New standards, guidelines or regulations for ventilation due to COVID-19

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Introduction

- During 2020-2022 the whole world was impacted by the COVID-19 pandemic.
- A group of scientist convinced WHO of the importance of ventilation
- Several organizations working with ventilation and the indoor environment have been active in leading research and distributing information
- The present webinar includes presentations of new guidelines, standards, or regulations from North America, Europe and Asia.
- This webinar is organized with the support of the Air Infiltration and Ventilation Centre and facilitated by INIVE..

AGENDA

- 15:00 | Welcome & Introduction, Bjarne W. Olesen (Prof. at ICIEE, Technical University of Denmark
- ASHRAE standard 241-2023 Control of Infectious Aerosols, William P. Bahnfleth (Prof. of Architectural Engineering, the Pennsylvania State University, **USA**) -
- Revision of European standard EN 16798-1: Ventilation and air cleaning in reducing airborne transmission, Jarek Kurnitski (REHVA Technology and Research Committee, **EU**)
- India task force on Covid guidelines, Jyotirmay Mathur (Prof. in Mechanical Engineering and Centre for Energy and Environment, MNIT Jaipur, **INDIA**)
- An overview of the revision of Singapore Standards (SS553 and SS554) for control of infectious aerosols in buildings, Chandra Sekhar (Prof. Department of the Built Environment College of Design and Engineering, National University of **Singapore**, SG)
- A new system adopted by Tokyo to address the threat of infectious diseases, Shin-Ichi Tanabe (Prof., Ph.D Department of Architecture, Waseda University, **JAPAN**) -
- Questions and answers - 25 min
- 16:30 | End of the webinar

PennState College of Engineering | ARCHITECTURAL ENGINEERING

ASHRAE

AIVC – New Standard, Guidelines, or Regulations for Ventilation due to COVID-19

ASHRAE STANDARD 241
Control of Infectious Aerosols

Prof. William P. Bahnfleth, PhD, PE
The Pennsylvania State University
Chair, ASHRAE SSPC 241

February 12, 2024

1

ASHRAE Standard 241-2023
Control of Infectious Aerosols

Purpose

- Requirements for control of infectious aerosols to reduce risk of airborne transmission
  - Occupiable space in existing and new buildings, additions, and major renovations
  - Non-residential, residential, and health care spaces
  - Covers outdoor air and air cleaning system design, installation, commissioning, operation, maintenance
- Specify *equivalent clean air* to be provided in *infection risk management mode*

Scope

- Based on reduction of *long range transmission* risk
- Does not establish overall requirements for acceptable indoor air quality but requires IAQ as a pre-requisite

2

Infection Risk Management Mode (IRMM)

The mode of operation in which measures to reduce infectious aerosol exposure documented in a building readiness plan are active

Decision on IRMM Enable / Disable: Not specified in 241

- Public health official
- Owner
- Occupant

Why not all the time?

- Potential Energy use and cost increase
- Infection risk and consequences of infection vary over a wide range

An example of resilience applied to IAQ

Normal IRMM

3

Equivalent Clean Airflow (ECA)

The flow rate of pathogen-free air that, if distributed uniformly within the breathing zone, would have the same effect on infectious aerosol concentration as the sum of actual outdoor airflow, filtered airflow, and inactivation of infectious aerosols

Concept on which the entire standard depends

- Determine ECA for infection risk mitigation (ECAi)
- Determine total ECA for spaces, systems (V_{ECAi})
- Analyze options to reach target in IRMM

Also adopted from Epidemic Task Force guidance
(same as *equivalent outdoor air*)

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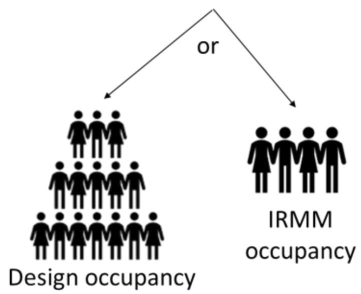
ECAi depends on space type, number of people, activity

$$V_{ECAi} = ECAi \times P_{Z,IRMM}$$



Double table ECAi for high vocalization spaces

Occupancy Category	ECAi cfm/person	ECAi L/s/person
Correctional Facilities		
Cell	30	15
Dayroom	40	20
Commercial/Retail		
Food and beverage facilities	60	30
Gym	80	40
Office	30	15
Retail	40	20
Transportation waiting	60	30
Educational Facilities		
Classroom	40	20
Lecture hall	50	25
Industrial		
Manufacturing	50	25
Sorting, packing, light assembly	20	10
Warehouse	20	10
Health Care		
Exam room	40	20
Group treatment area	70	35
Patient room	70	35
Resident room	50	25
Waiting room	90	45
Public Assembly/Sports and Entertainment		
Auditorium	50	25
Place of religious worship	50	25
Museum	60	30
Convention	60	30
Spectator area	50	25
Lobbies	50	25
Residential		
Common space	50	25
Dwelling unit	30	15

Meeting the ECA target

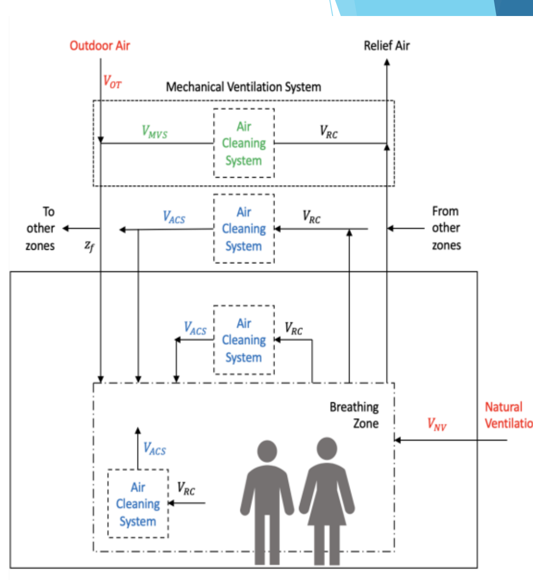
Requirement can be met by

- Outdoor airflow – mechanical/natural
- ECA from multi-zone air cleaning systems
- ECA from in-room air cleaning systems

Approach allows maximum flexibility to user

Limitations on compliance

- Must have prerequisite minimum outdoor air
- To receive credit toward meeting requirements, mechanical filters must be MERV-A 11 or higher or equivalent (ePM2.5>50%)
- MERV 11 acceptable until 1/1/2025
- Hope to raise to ePM1>50%



Air Cleaning

Reducing infectious aerosol concentration through capture and removal or inactivation

Air cleaning technologies

- Mechanical filters (including electret media)
- Germicidal ultraviolet light
- Reactive species – ionizers, photocatalytic oxidation, other oxidants

Mention of specific technologies in the standard is not endorsement!

