Improving Ventilation and Indoor Air Quality in Buildings amid the COVID-19 situation

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Key Information

It is important to have Sufficient and Effective ventilation to reduce the risk of COVID-19 transmission in an enclosed space

- Covid-19 virus can be transmitted through air and fresh air helps to reduce the risk
- Natural ventilated space provides the lowest risk; if you have AC, make sure you have fresh air intake
 - o When you are in a NV space, make sure that you enhance ventilation by keeping the doors and windows opened and fans are blowing outward
 - o Spaces with central AC usually have provision of fresh air, such as those with centralised air-conditioning system for air-conditioned premises. Please ensure proper maintenance and operation of the AC system and maximise fresh air intake
 - o Split-unit AC do not provide fresh air, so you need measures to improve air exchange in spaces that use split unit. These include opening doors and windows as frequently as possible or installing exhaust fans to expel indoor air.
- Check adequacy of ventilation through measurement of CO2
- If no option to ventilate or doing high-risk activities, can use air cleaning equipment such as HEPA filter air purifier

Routes of transmission



- Higher risk of COVID-19 transmission occurring indoors.
 - Odds of a primary case transmitted COVID-19 indoors was 18.7 times greater than an open-air environment ^[a].
- Mask wearing, social distancing and personal hygiene are key personal measures to reduce the risk of infection.
- Addressing the risk of environmental transmission routes via contaminated fomites or air is as important as addressing transmission risk of human-tohuman contact.

^[a] Hiroshi *et al.* Closed Environments facilitate secondary transmission of coronavirus disease 2019. MedRxiv Preprint (2020)

^[b] Dhand et al. Coughs and Sneezes: Their Role in Transmission of Respiratory Viral Infections, Including SARS-CoV-2, American Journal of Respiratory and Critical Care Medicine (2020)

Modes of Transmission-Airborne

WHO

- Can be transmitted by airborne route indoors
- Super-spreading incidents with observed or suspected low outdoor air exchange rates
- Evidence of impact on transmission by in-room recirculation when outdoor air exchange is inadequate
- Aerosols can suspend in the air/travel further than 2 meter in poorly ventilated space

World Health Organization World World World Organ Dr. Maria Neira MHO Director, Department of Public Health, Environmental and Social Determinants of Health

"Ventilation represents a very important aspect, a very important factor to prevent the virus from spreading indoors"

> - WHO Science in 5 https://www.youtube.com/ watch?v=XJC1f7F4qtc

The Guangzhou restaurant incident was the most influential evidence of airborne spread



Li et. al. 2020. COVID-19 Outbreak associated with air conditioning in restaurant, Guangzhou, China, 2020.

3 key strategies to guide IAQ management



Spaces with Different Types of Ventilation

Naturally Ventilated Space

Air-Con space with Mechanical Ventilation Provision

(eg: centralised air-conditioning system)

Air-con space without mechanical ventilation Provision

(eg:split-unit air-conditioners or FCUs without fresh air supply)







Generally, Natural ventilated space has the lowest risk;

For enclose space with air-conditioning, make sure there is fresh air intake

General Guidance for naturally ventilated premises



occupied

spaces (e.g.:

water seal).

Potential pitfalls -Use of fans in naturally ventilated areas





1. Use of fans when windows and door are closed

Keep windows and/or doors open at all times, unless outdoor air quality is poor or the weather condition does not allow.
b. Position fans at windows to blow air outwards and increase air exchange

Toilets

Ensure that the water seal under the floor trap is intact. i.e. water runs through these traps regularly.

As a precaution, disinfectant can be poured into the trap daily or install a lid with one way valve



Keeping homes sanitary

Sanitation systems in residential buildings here have safeguards that prevent pathogens from being transmitted between households. AUDREY TAN speaks with Mr Maurice Neo, director of the water reclamation network at national water agency PUB, to find out more.





1. Increase ventilation and enhance air exchange.

E.g.: Open operable windows and doors as frequently as possible 2. Consider installing windowmounted exhaust fans to enhance ventilation 3. In enclosed spaces with high risk of disease transmission , portable air cleaners for localised air cleaning may be considered as an interim measure 4. Where ceiling height allows, upper-room UVGI may be considered for air cleaning 5. Check other systems to ensure there is no undesired air leakage into occupied spaces.



Ensure minimum ventilation rates specified in SS553

Check AHUs/FCUs/PAUs/FAFs/EAFs 5 daily to ensure continuous operation

Check all supply/exhaust air diffusers/grilles to ensure airflow in the correct direction.

