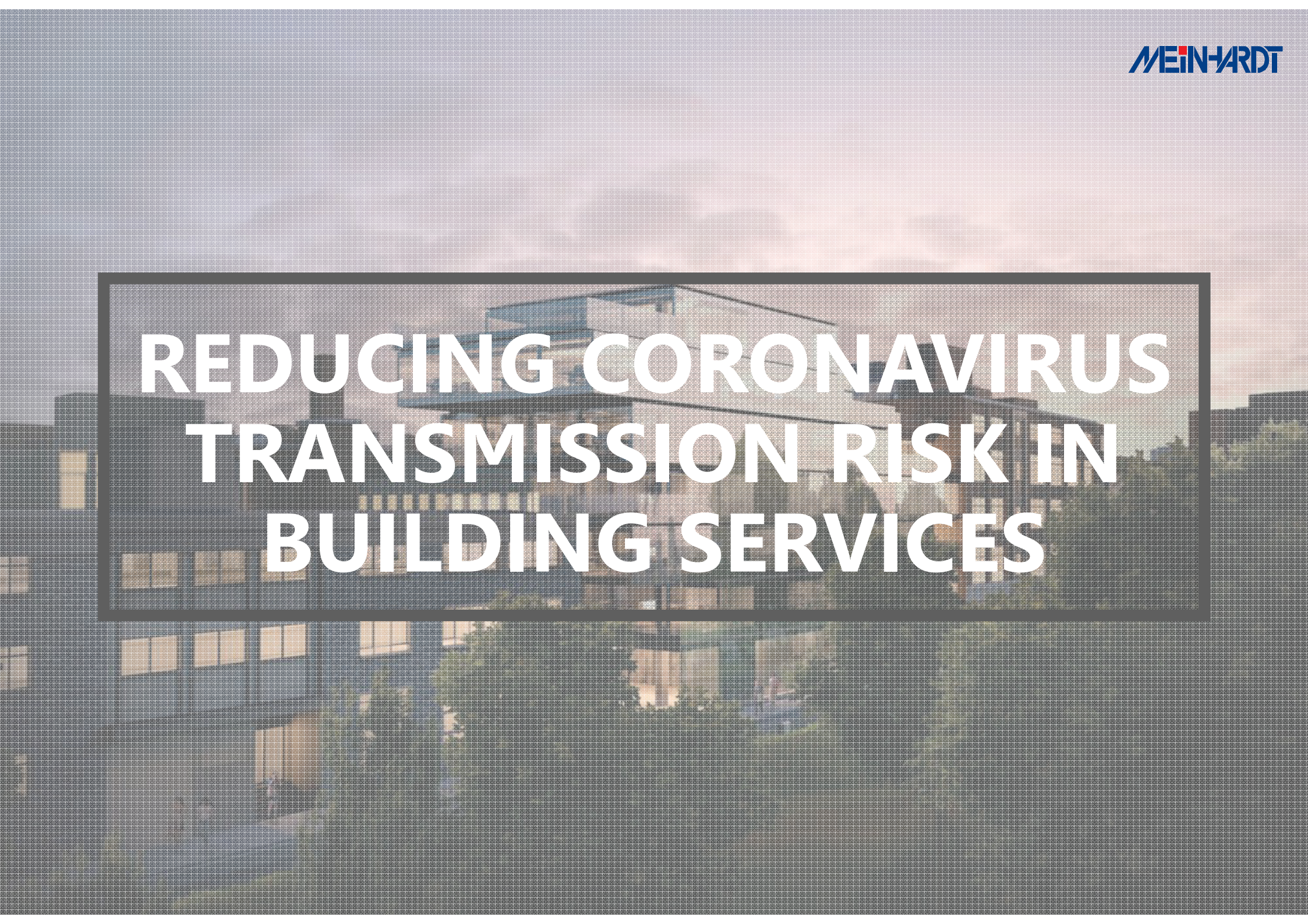


REDUCING CORONAVIRUS TRANSMISSION RISK IN BUILDING SERVICES

GUIDANCE ON REDUCING CORONAVIRUS TRANSMISSION RISK IN BUILDING SERVICES

GUIDANCE

This note is in response to the particular query regarding recommendations for the reduction of coronavirus transmission risk in Building Services systems, and in particular ventilation systems.

The Chartered Institute of Building Services Engineers (CIBSE) is the UK building services industry professional body. The latest guidance from CIBSE in relation to Covid-19 refers to UK government recommendations on infection control, which are not particularly targeted at Building Services systems.

CIBSE do reference guidance issued by the Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA) entitled "How to operate and use building services in order to prevent the spread of the coronavirus disease (Covid-19) virus (SARS-CoV-2) in workplaces". This has recently been updated on the 3rd April and is attached for information.