Air Cleaning Effectiveness and Safety

Lack of information and standards related to air cleaning systems was a major problem during the COVID19 pandemic:

- Effectiveness – ability to remove or inactivate infectious aerosols
- Safety – adverse effects of direct exposure (UV-C, oxidants), secondary contaminants (particles, ozone); not required for purely mechanical filtration

Standard 241 establishes backup minimum requirements for effectiveness and safety testing in Normative Appendix A

- For when no applicable standard exists

Goal is a level playing field for all technologies

Building Readiness Plan (BRP)

Reduced detail for dwellings

ASHRAE EPIDEMIC TASK FORCE

BUILDING READINESS | Updated 5-17-2022

General Information
- Building Readiness Intent
- Building Readiness Team
- Building Readiness Plan

Epidemic Conditions in Place (ECiP)
- Systems Evaluation
- Building Automation Systems (BAS)
- Ventilation per Code / Design
- Increased Ventilation above Code
- Increased Ventilation Control
- Building and Space Pressure
- Flushing Between Occupied Periods
- Equivalent Outdoor Air
- Upgrading and Improving Filtration
- Filter Droplet Nuclei Efficiency / Particle Size Expectations
- Energy Savings Considerations
- Exhaust Air Re-entrainment
- Energy Recovery Ventilation Systems Operation Considerations
- UVGI Systems
- Domestic Water & Plumbing Systems
- Maintenance Checks
- Shutdown a Building Temporarily-FAQ
- System Manual
- Reopening During Epidemic Conditions in Place

Post-Epidemic Conditions in Place (P-ECiP)
- P-ECiP: Prior to Occupying
- P-ECiP: Operational Considerations once Occupied
- P-ECiP: Ventilation
- P-ECiP: Filtration
- P-ECiP: Building Maintenance Program
- P-ECiP: Systems Manual

Additional Information
- Acknowledgements
- References
- Disclaimer

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. They are not intended and should not be relied upon as official statements of ASHRAE.

Assessment, planning, and implementation

Builds on ASHRAE Epidemic Task Force Building Readiness guidance

Applies commissioning practices to infection risk mitigation systems

Requirements for developing the Building Readiness Plan
- optional for dwellings

Assessment of existing V_{ECAi} to determine need for additional controls

Supporting information
- Tracer particle test procedure for determining V_{ECAi} in-place (appendix)
- Checklists for assessment and commissioning (appendix)
- Building Readiness Plan template (appendix)
- Equivalent clean air calculator (download at ashrae.org/241-2023)
- Guidance on assessing energy recovery ventilators (download)
- Guidance on preventing re-entry of contaminated air (download)

Operations

(Requirements are optional for dwellings)

- BRP on site, accessible, current
- Essential supplies stocked
- Operator training
- Occupant communication
- Operating modes in place:
  - Normal – occupied/unoccupied
  - IRMM – occupied/unoccupied
  - Temporary shutdown

Temperature and humidity

- maintain design set points when occupied

Operating schedules

- On for all occupied hours
- No on-off control of HVAC fans

Flushing not required between occupancy periods

Maintenance

Maintenance tasks and frequencies for all occupancies and system types follow ASHRAE/ACCA Standard 180 plus additional requirements →

Frequency of some checks increased for IRMM

Table 9-2 Minimum Maintenance Activity and Frequency for Additional Engineering Controls and Associated Components While in Use

Engineering Control	Inspection/Maintenance Task	Frequency
In-room air cleaners	Verify unit is in appropriate location and operating as intended per the *BRP*. Confirm that the air cleaner is operating at the speed or setting assumed in the V_{ECAi} calculation. Maintain systems and equipment and verify performance per manufacturer's instructions. Visually inspect intake for debris and clean as necessary.	Monthly
Ultraviolet (UV) germicidal irradiation	Maintain systems and verify performance and safety per manufacturer's instructions and in accordance with ANSI/IES RP-44-21 [11] and ANSI/IES RP-27.1.22 [20] or equivalent. Adjust, clean, and replace equipment as needed.	Assess quarterly or per manufacturer's recommended interval
All air cleaning systems and equipment (including in-room, in-duct, and UV air cleaners)	Maintain systems and equipment and verify performance per manufacturer's instructions. Adjust, clean, and replace equipment as needed. If equipment cannot be repaired, remove equipment from service and use a substitute engineering control to maintain V_{ECAi} in occupied space.	Assess quarterly or per manufacturer's recommended interval
Separation space	The designated temporary separation areas shall be tested for negative pressure whenever an infected individual is present.	As used

Summary

1. Assess facility – condition and existing *equivalent clean air* delivered
2. Determine target equivalent clean air required by space and system
3. Determine need for additional equivalent clean air in *Infection Risk Management Mode (IRMM)*
4. Determine the best option for providing required equivalent clean air using outdoor air, particle filtration, and air cleaners tested as required, and operational measures
5. Prepare a Building Readiness Plan to document assessment and decisions
6. Perform repair and maintenance as needed and required
7. Make upgrades if needed
8. Apply IRMM when needed

Thank You

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NORDIC VENTILATION GROUP
Scientific collaboration

REHVA

Revision of European standard EN 16798-1: Ventilation and air cleaning in reducing airborne transmission

AIVC Webinar February 12, 2024

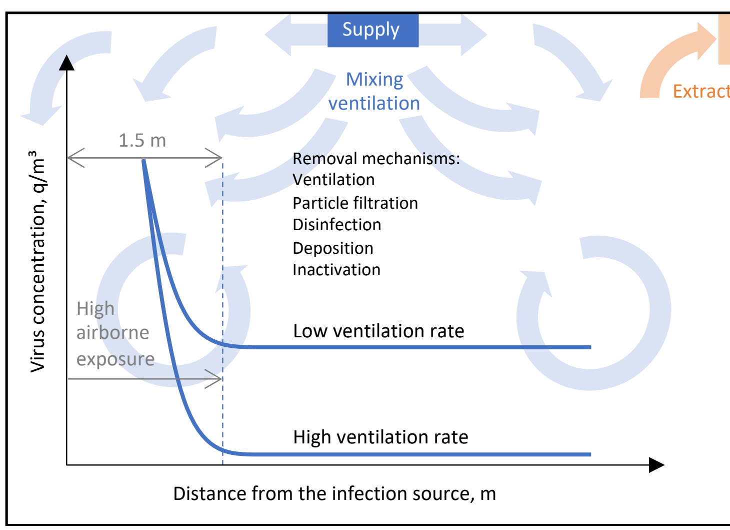
Jarek Kurnitski

Tallinn University of Technology, Aalto University, REHVA Technology & Research Committee, Nordic Ventilation Group

1

HVAC design for airborne transmission

- Exposure = dose is a product of the breathing rate, **concentration** and time
- Concentration control of virus containing particles: remove with **outdoor air ventilation** and **filtration** or deactivate with **UVG**
- **General ventilation** solutions for >1.5 m may be complemented with **personal ventilation** and room partitioning/zoning



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EN 16798-1 revision: Design for Health and Airborne Transmission

- Provides an opportunity for infection risk based ventilation design – not mandatory
- Calculation method of Wells-Riley model modification with latest dose-response model and quanta emission rates https://doi.org/10.1016/j.buildenv.2022.109924
- While quanta values have high variations, median viral load values provided as defaults in the informative annex, however may be specified in national annexes
- Infection risk control concept based on basic reproduction number R_0 = 1 during pre-symptomatic infectious period accounting all possible out-of-home interactions with susceptible persons https://doi.org/10.1016/j.enbuild.2023.113386
- For non-residential buildings (residential and health care settings excluded)
- Provides space category specific target ventilation rates for fully mixing air distribution
- Introduces point source ventilation effectiveness for actual air distribution solution

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Complementary for perceived air quality ventilation

Current ventilation criteria is based on perceived air quality by the visitors (unadapted) and occupants (adapted persons) that depend on the emissions from humans and building materials

Outdoor air flow rate:

$$q_{tot} = nq_p + A_R q_B$$

where
q_{tot} = total ventilation rate for the breathing zone, L/s
n = design value for the number of the persons in the room,
q_p = ventilation rate for occupancy per person, L/(s* person)
A_R = room floor area, m^2
q_B = ventilation rate for emissions from building, L/(s,m^2)

