25 May 2021

UPDATED GUIDANCE NOTE ON IMPROVING VENTILATION AND INDOOR AIR QUALITY IN BUILDINGS AMID THE COVID-19 SITUATION

1. Introduction

1.1. COVID-19 is mainly transmitted by close contact and respiratory droplets which are released when an infected person coughs, sneezes, talks, or sings. It can also be spread through virus aerosols in the air under certain settings, such as enclosed environments which are poorly ventilated. Hence, it is critical to mitigate this risk by improving ventilation and air quality in indoor environments.

1.2. This Guidance Note provides building owners and facilities managers with updated recommended measures to enhance ventilation and air quality in indoor spaces, through the proper operations and maintenance of air-conditioning and mechanical ventilation (ACMV)[1] systems. It is aimed at reducing disease transmission amid the current COVID-19 situation and resurgence of community cases. An earlier version of this document was issued on 29 May 2020.

1.3. This Guidance Note applies to non-residential premises where air-conditioning is used intermittently or continuously, as well as to naturally ventilated premises, with the exception of specialised premises[2] such as certain factory production areas, hospitals, polyclinics, and laboratories. Advice from subject matter experts and specialists should be sought for specialised premises.

1.4. Occupants of residential homes may improve home ventilation by opening doors and windows, especially when hosting non-household guests. Fans can be used to promote air circulation when needed.

1.5. The recommended measures in this Guidance Note should be accompanied by other key measures to reduce disease transmission, such as requiring building occupants to practise safe distancing, wearing masks, and carrying out regular disinfection of high-touch points within the building[3].

1.6. A comprehensive plan should be created for safe management of indoor spaces, including developing communication plans to garner support from occupants, increasing ventilation, and ensuring supply of critical items such as filters. Managers should tailor the measures to each space, maximising

[1] ACMV systems include air handling units and fan coil units such as cassette- or wall-mounted types.
[2] Specialised premises refer to those with ACMV systems that fall outside the scope of SS553: Code of Practice for Air Conditioning and Mechanical Ventilation in Buildings.
[3] https://www.nea.gov.sg/our-services/public-cleanliness/environmental-cleaning-guidelines

ventilation while taking factors such as the type of ventilation system in the indoor space, the area of the indoor space, occupants' thermal comfort, and relative humidity into consideration. Indoor relative humidity should be closely monitored and maintained according to Singapore Standard SS554: Code of Practice for Indoor Air Quality for Air-Conditioned Buildings.

2. Measures for air-conditioned premises with mechanical ventilation provision (e.g. centralised air-conditioning system)

2.1. Ensure that ventilation systems are in good working order:

a. Check ACMV systems to ensure adequate ventilation in all occupied spaces, based on at least the minimum outdoor air supply rates specified in Singapore Standard SS553: Code of Practice for Air Conditioning and Mechanical Ventilation in Buildings[4]. Use of sensors and systems for monitoring outdoor air supply rate should be considered.
b. Check AHUs/FCUs/PAUs/FAFs/EAFs [5] daily to ensure continuous operation, especially in occupied spaces.
c. Check all supply air diffusers and exhaust grilles to ensure airflow movement is in the correct direction.
d. Maintain ACMV systems regularly. This includes inspecting and cleaning supply fans and exhaust fans to ensure optimal operation, checking of air ducts and dampers to ensure no air leakages or blockages, and checking filter seals to avoid air bypass. Recommended maintenance frequencies are specified in SS554:2016 Annex H. Changing of filters should be done during non-operational periods, with the ACMV system turned off. Used filters should be properly disposed of in sealed bags. Maintenance staff should wear the appropriate PPE, comprising at least N95 masks, eye protection, and gloves, especially when changing filters.
e. Check other systems to ensure there is no undesired air leakage into occupied spaces, including water seals in the sanitary system, cracks in pipes and ducts, and wall gaps. Rectify faults detected.