The document provides interim guidance on the operation and use of building services in areas with a coronavirus disease (Covid-19) outbreak, and aims to prevent the spread of coronavirus through HVAC or plumbing systems. Its scope is limited to commercial and public buildings, such as offices, schools, shopping areas and sports premises, where only occasional occupancy by infected people is expected.

The REHVA guidance is focused on 'temporary, easy-to-organise measures that can be implemented in existing buildings which are still in use with normal occupancy rates'. REHVA intends the advice to be for a short period depending on how long local outbreaks last.

The REHVA suggested measures are in addition those in the World Health Organisation (WHO) document entitled "Getting workplaces ready for Covid-19".

In the UK there is detailed guidance available for hospitals and healthcare premises including the following from the Department of Health;-

- Heating and ventilation systems – Health Technical Memorandum – 03-01 – Specialised ventilation for healthcare premises
- Health Building Note 04-01 – Supplement 1 – Isolation facilities for infectious patients in acute settings
- Health Building Note 00-09 - Infection control in the built environment

General ventilation is used extensively in all types of healthcare premises to provide a safe and comfortable environment for patients and staff. More specialised ventilation is provided in normally only provided in primary patient treatment areas such as operating departments, critical care areas and isolation units.

GUIDANCE

Transmission routes

The guidance document states that there are two dominant transmission routes: via large droplets (droplets/particles emitted when sneezing, coughing or talking); and via surface contact (hand-to-hand, hand-to-surface, and so on).

However, the World Health Organization (WHO) also recognises a faecal-oral transmission route for SARS-CoV-2. In a technical briefing on 2 March, WHO recommended closing toilet lids when flushing, and avoiding dried-out drains in floors and other sanitary devices by regularly adding water (every three weeks, depending on climate).

In the SARS 2003-04 outbreak, open connections with sewage systems appeared to represent the primary transmission route in the Amoy Gardens apartment building in Hong Kong. Transmission was probably because of a dried-out floor drain and airborne dissemination by the toilet exhaust fan and winds.

Professor Catherine Noakes, professor of environmental engineering for buildings at Leeds University, says aerosolisation from water systems may be important. 'The REHVA guidance recommends checking floor-drain traps, but drain traps in high-rise buildings can be susceptible to being blown out by wind pressure. So even traps in drains that are used more regularly are important to watch, too.'

Air transmission

There are two exposure mechanisms, which the guidance document describes as follows:

Large droplets (> 10 microns)

Airborne transmission through large droplets that are released and fall to surfaces no further than 1-2 metres from the infected person. Droplets are formed from coughing and sneezing (the latter typically forms more particles).

Most of these fall on surfaces such as desks and tables. People could catch the infection by touching contaminated surfaces and objects and then their eyes, nose or mouth. People standing 1-2 metres from an infected person could catch it directly in droplets sneezed or coughed out.

Noakes believes that drops greater than 10 microns can travel further than two metres. 'Some of those very big droplets will fly ballistically, but even particles up to 20 microns can be carried further than we might expect because of airflows in the room,' she says. 'It doesn't necessarily mean there's huge additional risk, because there's probably a small concentration of virus, but we should be aware of where surfaces might be contaminated.'

GUIDANCE

Small particles (< 5 microns)

These may stay airborne for hours and can be transported long distances. They are generated through coughing, sneezing or talking. Small particles (droplet nuclei or residue) form from droplets that evaporate (usually within milliseconds) and desiccate.

The coronavirus particle is 80-160 nanometres (1 micron = 1,000 nanometres) and remains active in common indoor air conditions for up to three hours and two to three days on room surfaces. These small particles can stay airborne and travel long distances by airflows in the room or via air ducts of ventilation systems.

REHVA says there is no evidence yet for Covid-19 infection via this route, but it noted that there were no studies that ruled it out. It also referred to a case where coronavirus SARS-Cov-2 was isolated from swabs taken from exhaust vents in rooms occupied by infected patients.

This implies that keeping 1-2 metre from an infected person might not be enough, concluded REHVA, and that increases in ventilation may be useful, as it would remove more particles.

GUIDANCE

The main recommendation from the REHVA are as below;-

Increase air supply and exhaust ventilation

The general advice is to supply as much outside air as possible. Expanded operation times are recommended for buildings with mechanical ventilation. Consider keeping the ventilation on 24/7 with lower ventilation rates when people are absent.

If employee numbers reduce, do not place remaining staff in smaller areas. Exhaust ventilation systems of toilets should always be left on 24/7, and relatively negative pressure must be maintained in the room air to help avoid faecal-oral transmission.

