteria, they are much less effective at capturing significantly smaller virus particles.

HEPA filters are typically larger than standard filters and much higher pressures are needed to drive the required air volumes through them. Consequently, unless a ventilation system has been specifically designed for them, retrofitting HEPA filters to a standard system will overwhelm the fan and cause the system to underperform.

It is generally not practical to retrofit HEPA filters to typical commercial ventilation systems as an immediate countermeasure to the transmission of airborne infectious diseases.

6. Portable air cleaners with HEPA filters

In-room air cleaning units recirculate air within a room and 'clean' it, using pre-filters and typically a HEPA grade filter as an alternative to built-in HEPA filtration systems.

As these units can only serve local areas, they will not completely remove all particles and water droplets from the air. However, they will help to reduce the number of residual particles available for recirculation, lessening the chance of transmission of infected particles & water droplets.

7. Retrofitting ultra-violet germicidal irradiation in ventilation systems

Ultra-violet germicidal irradiation (UVGI) is a proven method for disinfecting air streams using UV lamps installed within a section of ductwork or an Air Handling Unit. The systems generate UV-C radiation which can help kill bacteria and viruses in air particles or water droplets.

To be effective, the air stream must be exposed to the UV-C radiation for a specific minimum amount of 'residence' time, making the systems quite large. If a ventilation system has not been specifically designed to accommodate a UVGI system, it can be impractical to retrofit, limiting its suitability as an immediate countermeasure to the transmission of airborne infectious diseases. The application of this technology should be considered on a case-by-case basis.

Systems which utilise clean outdoor air and avoid recirculation don't usually require UVGI systems..

Humidity Control

The importance of controlling relative humidity to assist with limiting the transfer of airborne infections has been well researched. Unfortunately HVAC systems within most commercial office buildings do not actively control humidity and are typically not fitted with humidifiers.

HVAC systems typically spend significant times in cooling mode, removing moisture at the cooling coil (dehumidification), resulting in room humidity's typically around 45 – 60%. As this generally falls within normal comfort ranges, there is no justification for installing humidifiers year-round.

However, during winter months, the moisture content of outdoor air is much lower, so the conditioned air delivered to spaces is drier. Room relative humidity can fall below 40% for considerable periods, causing some undesirable comfort and health effects.

The optimum relative humidity (%rH) ranges for health are:

- Optimum bacteria control between 40 – 60% RH.
- Optimum control of viruses between approximately 45 – 65% RH.

In general, the optimal range falls between 40 – 65% RH, at normal room temperatures. We recommend a control setpoint of 55 - 60% RH, with a proportional band of +/- 5%. This should provide an optimum relative humidity range to minimise the activity of viruses.

Non-HVAC Based Strategies

Non-HVAC based strategies for controlling airborne infectious diseases in the workplace include encouraging high levels of personal hygiene, consideration towards the wellbeing of others, high standards of workplace cleaning and the isolation of sick staff.

With respect to the current 2021 Coronavirus outbreak, advice is available from the World Health Organisation, Centers for Disease Control and New Zealand government COVID-19 websites.

Further information

This article has been condensed from the full article available here:

The articles provide general strategies that apply to commonly used HVAC systems. We strongly recommend seeking professional advice on a building-by-building basis prior to implementing any of these strategies. For further information or specific advice for you situation, contact us at www.jacksons.co.nz

Jacksons Engineering

Information provided by
Jacksons Engineering Advisers Ltd

For any enquiries or assistance, please contact us on the numbers below.

Auckland – Head Office
t. +64 9 378 8736
e. info@jacksons.co.nz

Waikato
t. +64 9 378 8736
e. info@jacksons.co.nz

Bay of Plenty
t: +64 9 378 8736
e. info@jacksons.co.nz

Hawkes Bay & Central Region
t. +64 6 870 1300
e. info@jacksons.co.nz

Otago & Southland
t. +64 3 474 9338
e. info@jacksons.co.nz

Filtration & Pumping Commercial Ltd (FPC)

Palmerston North - National Office

t. +64 6 358 1933
e. david@filtrationandpumping.co.nz