2.2. Maximise ventilation for indoor air dilution:

a. Maximise outdoor air intake and supply by setting AHUs/FCUs/PAUs/FAFs/EAFs to maximum speed and capacity with all air dampers (e.g. volume control dampers) opened fully. Increase outdoor air supply rate to 10 L/s/person if the system can accommodate this[6].
b. Deactivate demand control systems, such as those with CO_2 sensors, to avoid automatic reduction of outdoor air supply.
c. Open all air dampers and do not block air ducts to ensure optimal provision of outdoor air to all occupied spaces.
d. The air distribution system should be balanced to ensure outdoor air provision to all intended spaces.

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[4] For building/occupancy types not listed in SS553, ASHRAE 62.1 should be used as reference.
[5] AHU: air handling unit; FCU: fan coil unit; PAU: primary/pre-cool air handling unit; FAF: fresh air fan; EAF: exhaust air fan
[6] World Health Organization - Roadmap to improve and ensure good indoor ventilation in the context of COVID-19. https://www.who.int/publications/i/item/9789240021280

e. Operate exhaust fans (e.g. in toilets, kitchens) at full capacity to expel air from indoor spaces. Keep windows and other openings (e.g. back door) around exhaust fans closed to avoid short-circuiting of air flow.
f. Install additional supply and/or exhaust fans if the existing system does not deliver sufficient outdoor air[7].
g. If the system does not allow for increasing the ventilation up to the recommended minimum per person requirement, consider reducing the maximum room occupancy.

2.3. Purge indoor air before occupancy:
a. Perform air purging at least once a day and for at least two hours before each occupancy. Increased purging frequency can be considered for spaces with high disease transmission risk[8].
b. For buildings without air purging systems, extend operation of ACMV systems with outdoor air intake for two hours before and after each occupancy.

2.4. Minimise indoor air recirculation; use high-efficiency filters in AHUs to treat recirculated air:
a. Set recirculation air dampers to a minimum.
b. Use high-efficiency filters (at least MERV14 or F8 is recommended) in AHUs to treat recirculated air. Filters should be properly installed and maintained according to manufacturers' recommendation.
c. Use of air-cleaning technologies such as ultraviolet germicidal irradiation (UVGI) in AHUs may be considered to augment MERV14 filters. Efficacy and safety of all air-cleaning devices under the operating conditions must be considered.
d. Switch off rotatory heat changers or heat recovery wheels to reduce risk of carry-over leakage from exhaust air.

2.5. Increase ventilation in premises with limited ventilation and air filtration provision (e.g. meeting rooms with only FCU):
a. Open operable windows and doors as frequently as possible[9], unless outdoor/outside air quality is poor. Air-conditioning should be reduced or turned off when doors and/or windows are opened.
b. Consider positioning fans at windows to blow air outwards and increase air exchange.
c. Consider adding dedicated outdoor air supply and/or exhaust[7].
d. Where there is a high risk[8] of disease transmission, portable air cleaners for localised air cleaning may be considered as an interim measure, in line with the recommendation for spaces without mechanical ventilation (please see section 3.3).

[7] To avoid mould growth due to condensation caused by introduction of excessive humid outdoor air, outdoor air may be treated by a dedicated outdoor air processing system. The outdoor air system can be designed such that high-efficiency (MERV14 or F8) filters can be fitted when necessary. The filter will be useful during times when windows cannot be opened due to poor outdoor air quality.
[8] Such spaces include those where bioaerosol-generating procedures are performed on people (e.g. nasophryngeal swab taking and dental procedures), where COVID-19 patients may be present, or where masks must be removed.
[9] European CDC: Heating, ventilation and air-conditioning systems in the context of COVID-19: first update, Nov 2020

3. Measures for enclosed air-conditioned premises without mechanical ventilation provision (e.g. split-unit air-conditioners or FCUs without fresh air supply)

3.1. Increase ventilation and enhance air exchange:

a. Open operable windows and doors as frequently as possible[10], unless outdoor air quality is poor. Air-conditioning should be reduced or turned off when doors and/or windows are opened.
b. Consider adding dedicated outdoor air supply and/exhaust[11].
c. Operate exhaust fans (e.g. toilet, kitchen) at full capacity to expel air form the indoor space. Keep windows or other openings (e.g. back door) around exhaust fans closed to avoid short-circuiting of air flow.