Use more window-driven natural ventilation

In buildings without mechanical ventilation, the use of openable windows is recommended, even if this causes thermal discomfort. Even in buildings with mechanical ventilation, open windows can be used to boost ventilation.

Open windows in toilets with passive stack or mechanical exhaust systems may cause contaminated airflow from the toilet to other rooms so, in these circumstances, it is recommended that toilet windows remain shut. If there is no adequate exhaust ventilation from toilets, and window airflow cannot be avoided, keep windows open in other spaces to achieve crossflows through buildings.

Humidification has no practical effect

Covid-19 is resistant to environmental changes and is susceptible only to a very high relative humidity (RH) above 80% and a temperature above 30°C, which is not acceptable for reasons of thermal comfort.

The reason humidification is suggested in winter (up to a level of 30%) is because nasal systems and mucous membranes are more susceptible to infections at very low RH of 10-20%. However, from March, climatic conditions will see RH higher than 30% in all European climates, without humidification.

Safe use of heat-recovery devices

Virus particles in extract air can re-enter the building. Heat-recovery devices may carry over the virus attached to particles from the exhaust airside to the supply airside via leaks. In rotary heat exchangers (including enthalpy wheels) particles deposit on the return airside of the heat exchanger surface, after which they might be re-suspended when the heat exchanger turns to the supply airside.

GUIDANCE

Based on current evidence, REHVA recommends turning off rotary heat exchangers temporarily during SARS-CoV-2 episodes. Its document goes on to state: if leaks are suspected in the heat-recovery sections, pressure adjustment or bypassing can be an option to avoid a situation where higher pressure on the extract side causes air leakages to the supply side.

Transmission via heat-recovery devices is not an issue when a HVAC system is equipped with a twin-coil ('run around' coil) or other heat-recovery device that guarantees air separation between return and supply side.

No use of recirculation

The guidance document says virus particles in return ducts can re-enter a building if centralised air handling units have recirculation. It recommends avoiding central recirculation during SARS CoV-2 episodes and closing the recirculation dampers, even if there are return air filters, as the guidance says these don't normally filter out viruses.

It also advises that decentralised systems, such as fan coil units that use local circulation, should be turned off to avoid resuspension of particles at room level. If they can't be turned off, they should be cleaned regularly.

Duct cleaning has no practical effect

Virus particles will not deposit easily in ventilation ducts and will normally be carried away by the airflow, says REHVA. No changes are needed to normal duct cleaning and maintenance procedures. Increasing the fresh-air supply and avoiding recirculation are more important.

Change of outdoor air filters not necessary

In rare cases of virus-contaminated outdoor air, fine outdoor air filters provide reasonable protection for a low concentration, but occasionally spread viruses from outdoor air, according to the guidance. Clogged filters are not a contamination source, but should continue to be changed as part of any good-practice maintenance regime.

Room-air cleaners can be useful

Particles can be removed from the air, but air cleaners must have at least HEPA filter efficiency. 'Attractively priced' room-air cleaners are not effective enough, says REHVA. As the airflow through air cleaners is limited, the floor area they can serve is normally quite small, typically less than 10m^2. If used, they should be placed close to the 'breathing zone'.

Special UV cleaning equipment for supply-air or room-air treatment is effective at killing bacteria and viruses, but the guidance document says this is normally only suitable for healthcare facilities.