Maintain ACMV systems regularly







3. Purge indoor air before occupancy Air purging at least once a day and for at least two hours before each occupancy

4. Minimise indoor air recirculation; use efficient filters in AHUs to treat recirculated air 4a.Reduce return air damper (or airflow) setpoints to minimise recirculation, when conditions allow

4c. Switch off rotatory heat changers or heat recovery wheels

4. Minimise indoor air recirculation; use efficient filters in AHUs to treat recirculated air

4d. Ultraviolet Germicidal irradiation (UVGI) may be used in AHUs/ducts

5. Increase ventilation in premises with limited ventilation and air filtration provision Kept toilet/bathroom exhaust running at full capacity for longer operating hours (24/7) to enhance ventilation. Check no reverse flow of toilet exhaust air.

Potential pitfalls – Exhaust fans

Pay attention on toilets and shower rooms, because they are shared space and a place with frequent discharge of bodily fluid which can carry virus if user is infected

Ensure very good ventilation, install exhaust fan, wall fans. Ensure exhaust not discharged near windows of occupied space, or where many people pass by or spend time

Potential pitfalls – Exhaust fans

- Exhaust fan located too near the open window – short circuit of air flow. I.e.
- To allow cross ventilation by opening all the windows except those windows around exhaust fans to avoid short-circuiting of air flow.
- 2. Exhaust blocked, and outdoor ventilation poor; or exhaust too close to windows of occupied space
- Exhaust positioned in well ventilated space with little risk of introducing air into other indoor space

Standard for Indoor Air Quality in Air-conditioned Buildings

Provides information and guidance to achieve indoor air quality that will be <u>acceptable</u> to building occupants and to minimise the potential of adverse health effects.

Air in an occupied space toward which a substantial majority (80 %) of occupants express no dissatisfaction and in which there are not likely to be known contaminants at concentrations leading to exposures that pose a significant health risk.

New amendment has been published in September 2021

Inclusion of an Annex on Mitigating risk of aerosol-mediated transmission of infectious diseases

- Advises building/facilities managers to conduct assessment of risk of aerosol transmission of diseases in building
- Recommends measures for **enhancing ventilation** and/or **air cleaning** in spaces
- Encourages the use of carbon dioxide concentrations as a surrogate for ventilation, where measurement of ventilation rates is not feasible

IAQ parameters and audits

- The SS554 lists a set of recommended IAQ parameters and their respective acceptable limits. Acceptable limits for particulate matter (PM) and chemical contaminants (e.g. carbon dioxide, VOCs) are specified by concentration and duration of exposure.
- ii. In addition to this list, acceptable limits of contaminants triggered by specific sources (e.g. ozone, asbestos and nicotine) are also specified in the SS554.
- iii. An IAQ laboratory accredited by the Singapore Accreditation Council (SAC) may be engaged to conduct IAQ audits. Building managers may tailor the coverage of IAQ audits according to their IAQ management strategy

Standard for Air Conditioning and Mechanical Ventilation

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The SS553:2016 provides minimum requirements in design, and operation of mechanical ventilation and air-conditioning systems to help attain an acceptable indoor thermal environment in an energy efficient manner

Outdoor air supply requirements for comfort air conditioning

Type of building/occupancy	Minimum outdoor air supply				
	l/s per m ² floor area	m ³ /h per m ² floor area	l/s per person		
Restaurants	3.4	12.2	5.1		
Dance hall	7.0	25.0	10.5		
Gym	3.8	13.6	13.2		
Offices	0.6	2.0	5.5		
Shops, supermarkets & department stores	1.1	3.8	5.5		
Theatres & cinema seating area	2.0	7.3	3.0		
Lobbies & corridors	0.3	1.1	3.3		
Concourse	1.1	4.0	3.3		
Hotel guest rooms	15 per room	54.0 per room	5.5		

WSH Guidelines for Management of IAQ in Air-Conditioned Workplaces

Workplace Safety and Health Guidelines Management of Indoor Air Quality In Air Conditioned Workplaces

Recommends implementing IAQ Management Programme for a systematic approach to achieving good IAQ in indoor work premises

Use CO2 concentration level as a surrogate for ventilation

Carbon dioxide (CO_2) monitoring can provide information on ventilation in indoor spaces, which can be used as indicators to enhance protection against COVID-19 transmission. There is, however, no direct correlation between CO_2 levels and transmission risk.