3.2. Consider installing window-mounted exhaust fans to enhance ventilation:

a. The fan system should at least provide the minimum air changes specified in SS553.
b. Air supply and exhaust system can be aligned to provide uni-directional airflow in a poorly ventilated space.

3.3. In enclosed spaces with high risk[12] of disease transmission, portable air cleaners for localised air cleaning may be considered as an interim measure:

a. Portable air cleaners should be equipped with high-efficiency air filters such as HEPA filters, which are effective at removing virus aerosols.
b. The clean air delivery rate (CADR) or equivalent of a portable air purifier should be used to determine the size and number of portable air cleaner devices needed in a space[13].
c. If present, the portable air cleaner's ozone generation function should be turned off to avoid exposure to excessive ozone levels and by-products, which may be hazardous to health.
d. The use of portable air cleaners should be considered an interim measure. **Air cleaning does not replace the need for adequate ventilation**. Regular surface cleaning and disinfection[14] should also continue, as portable air cleaners do not remove surface contamination.

3.4. Check other systems to ensure there is no undesired air leakage into occupied spaces, including water seals in the sanitary system, cracks in pipes and ducts, and wall gaps. Rectify faults detected.

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[10] European CDC: Heating, ventilation and air-conditioning systems in the context of COVID-19: first update, Nov 2020

[11] To avoid mould growth due to condensation caused by introduction of excessive humid outdoor air, outdoor air may be treated by a dedicated outdoor air processing system. The outdoor air system can be designed such that high-efficiency (MERV14 or F8) filters can be fitted when necessary. The filter will be useful during times when windows cannot be opened due to poor outdoor air quality.

[12] Such spaces include those where bioaerosol-generating procedures are performed on people (e.g. nasophryngeal swab taking and dental procedures), where COVID-19 patients may be present, or where masks must be removed.

[13] The size and number of portable air cleaner devices used shall be based on CADR. If the unit of CADR is in m^3/h, the total CADR of the air purifier(s) should be at least five times the room volume in m^3.

[14] https://www.nea.gov.sg/our-services/public-cleanliness/environmental-cleaning-guidelines

4. Measures for naturally ventilated premises

4.1. Natural ventilation is weather dependent. It could be limited to the area around the windows and doors (perimeter zones), with little air exchange in the mid portion of the space (internal zones). Cross ventilation is significantly more effective than single-sided ventilation.

4.2. Increase natural ventilation with enhancement by fans:

a. 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
c. Operate exhaust fans (e.g. toilet, kitchen) at full capacity to expel air form the indoor space. Keep windows or other openings (e.g. back door) around exhaust fans closed to avoid short-circuiting of air flow.

4.3. Consider installing window-mounted exhaust fans to enhance ventilation:

a. The fan system should at least provide the minimum air changes specified in SS553.
b. Air supply and exhaust system can be aligned to provide uni-directional airflow in a poorly ventilated space.

4.4. Check other systems to ensure there is no undesired air leakage into occupied spaces, including water seals in the sanitary system and cracks in pipes and ducts. Rectify faults detected.

5. More information and contacts

5.1. To assess the adequacy of ventilation, measurement of ventilation rate is required. If not possible, carbon dioxide levels at occupied areas may be used as a surrogate. According to SS554, high carbon dioxide levels, more than 700 ppm in excess of outdoor level, indicates poor ventilation or overcrowding. In view of the current COVID-19 situation, premises owners should achieve lower levels.

5.2. Further reference can be made to similar guidance documents published by ASHRAE[15], REHVA[16], WHO[17] and SS553:2016 Annex D[18].

5.3. Please feel free to contact the following officers if you need further clarifications.
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[15] American Society of Heating, Refrigerating and Air-Conditioning Engineers https://www.ashrae.org/technical-resources/resources
[16] Federation of European Heating, Ventilation and Air Conditioning Association https://www.rehva.eu/activities/covid-19-guidance
[17] World Health Organization - Roadmap to improve and ensure good indoor ventilation in the context of COVID-19. https://www.who.int/publications/i/item/9789240021280
[18] SS553 Annex D is currently undergoing public comment process.