TYPICAL VENTILATION SYSTEM DESCRIPTIONS

CONSTANT AIR VOLUME

Single Zone

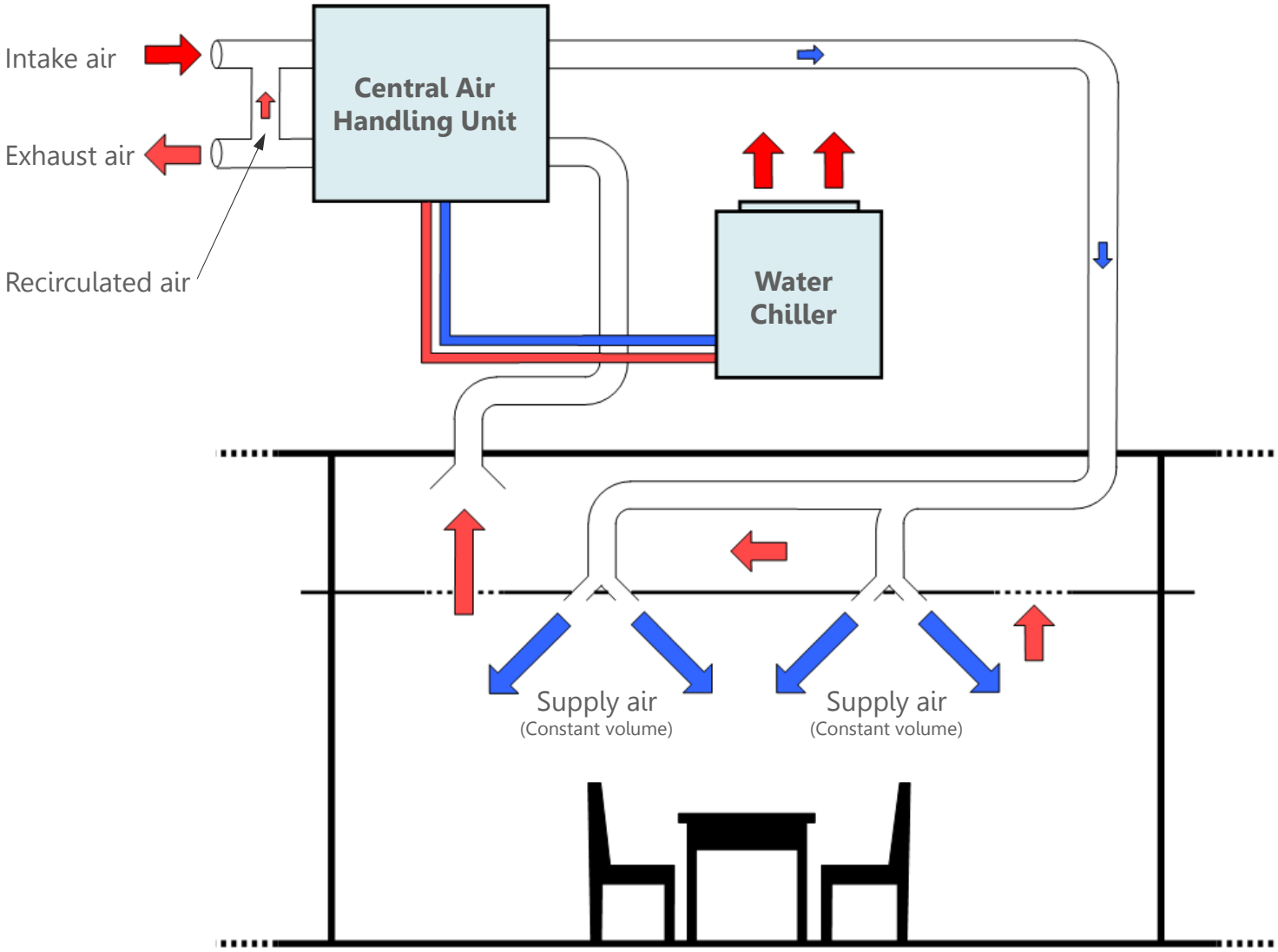
The central Air Handling Unit (AHU) cools outside air using a chilled water coil. The chilled water is generated by electric water chillers (or a district cooling system).

The central AHU distributes the cool air through the building to the room/zone to control space temperature.

Cool air is supplied to the room at a constant volume, with variable temperature.

Warm air is extracted and returned to the AHU.

Some exhaust air may be recirculated at AHU to reduce AHU cooling load.



VARIABLE AIR VOLUME

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Basic

The central Air Handling Unit (AHU) cools outside air using a chilled water coil. The chilled water is generated by electric water chillers (or a district cooling system).