For low polluting materials (1 L/s = 3.6 m^3/h):

10 L/s per person + 1 L/s per floor area in Category I;

7 L/s per person + 0.7 L/s per floor area in Category II;

4 L/s per person + 0.4 L/s per floor area in Category III.

Cat II will lead to 2-2.5 ach in offices and 5 ach in classrooms and meeting rooms

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Follows proposal by Nordic Ventilation Group and REHVA

Target outdoor air ventilation rates *Q* (L/s) are calculated using the number of persons in room *N* (-) and the room volume *V* (m^3)

Space category	Ventilation rate, L/s
Classroom	Q = 10(N-1) – 0.24V
Office	Q = 23(N-1) – 0.24V
Assembly hall	Q = 30(N-1) – 0.24V
Meeting room	Q = 40(N-1) – 0.24V
Restaurant	Q = 40(N-1) – 0.24V
Gym	Q = 70(N-1) – 0.24V

Design ventilation rate supplied by the ventilation system:

$$Q_s = \frac{Q}{\varepsilon_b}$$

ε_b point source ventilation effectiveness for the breathing zone (-)

https://www.rehva.eu/activities/post-covid-ventilation

Proposed implementation in EN 16798-1 revision

- Infection-risk based target ventilation rates for fully mixing air distribution – generic equation (originally based on quanta, but may be also on relative risk reduction):

$$Q = q_q(N-1) - q_r V$$

where

Q target ventilation rate (L/s) (sum of outdoor and clean recirculated airflow rate)

q_q quanta emission specific ventilation rate for occupancy per person (L/(s person))

q_r removal rate of virus decay and deposition (L/(s m^3))

N **the number of persons in the room**

V **room volume (m^3)**

- q_q (viral load and risk level) and q_r (removal mechanisms) are virus specific parameters
- This equation may also be used to calculate allowed *N* at given ventilation rate

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Kurnitski et al. 2023 https://doi.org/10.1016/j.enbuild.2023.113386

Proposed implementation in EN 16798-1 revision

- Tabulated values for virus specific ventilation parameters q_q and q_r

Space category	q_q, L/(s person)	q_r, L/(s m^3)
Classroom	10	$0.24 + k_f/3.6$
Office	23	$0.24 + k_f/3.6$
Assembly hall	30	$0.24 + k_f/3.6$
Meeting room	40	$0.24 + k_f/3.6$
Restaurant	40	$0.24 + k_f/3.6$
Gym	70	$0.24 + k_f/3.6$

- In the case of no air cleaner, filtration removal rate (1/h) $k_f = 0$

$$k_f = \frac{Q_f \eta_f}{V}$$

- There are no IEQ categories in this case
- Tabulated values are informative (Annex B) and may be provided in the national annex

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Kurnitski et al. 2023 https://doi.org/10.1016/j.enbuild.2023.113386

Proposed implementation in EN 16798-1 revision

- Design ventilation rate supplied by the ventilation system Q_s is calculated with point source ventilation effectiveness ε_b for the breathing zone:

$$Q_s = \frac{Q}{\varepsilon_b}$$

- ε_b is to be calculated as an average of two or more tracer gas measurements with different source locations (or CFD simulations):

$$\varepsilon_b^j = \frac{C_{je} - C_{jo}}{C_{jb} - C_{jo}}$$

$$\varepsilon_b = \frac{\sum_j \varepsilon_b^j}{m}$$

- or with more dedicated method

where

ε_b^j	point source ventilation effectiveness of measurement *j*
ε_b	point source ventilation effectiveness for the breathing zone
C_{je}	measurement *j* concentration in the extract air duct
C_{jb}	measurement *j* concentration at the breathing level
C_{j0}	concentration in the supply air
m	total number of measurements with different point source locations

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Ventilation effectiveness

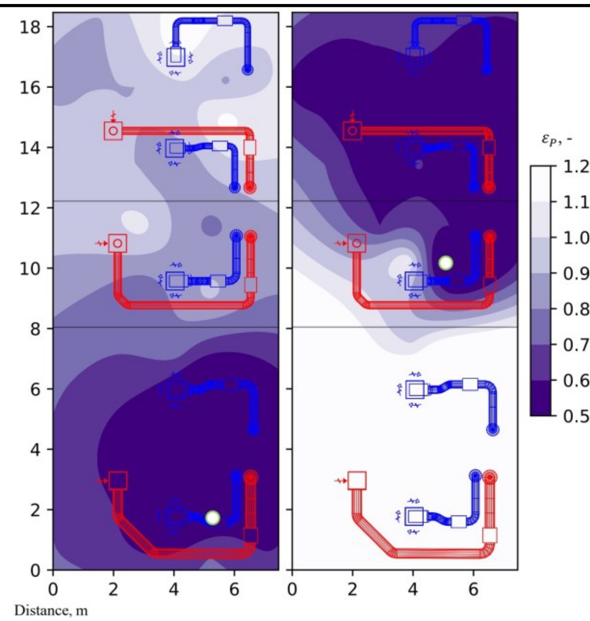
- To be determined with the point source (=infector)
- Existing values do not apply because measured with distributed source (=normal occupancy)

$$Q_s = \frac{Q}{\varepsilon_b}$$

$$\varepsilon_{P,i} = \frac{C_e - C_o}{C_i - C_o}$$

- ε_b can be calculated from local air quality index values:

$$\varepsilon_b^j = \frac{1}{\frac{\sum_{i=1}^{k}\left(\frac{1}{\varepsilon_{P,i}}\right)}{k}}$$



Large teaching space of 130 m² with 4 L/(s m²) ventilation: ε_b^1=0.76 (left) and ε_b^2=0.77 (right) and the average value of two measurements ε_b=0.76

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Calculation examples for typical rooms

	Floor area m²	Room height m	No of persons N, -	Ventilation effectiveness ε_b, -	Infection-risk-based ventilation: Ventilation rate L/(s pers)	Ventilation rate L/(s m²)	Air change rate 1/h	CO_2 conc. ppm	Comfort ventilation: Cat. II ventilation L/(s m²)	Cat. I ventilation L/(s m²)
Small classroom	31.6	3.5	13	1.00	7.2	3.0	3.0	1097	3.6	5.1
Classroom	42.5	2.9	25	0.91	9.2	5.4	6.7	941	4.8	6.9
Classroom	56.5	2.9	25	0.90	8.9	3.9	4.9	962	3.8	5.4
reduced occ.	56.5	2.9	20	0.90	8.4	3.0	3.7	999	3.2	4.5
Large teaching space	129.5	2.9	50	0.60	13.3	5.1	6.4	776	3.4	4.9
reduced occ.	129.5	2.9	40	0.60	12.5	3.8	4.8	801	2.9	4.1
2-person office	21.0	2.6	2	1.00	4.9	0.5	0.6	1535	1.4	2.0
Open-plan office	56.7	2.6	6	0.80	16.5	1.7	2.4	736	1.4	2.1
Open-plan office	173.0	2.6	17	0.60	25.4	2.5	3.5	619	1.4	2.0
Meeting room	29.2	2.6	10	1.00	34.2	11.7	16.2	563	3.1	4.4
reduced occ.	29.2	2.6	6	1.00	30.3	6.2	8.6	584	2.1	3.1