- Singapore Standard SS554:2016 Code of Practice for Indoor Air Quality for Air-Conditioned Buildings CO₂ thresholds:
 - <800 ppm for enclosed space (recommended for COVID-19 situation under <u>SS554</u>*)
 - <1,100 ppm (limits under <u>SS554</u>*)
- The US Centre of Disease Control and Prevention (CDC) recommends enhancing air filtration (e.g. portable HEPA air purifiers) if levels cannot be maintained below 800ppm (gross)
- The Federation of European Heating, Ventilation and Air-conditioning Associations (REHVA) recommends 800ppm as a warning level to trigger remedial action to achieve sufficient ventilation.

CO2 Levels are Linked to Ventilation Type

• NV spaces (e.g. hawker centres, markets, NV classrooms, coffeeshops) generally well ventilated, 1% of premises surveyed (5) exceeded 800ppm, none exceeded 1,100ppm

Non-MV premises were 3.1 times more likely than MV premises to exceed 1,100ppm threshold, and 2.9 times more likely to exceed 800ppm threshold

• Improvement of ventilation of non-MV premises is warranted

Ventilation Type	Proportion of premises* (%)				
	<800 ppm	800 to <1,100 ppm	1,100 to <2,000 ppm	≥2,000 ppm	
NV (n=548)	99.1	0.9	0.0	0.0	
MV (n=889)	76.7	16.1	6.9	0.3	
Non-MV (n=549)	58.3	24.6	15.3	1.8	

Recommend CO2 concentration level to be as close to ambient 400 ppm as possible for NV space

If no option to ventilate or doing high-risk activities, can use air cleaning tech to supplement to clean the air

The minimum smoke CADR can be estimated as follows, according to AHAM AC-1 standard: smoke CADR (cmh) \geq room size (cubic meter) \times 5 smoke CADR (cfm) \geq room size (cubic feet) \div 12

Recommendations on portable air purifiers

https://www.nea.gov.sg/our-services/public-cleanliness/environmental-cleaning-guidelines/guidelines/guidancenote-on-use-of-air-cleaning-technologies-to-mitigate-covid-19-aerosol-transmission-risk

Potential pitfalls for use of air purifier

Air purifiers were placed near the open window instead of residents' beds.

• Air purifier should be positioned near to residents to provide maximum treatment of possible source of infection.

If no option to ventilate or doing high-risk activities, can use air cleaning tech to supplement to clean the air

Recommendations on Air-Cleaning Technologies

https://www.nea.gov.sg/our-services/public-cleanliness/environmental-cleaning-guidelines/guidelines/guidancenote-on-use-of-air-cleaning-technologies-to-mitigate-covid-19-aerosol-transmission-risk

References and Links

SS554:2016 Code of practice for indoor air quality for air-conditioned buildings SS553:2016 Code of practice for air-conditioning and mechanical ventilation in buildings

Free access currently available at https://www.singaporestandardseshop.sg/Covid19/Desktop

• https://www.singaporestandardseshop.sg/

Guidance on Improving Ventilation and Indoor Air Quality in Buildings amid the COVID-19 situation

• <u>https://www.nea.gov.sg/our-services/public-cleanliness/environmental-cleaning-guidelines/advisories/guidance-on-improving-ventilation-and-indoor-air-quality-in-buildings-amid-the-covid-19-situation</u>

Technical Advisory on Use of Air-Cleaning Technologies to Mitigate COVID-19 Aerosol Transmission Risk

• <u>https://www.nea.gov.sg/our-services/public-cleanliness/environmental-cleaning-guidelines/guidelines/guidance-note-on-use-of-air-cleaning-technologies-to-mitigate-covid-19-aerosol-transmission-risk</u>

List of laboratories accredited by the Singapore Accreditation Council

<u>https://sac-accreditations.gov.sg/Pages/Homepage.aspx</u>

Roadmap to improve and ensure good indoor ventilation in the context of COVID-19, World Health, 1 March 2021,

https://www.who.int/publications/i/item/9789240021280

Heating, ventilation and air-conditioning systems in the context of COVID-19: first update, European Centre for Disease Prevention and Control, 11 November 2020,

• https://www.ecdc.europa.eu/en/publications-data/heating-ventilation-air-conditioningsystemscovid-19

Ventilation in Buildings, Centers for Disease Control and Prevention, 2 June 2021,

<u>https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html</u>

How to operate HVAC and other building service systems to prevent the spread of the coronavirus (SARS-CoV-2) disease (COVID-19) in workplaces, REHVA COVID 19 Guidance version 4.1, 15 April 2021,

• <u>https://www.rehva.eu/activities/covid-19-guidance/rehva-covid-19-guidance</u>

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