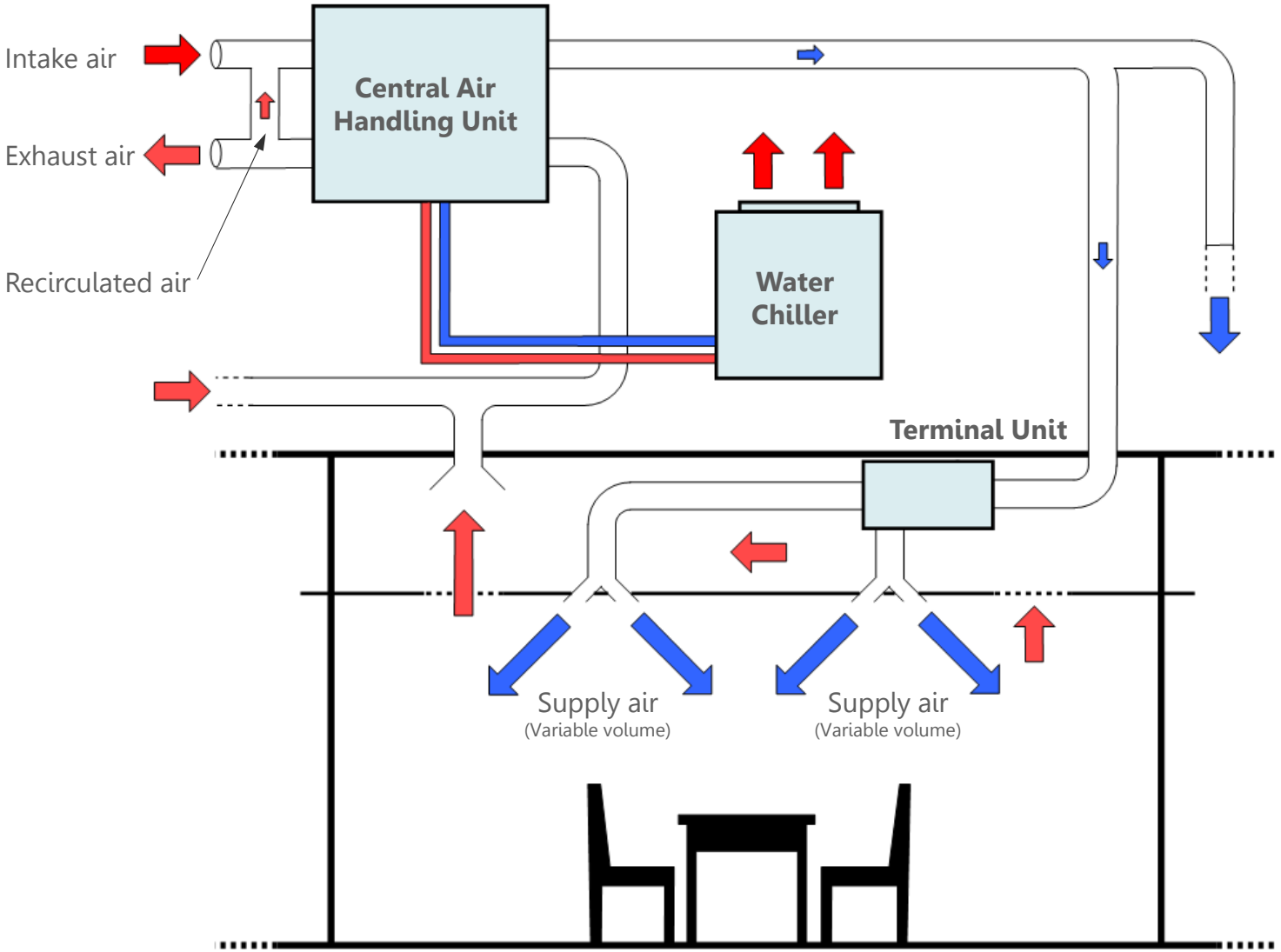
The central AHU distributes the cool air through the building.

A damper in the Terminal Unit in each room adjusts the volume of cool supply air to control space temperature.

Cool air is supplied to the room at a constant temperature, with variable volume.

Warm air is extracted and returned to the AHU.

Some exhaust air may be recirculated at AHU to reduce AHU cooling load.



VARIABLE AIR VOLUME

Fan Assisted

The central Air Handling Unit (AHU) cools outside air using a chilled water coil. The chilled water is generated by electric water chillers (or a district cooling system).