In highlighted cases, EN 16798-1 PAQ ventilation rate is higher

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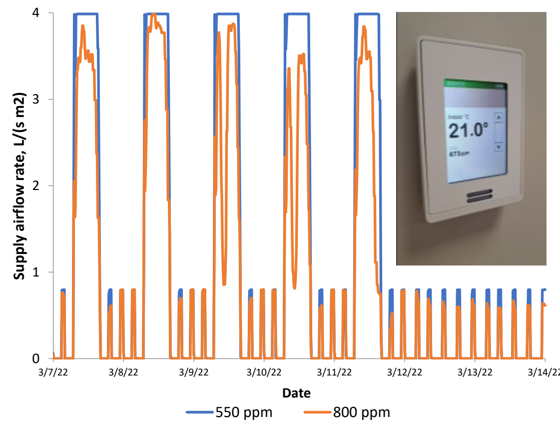
Operation for optimal indoor air quality - addressed in EN 16798-1 revision

Epidemic periods:

- CO_2 setpoint 550 ppm

Outside epidemic periods:

- operation according to perceived air quality design ventilation rate
- recommended CO_2 setpoints:
  - 800 ppm in classrooms and meeting rooms
  - 650 ppm in offices, restaurants, and gyms



Ventilation airflow rates in a typical classroom with CO_2 set point of 550 ppm and 800 ppm

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Conclusions

- EN 16798-1 revision proposes normative but selected-by-the-client design method for airborne transmission – not mandatory
- The method allows reverse engineering – max occupancy for epidemic periods can be calculated at given ventilation rate
- Stresses ventilation effectiveness: the issue of the point source / advanced air distribution solutions enable to reduce ventilation rates
- The aim is not to eliminate, but considerably reduce the infection risk: infector will cause no more than one new disease case during pre-symptomatic infectious period
- In typical classrooms and offices, infection risk-based ventilation rates mostly do not exceed Category I ventilation rates, ranging in classrooms 8-13 L/s per person
- In meeting rooms, restaurants and gyms, infection-risk based ventilation rates are remarkably high, indicating that feasible ventilation design would suggest to reduce occupancy and to use advanced air distribution

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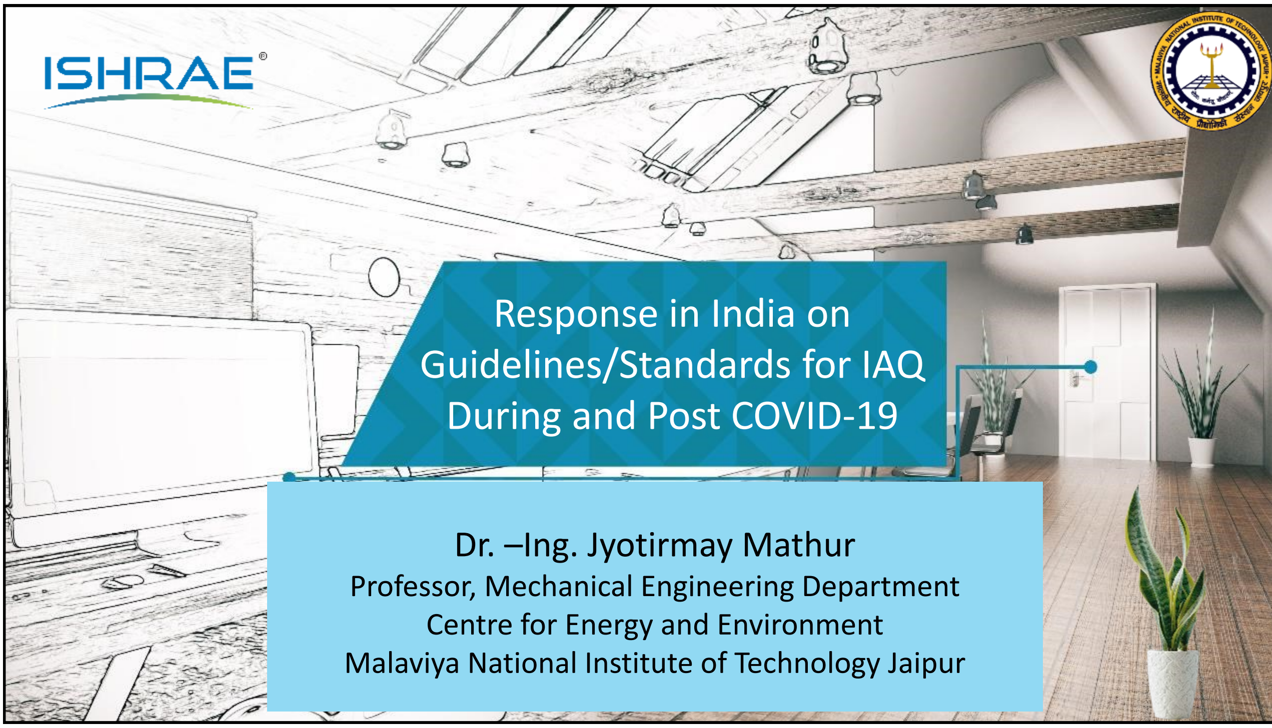
ISHRAE
Response in India on Guidelines/Standards for IAQ During and Post COVID-19
Dr. –Ing. Jyotirmay Mathur
Professor, Mechanical Engineering Department
Centre for Energy and Environment
Malaviya National Institute of Technology Jaipur

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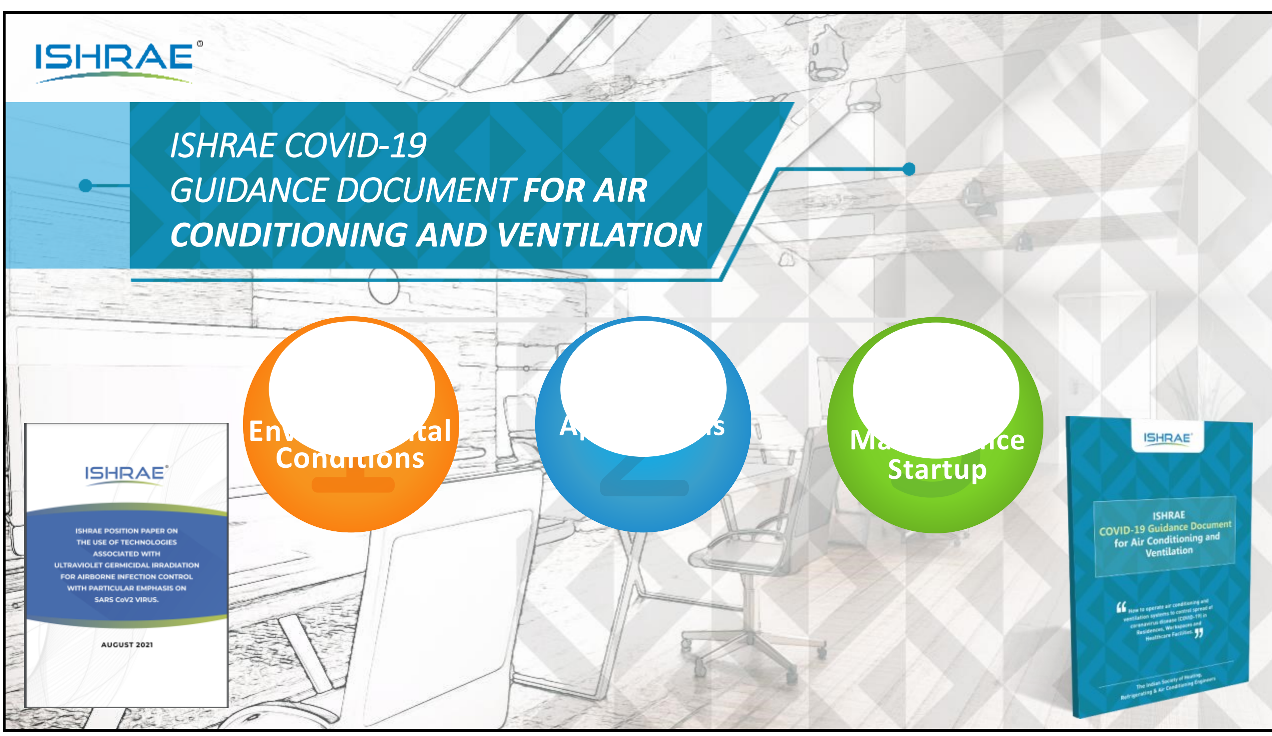
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ISHRAE COVID-19 GUIDANCE DOCUMENT FOR AIR CONDITIONING AND VENTILATION
Startup
ISHRAE
ISHRAE POSITION PAPER ON THE USE OF TECHNOLOGIES ASSOCIATED WITH ULTRAVIOLET GERMICIDAL IRRADIATION FOR AIRBORNE INFECTION CONTROL WITH PARTICULAR EMPHASIS ON SARS CoV2 VIRUS.
AUGUST 2021
ISHRAE
ISHRAE COVID-19 Guidance Document for Air Conditioning and Ventilation