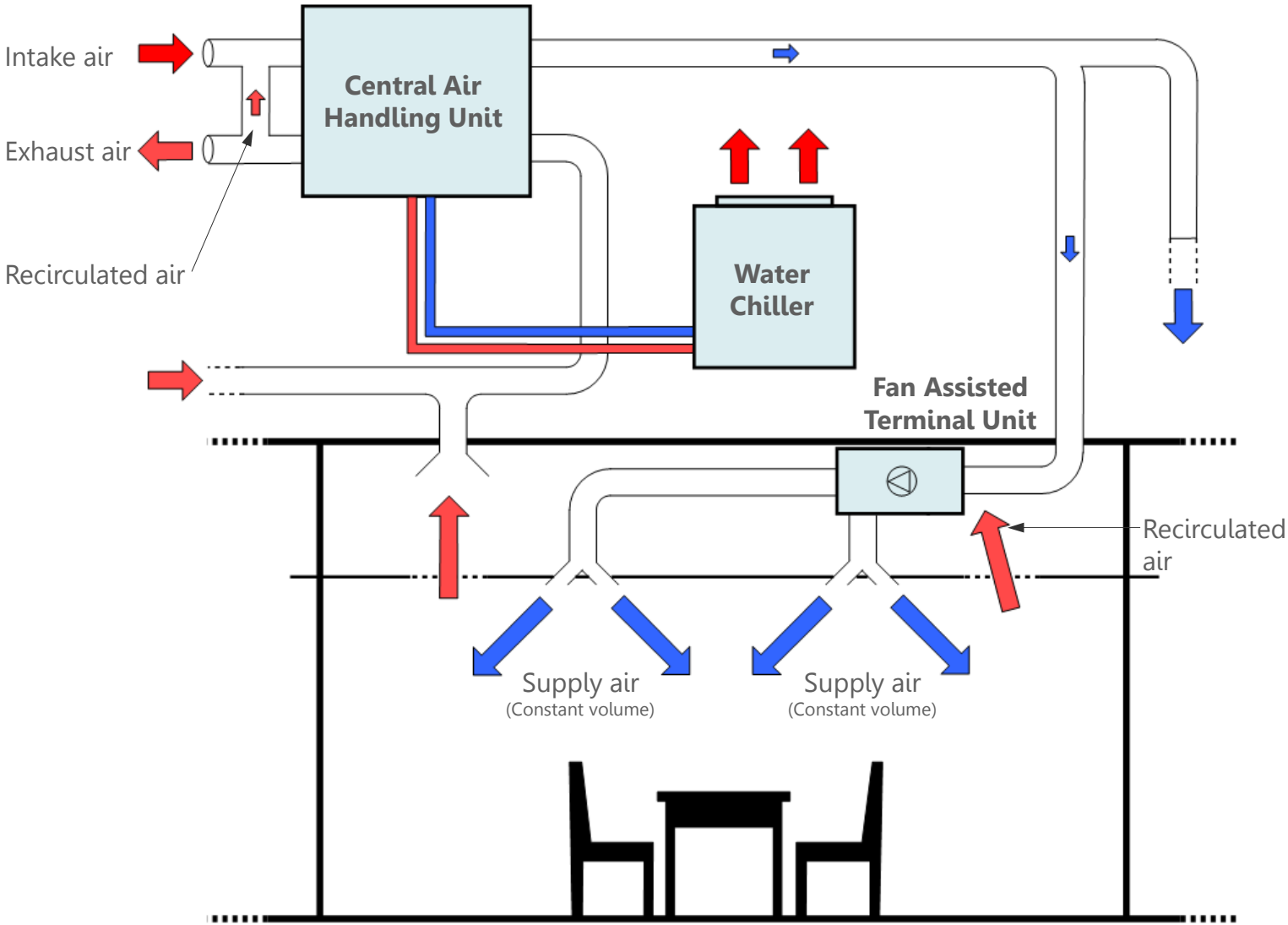
The central AHU distributes the cool air through the building.

A damper in the Terminal Unit in each room adjusts the mix of cool supply air and warmer recirculated air to control space temperature.

Cool air is supplied to the room at a constant volume with variable temperature.

Warm air is extracted and returned to the AHU.

Some exhaust air may be recirculated at AHU to reduce AHU cooling load.



FAN COIL UNITS

Mechanical Fresh Air

Electric water chillers (or a district cooling system) generate chilled water which is supplied to the central Air Handling Unit (AHU) and Fan Coil Units (FCUs) through the building.