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Indoor Environment

Commercial & Industrial Facilities

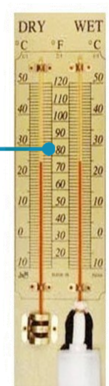
Operation, Maintenance & Starting Up

Residences

Portable Air Cleaners

Healthcare Facilities

Temperature and Relative Humidity



Suggested relative humidity level range: 40%-70%.

Caution against high humidity issues such as mould

Set Room Temperature between 24°C and 30°C.
(In humid climates set temperature closer to 24°C for de humidification and in dry climates closer to or at 30°C and use fans to increase air movement).

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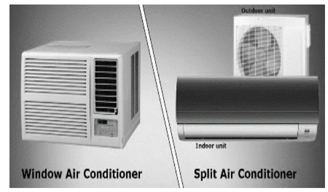
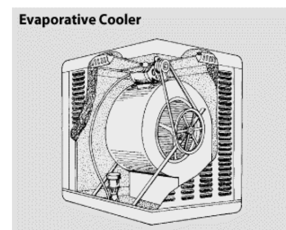
Room Air Conditioners and evaporative coolers

Recirculation of cool air by Room Air conditioners, must be accompanied by outdoor air intake through slightly open windows and exhaust by natural exfiltration.



In dry climates, do not allow Relative Humidity to fall below 40% .

Use humidifier if it falls below 40%.



Recommended to **add filter to evaporative cooler** to prevent dust entry

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Commercial Facilities – Operating Guidelines

- ***Provide adequate Ventilation (Fresh Air and Exhaust).***
  - *A minimum fresh air volume of 8.5 cum/hour per person and 1.1 cum per hour per sqm (5 cfm per person and 0.06 cfm per sq ft) must be provided . The recommendation is to **maximize supply of outside air** within the limits of the system.*
- ***Fresh air must preferably be provided by an inlet duct and fan.***
- **Heat Recovery Wheel (HRW) :** It is advisable to **keep this wheel in off mode** to reduce cross contamination.
- ***It is advisable to provide a MERV13 or higher filter fitted on the Air Handling Unit***.
- Install UVGI (Ultraviolet germicidal irradiation) for larger Ducted Units and AHUs to keep Coils continuously clean and disinfected.

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ADDITIONAL RECOMMENDATIONS FOR INDUSTRIAL FACILITES

- Minimum air changes of around **10-15 ACH** (Air Changes per Hour, of the Volume of the Space) is advised .
- The mechanical **exhaust air shall be 70% to 80% of fresh air quantity** to maintain necessary positive pressure in the space.
- In cases of evaporative cooling / air washers it is advisable to disinfect the water using UVGI or Ionization or chemical dosing.
- In case of re-circulating system, it is recommended to limit return air circulation. **The return air system could be converted to an exhaust system**.

The same process must be followed in case evaporative cooling is used for a commercial facility.

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CONVERTING GENERAL PATIENT ROOMS OR ICUs INTO COVID-19 PATIENT AREAS

- ***Convert the room into a non-recirculatory system (100% once through system).***
- Make sure that the AHU will have provision to receive adequate outdoor air supply.
- The outdoor air source for the AHU shall not be from within the building and all care shall be taken to avoid intake of outdoor contaminants, to the best possible extent.
- ***Independent exhaust blower shall be provided to extract the room air and exhaust out into the atmosphere, preferably, after suitable "exhaust air treatment".***

CONVERTING GENERAL PATIENT ROOMS OR ICUs INTO COVID-19 PATIENT AREAS

- The exhaust air quantity shall be greater than the supply air quantity such that a negative pressure of minimum 2.5Pa (preferably >5 Pa) is achieved in the room .
- ***It is advisable to install differential pressure meters to measure this metric.***
- The supply air quantity shall be such that it will provide a minimum of **12 air changes per hour**.
- The position of the extract air in the room shall be just above the head of the patient's bed.

TREATMENT OF EXHAUST AIR FROM COVID-19 PATIENT AREAS

- ***Treatment by HEPA filtration minimum of H13 (EN1822-1) filter class or equivalent.***
- Treatment of exhaust air by Chemical disinfection.
- ***When both the methods are not viable, the exhaust air shall be let off into the atmosphere through an upward plume at a height of 3 m above the tallest point of the building.***
- The other two options available for exhaust air treatment being **UV irradiation and heating.**

Air filters for general ventilation – A special task executed for BIS

Request by Bureau of Indian Standards to ISHRAE.

Standard to support Indian industry

- Harmonize with International Standard ISO 16890
- Particularly keeping MSME in consideration

Published as National Difference to the international standard ISO 16890 adopted by BIS.

Scope:

- Classification of particulate air filters for general ventilation purpose
- The test equipment – 5 channel test method and calculation for measuring the fractional efficiency of air filters through a laboratory test

Post COVID initiatives

Modification in ISHRAE IEQ Std. 2024 version (draft)

- A new annexure added for ventilation
- Special mention about what is to be done during epidemic

Modification in Energy Conservation Sustainable Building Code 2024

- A new chapter on IEQ added
- Emphasis on source control
- Special mention about what is to be done during epidemic

Summary and impact on HVAC industry

Many forgotten good practices came back to practice:

- Humidification
- Exhaust air treatment in healthcare facilities
- Awareness and extent of filtration use increased
- Separate healthcare guide prepared by ISHRAE
- IAQ monitoring increased
- Epidemic ready design coming in practice and codes

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Thanks!!