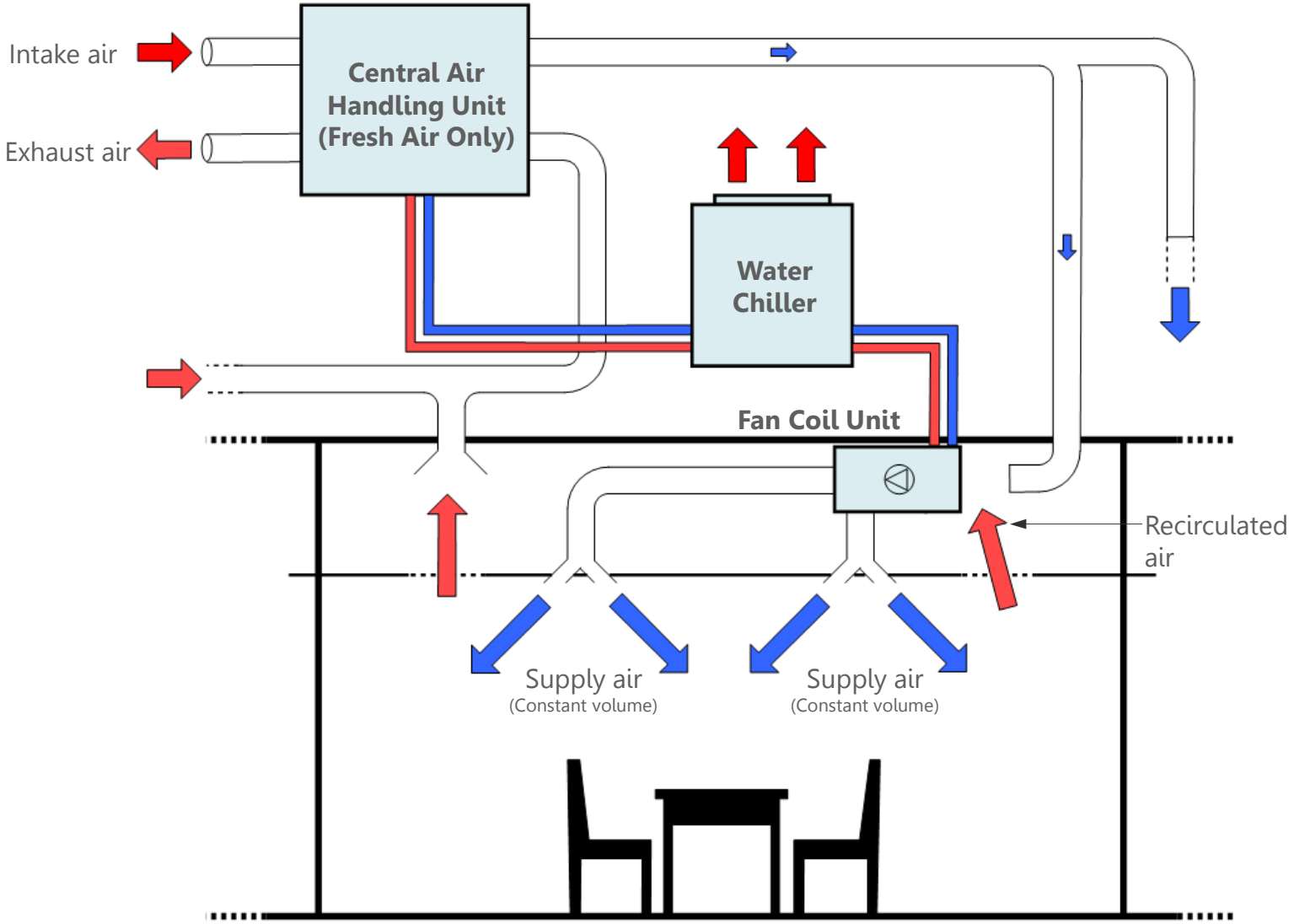
The FCU in each room cools recirculated air using it's chilled water coil. Space temperature is controlled by adjusting the flow of chilled water through the coil.

Cool air is normally supplied to the room at a constant volume with variable temperature.

An FCU system recirculates the air in the space, so it is necessary to provide outside (fresh) air for occupant comfort.

The central Air Handling Unit (AHU) cools outside air using a chilled water coil and distributes it through the building to the rear of each fan coil unit.

Warm air is extracted and returned to the AHU.



VRF AND DX

Mechanical Fresh Air

Cooling is provided by Variable Refrigerant Flow (VRF) or DX (Direct Expansion) Condenser units, which use refrigerant as the heat transfer medium instead of water. The Condensers serve the central Air Handling Unit (AHU) and VRF/DX Indoor Units through the building.