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Acknowledgements: Vishal Kapoor, Ashish Rakheja

AIVC Webinar

New standards, guidelines or regulations for ventilation due to COVID-19

12 February 2024

An overview of the revision of Singapore Standards (SS553 and SS554) for control of infectious aerosols in buildings

Professor Chandra Sekhar, PhD

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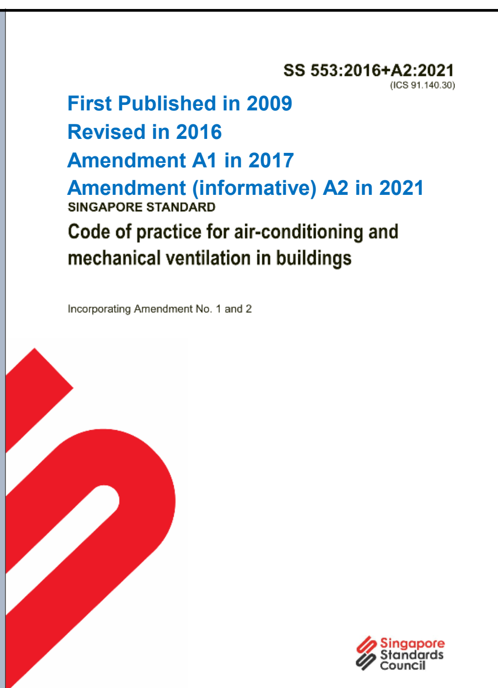

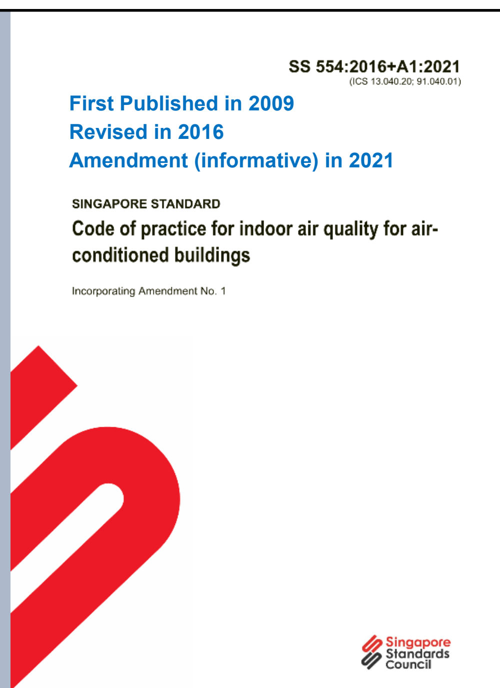

Revision in 2016 triggered due to prolonged Haze episodes experienced in 2015

Alignment for air filtration clauses with SS553

	Nature of the Standard	Filter ratings
SS554	Specifies performance	"SS553 specifies the minimum filter requirement. In preparation for unforeseeable haze events, the use of fine dust filters, especially those having at least a rating of Minimum Efficiency Reporting Value (MERV) 14 (ASHRAE 52.2:2012) or F8 (EN779:2012), is recommended. Such filters can remove particulates more effectively than coarse dust filters and can keep the building and the ACMV system clean at all times."
SS553	Specifies design specifications	"The Minimum Efficiency Reporting Value (MERV) for cleaning the air in all air-handling units shall be equivalent to MERV 6 or better, and MERV 14 when the outdoor pollution level is in the unhealthy range in accordance with MOH's guidelines. The MERV for cleaning outdoor air supplied to fan coil units shall be equivalent to MERV 6 or better, and MERV 14 when the outdoor pollution level is in the unhealthy range in accordance with MOH's guidelines. Fan motors shall be sized such that the required air flow rate can be maintained."

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Practical measures for existing building services operations amid pandemic

Singapore Standard SS 553 : 2016
Amendment No.2

May 2021

Annex D (Informative)

- D1 Scope
- D2 Key Measures – airflow pathway (air distribution) and occupancy layout
- D3 Air-conditioning system – Operational considerations – Increased ventilation; Increased air filtration & disinfection
- D4 Increased ventilation – OA supply; Purging of indoor air; Turn off energy recovery units
- D5 Increased air filtration & disinfection – air filtration; Disinfection; Portable air cleaners
- D6 Operation and maintenance –Maximise ventilation in toilets and common areas

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Annex K (Informative)
Mitigating risk of aerosol-mediated transmission of infectious diseases

Singapore Standard SS 554 : 2016
Amendment No.1

Sept 2021

Annex K (Informative)

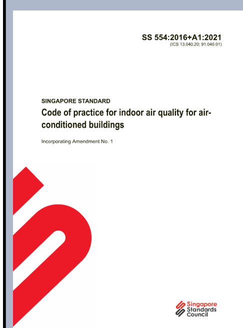
- K2.1 Scope
- K2.2 Risk assessment and mitigation
- K2.3 Recommended Measures
- K2.4 Enhanced measures to mitigate increased airborne disease transmission risks
- K2.5 Assessment of ventilation adequacy and use of CO_2 levels as a surrogate

Annex K (Informative)
Mitigating risk of aerosol-mediated transmission of infectious diseases

Singapore Standard SS 554 : 2016
Amendment No.1

K2.3 Recommended Measures (Key Highlights)

- Air-conditioned premises with MV (eg Centralised air-conditioning system) – Checks to ensure adequate ventilation provision, continuous operation, air balancing, maintenance activities
- Maximise ventilation for indoor air dilution – maximise OA, deactivate DCV systems, open all air dampers to ensure optimal supply of OA to all occupied zones, operate exhaust fans at full capacity, install additional supply and/or exhaust fans if found inadequate, use occupancy reduction if needed, increase filter efficiency and air cleaning strategies as feasible (if IAQ is worsened by increasing ventilation eg rise in PM2.5 levels)
- Purge indoor air before occupancy
- Treat recirculated air – use MERV14, F8 or ePM1 70-80% filters in AHUs, air cleaning technologies (such as UVGI) in upper rooms, AHU rooms or AHUs to augment filtration
- Increase ventilation in premises with limited ventilation and air filtration provision – open operable windows and doors, fans positioned at windows to blow air outwards and increase ACH, add dedicated OA supply and/or exhaust, use portable air cleaners
- Enclosed air-conditioned premises without mechanical ventilation provision (e.g. split-unit air-conditioners or FCUs without fresh air supply) - increased ventilation and ACH, install window-mounted exhaust fans, use air cleaners as localised air cleaning



Current Revision in Progress

- Infectious Aerosol Mitigation - 2021 amendments were informative – Enhancing them now to be part of SS553 and SS554
- Equivalent Clean Air (ECA_i) ASHRAE Standard 241-2023 reference
- **Building Resilience** – Haze Resilience incorporated in 2016 revision – current revision to include control of infectious aerosols
- Two modes of Design and Operation
  NORMAL/PEACE mode
  RESILIENT mode
- Target publication of revised version – **late 2024**

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Thank You for your Attention

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A new system adopted by Tokyo to address the threat of infectious diseases

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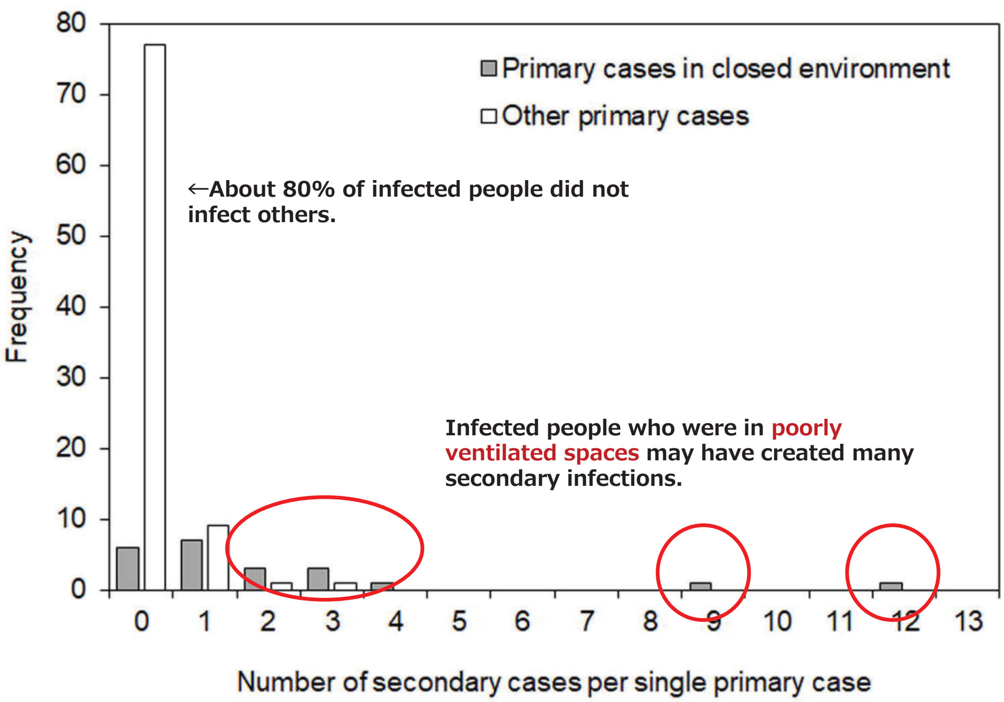
Waseda University
Shin-ichi Tanabe, PhD, Prof.

Analysis of infection spread cases in Japan by the expert committee (Feb 26, 2020)

WASEDA University



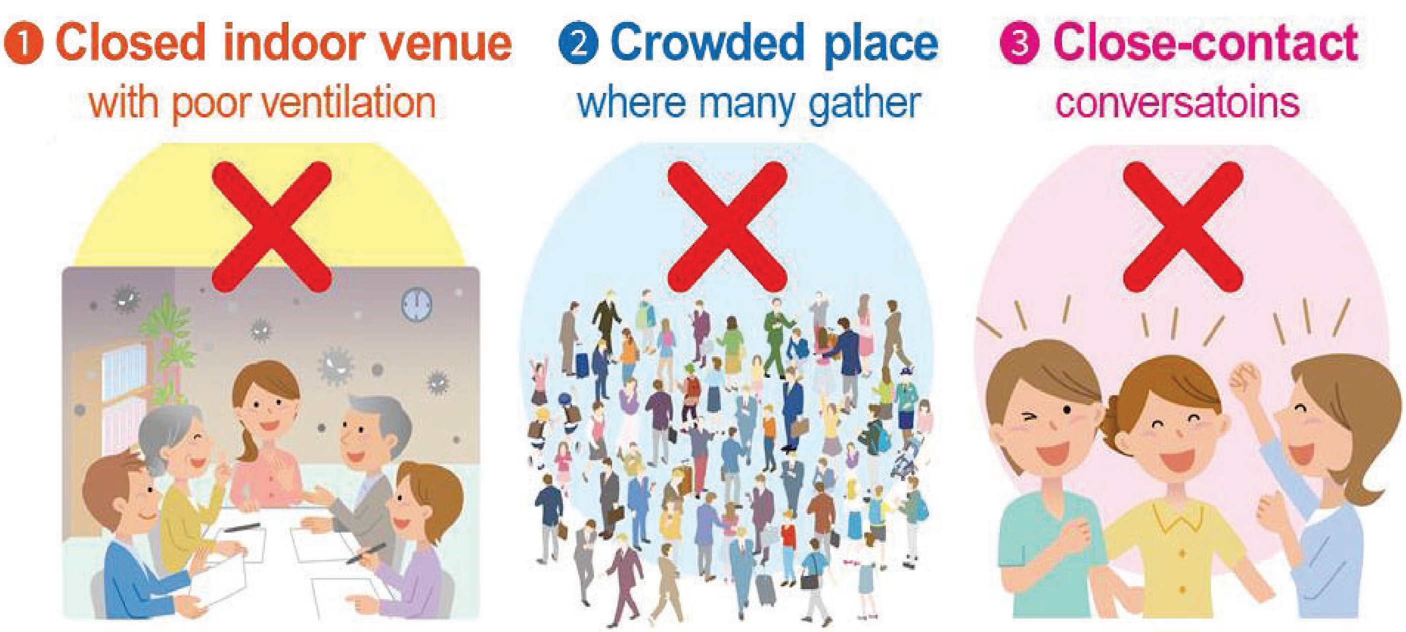
Nishiura H, Oshitani H et al., MHLW COVID-19 Response Team, Motoi Suzuki, Closed environments facilitate secondary transmission of coronavirus disease 2019 (COVID-19), *medRxiv* preprint, Feb 26, 2020. 0029272

Government Caution March 9, 2020

1. **Enforce ventilation**: In a room with windows, if possible, open the windows on opposite or different sides simultaneously to encourage ventilation. However, **there is no established evidence of how much ventilation is adequate**.
2. **Decrease the density of people**: In case of crowds, reduce the density of people by securing the space of the venue and increasing the distance between people by 1-2 meters.
3. **Avoid short-range conversations, vocalization, and chanting**: Avoid places where people are in close proximity to you. If you need to talk at a close distance, wear a mask to prevent the transmission of droplets.

Source: the Ministry of Health, Labour and Welfare's Expert Group on Countermeasures for Novel Coronavirus Infectious Diseases published "Positions for Countermeasures for Novel Coronavirus Infections", March 9, 2020

Avoid the "Three Cs"



Society of Heating, Air-conditioning and Sanitary Engineers (**SHASE**) and Architectural Institute of Japan (**AIJ**)

Emergency presidential discourse March 23, 2020

SHASE AIJ

March 23, 2020
The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan (SHASE)
President Shin-ichi Tanabe
Architectural Institute of Japan (AIJ)
President Izuru Takewaki

Role of ventilation in the control of the COVID-19 infection:
Emergency presidential discourse

At the Ministry of Health, Labour and Welfare's Expert Meeting on Novel Coronavirus Infectious Disease Control on March 9, 2020, "A View on Novel Coronavirus Infectious Disease Control" was announced [1]. Subsequently, on March 18, the Prime Minister's Office, together with the Ministry of Health, Labour and Welfare, published a leaflet titled "Let's Avoid These Three Conditions When We Go Out!" [2], according to which to be avoided are closed spaces with poor ventilation, crowded places, and close contact. Inquiries about ventilation have been received from members of the Architectural Institute of Japan and the Society of Heating, Air-Conditioning and Sanitary Engineers of Japan, both of which specialize in indoor environments.

Regarding the effects of ventilation on the novel coronavirus (COVID-19), Nishiura et al. analyzed the

https://www.aij.or.jp/covid19_info.html

Ministry of Health, Labor and Welfare's views on ventilation (March 30, 2020)

～ 商業施設等の管理権原者の皆さまへ ～

「換気の悪い密閉空間」を
改善するための換気の方法

新型コロナウイルス感染症対策専門家会議の見解（令和２年３月９日及び３月19日公表）では、集団感染が確認された場所で共通する３条件が示されています。新型コロナウイルス感染症厚生労働省対策本部では、この見解を踏まえ、**リスク要因の一つである「換気の悪い密閉空間」を改善**するため、**多数の人が利用する商業施設等**において**どのような換気を行えば良いのか**について、有識者の意見を聴取しつつ、文献、国際機関の基準、国内法令基準等を考察し、**推奨される換気の方法**をまとめました。