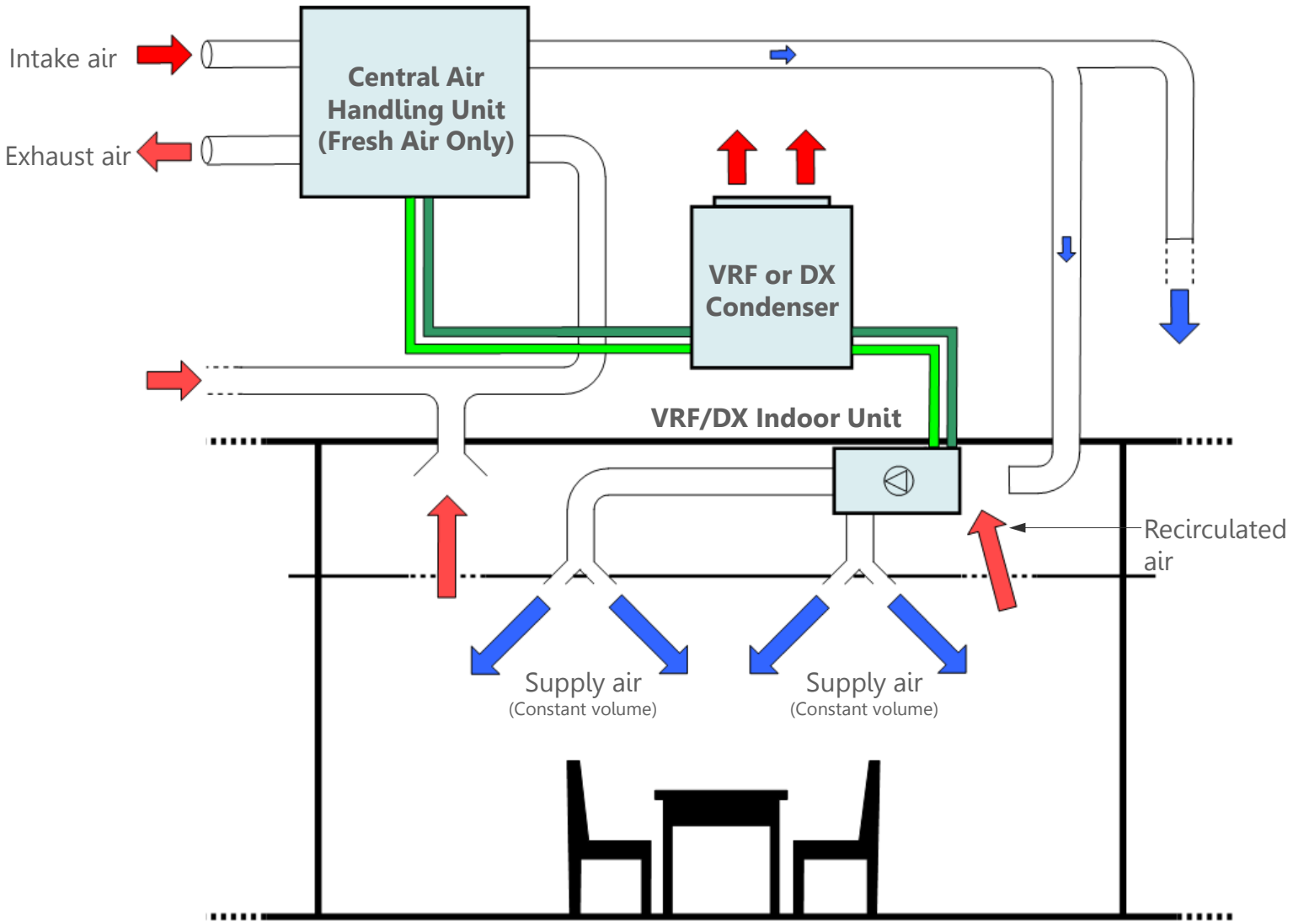
The indoor unit in each room cools recirculated air using it's refrigerant coil. Space temperature is controlled by adjusting the flow of refrigerant through the coil.

Cool air is normally supplied to the room at a constant volume with variable temperature.

The system recirculates the air in the space, so it is necessary to provide outside (fresh) air for occupant comfort.

The central Air Handling Unit (AHU) cools outside air using a refrigerant coil and distributes it through the building to the rear of each fan coil unit.

Warm air is extracted and returned to the AHU.



SUMMARY

SUMMARY OF GUIDANCE

For both interim measures and future standards the main recommendation from the REHVA should be considered;-

Increase air supply and exhaust ventilation - supply as much outside air as possible - exhaust ventilation systems of toilets should be left on 24/7.

Consider increasing regulatory minimum fresh air rates. Ventilation rates in healthcare facilities are considerably higher than normally commercial buildings.

Use more window-driven natural ventilation - open windows to boost ventilation.

Safe use of heat-recovery devices - rotary heat exchangers to be switched off temporarily during SARS-CoV-2 episodes. This could have an impact on the ability to maintain comfort conditions where cooling coils are not sized for the full load.

Consider adjusting regulations to promote the use of heat recovery that guarantees air separation between return and supply side (eg plate heat exchangers or run-around coils).

No use of central recirculation – avoid central recirculation during SARS CoV-2 episodes. This could have an impact on the ability to maintain comfort conditions where cooling coils are not sized for the full load.

Consider adjusting regulations to prevent the use of central recirculation and promote the use of heat recovery that guarantees air separation between return and supply side (eg plate heat exchangers or run-around coils).

Local recirculation systems – systems such as fan coil units, VRF, DX that use local circulation should be turned off where possible during SARS CoV-2 episodes. This will be difficult in Abu Dhabi without impacting on comfort conditions – so where they can't be turned off, they should be cleaned regularly.

Consider carrying out further studies to establish suitable guidance on system design, zoning, maintenance regimes etc.

Healthcare facility provisions - Specialised ventilation is provided in normally only provided in healthcare facilities in primary patient treatment areas such as operating departments, critical care areas and isolation units, but a further detailed assessment could be carried out to determine whether some or all of these design principles and provisions could be used in other areas of healthcare facilities or even in other building types.

This could include special UV cleaning equipment for supply-air or room-air treatment which is effective at killing bacteria and viruses, and the more widespread use of high efficiency filtration (such as HEPA or ULPA) but both would have considerable cost and maintenance implications.

THANK YOU

Q&A?

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