専門家検討会の見解（抄）

クラスター（集団）感染発生リスクの高い状況の回避

① **換気を励行する：換気の悪い密閉空間**にしないよう、**換気設備の適切な運転・点検**を実施する。定期的に**外気を取り入れる換気を実施**する。
② **人の密度を下げる：**人を密集させない環境を整備。会場に入る定員をいつもより少なく定め、入退場に時間差を設けるなど動線を工夫する。
③ **近距離での会話や発声 、高唱 を避ける：**大きな発声をさせない環境づくり（声援などは控える）。共有物の適正な管理又は消毒の徹底等。

推奨される換気の方法

ビル管理法（建築物における衛生的環境の確保に関する法律）における空気環境の調整に関する基準に適合していれば、**必要換気量（一人あたり毎時30m³）を満たす**ことになり、**「換気が悪い空間」には当てはまらない**と考えられます。このため、以下のいずれかの措置を講ずることを商業施設等の管理権原者に推奨いたします。

なお、**「換気の悪い密閉空間」はリスク要因の一つに過ぎず**、一人あたりの必要換気量を満たすだけで、**感染を確実に予防できるということまで文献等で明らかになっているわけではない**ことに留意していただく必要があります。

① 機械換気(空気調和設備、機械換気設備)による方法

- ビル管理法における特定建築物に該当する商業施設等については、ビル管理法に基づく**空気環境の調整に関する基準が満たされていることを確認**し、満たされていない場合、**換気設備の清掃、整備等の維持管理を適切に行う**こと。
- 特定建築物に該当しない商業施設等においても、**ビル管理法の考え方に基づく必要換気量（一人あたり毎時30m³）**が確保できていることを確認すること。必要換気量が足りない場合は、**一部屋あたりの在室人数を減らす**ことで、一人あたりの必要換気量を確保することも可能であること。

厚生労働省
Ministry of Health, Labour and Welfare

Ventilation methods to improve "poorly ventilated enclosed spaces".

For mechanical ventilation, if a ventilation rate of **30 m^3/h•person (8.3L/s•person)** is ensured, it cannot be said that infection can be prevented with certainty, but it is not deemed an enclosed space with poor ventilation.

https://www.mhlw.go.jp/content/10900000/000618969.pdf

Act on Environmental Health in Buildings (1970～)

WASEDA University

Standards on indoor air quality

Measurement / check	Item	Criterion	Remarks
Measured at least within every two months	Suspended dust	～0.15 mg/m^3	
	CO	～6ppm	Revised from 10ppm
	CO_2	**～1000ppm**	
	Air temperature	18℃～28℃	Revised from 17℃ By WHO recommentation
	Relative humidity	40%～70%	
	Air velocity	～0.5 m/sec	
At first measuring	Formaldehyde	0.1mg/m^3 (0.08ppm)	New-construction, renovation
Checking / cleaning	Cooling tower, water of humidifier	Water quality criterion, regular check, Cleaning, exchanging water	Legionella / microbes
	Drain pan of HVAC	regular check, cleaning	

Hayashi M, Kobayashi K, Kim H, Kaihara N. The state of the indoor air environment in buildings and related tasks in Japan. J. Natl. Inst. Public Health, 69(1) 2020.

CO2 monitors every where in Japan

WASEDA University

Air Cleaner November 11, 2020

1. The air cleaner must be a filtration type with a HEPA filter and have an air volume of $5m^3$/min or more.
2. Install an air cleaner within a range of about $10m^2$ (6 tatami mats) from where people live.
3. To avoid air stagnation, match the direction of the air that takes in outside air with the direction of the air cleaner.

Modes of Transmission

Contact transmission

The most common mode of transmission, contact transmission is divided into two subgroups: direct and indirect. Indirect transmission involves the transfer of an infectious agent through a contaminated intermediate object or person.
VRE, MRSA, Norovirus, etc.

Droplet transmission

Respiratory droplets carrying infectious pathogens transmit infection when they travel directly from the respiratory tract of the infectious individual to susceptible mucosal surfaces of the recipient, generally over short distances.
Influenza, Rubella, Mumps, etc.

Airborne transmission

Airborne transmission occurs by the dissemination of either airborne droplet nuclei or small particles in the respirable size range containing infectious agents that remain infective over time and distance.
Tuberculosis, Measles, Chickenpox, etc.

Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee, 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings

Airborne Precaution

WASEDA University

Airborne Precautions prevent transmission of infectious agents that remain infectious over long distances when suspended in the air (e.g., rubeola virus [measles], varicella virus [chickenpox], M. tuberculosis, and so on.

The preferred placement for patients who require Airborne Precautions is in an airborne infection isolation room (AIIR).

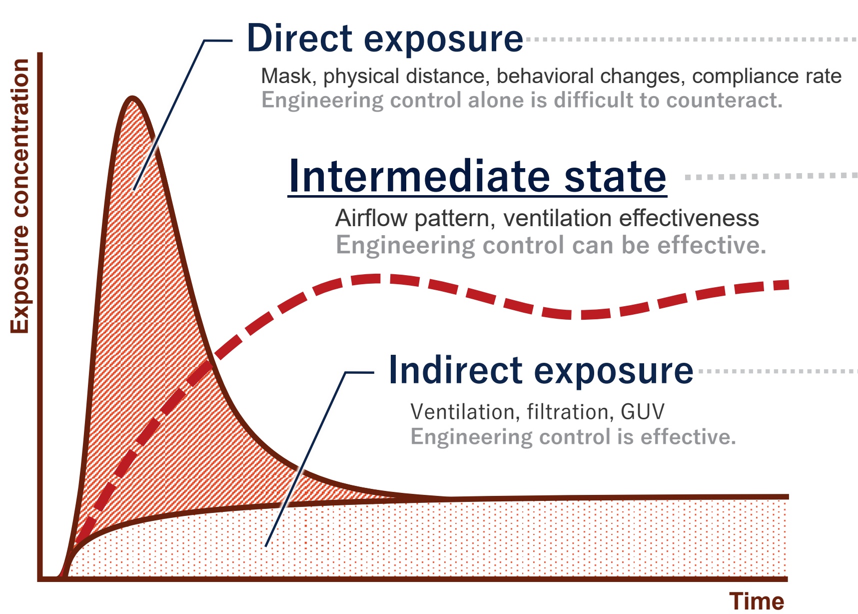
- **Single-patient room**
- **Monitored negative pressure to the surrounding area**
- **12 ACH for new construction and renovation**
- **6 ACH for existing facilities**
- **air exhausted directly to the outside or recirculated through HEPA filtration before return**
- **AIIR should have an ante-room (FGI, ASHRAE).**

A respiratory protection program that includes education about the use of respirators, fit-testing, and user seal checks is required in any facility with AIIRs.

Siegel JD, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee, 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. https://www.cdc.gov/infectioncontrol/guidelines/isolation/index.html

Modeling the Modes of Exposure to respiratory aerosol particles

WASEDA University



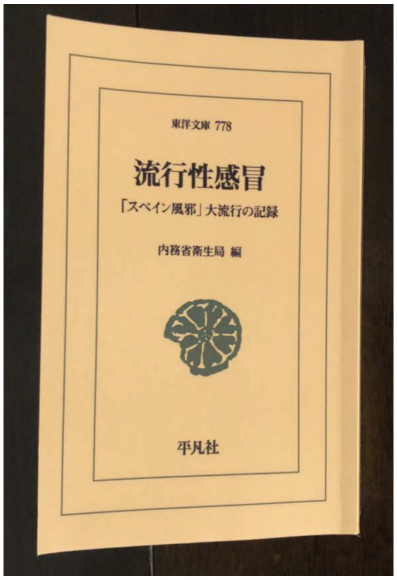
Short-range
Distance, angle,

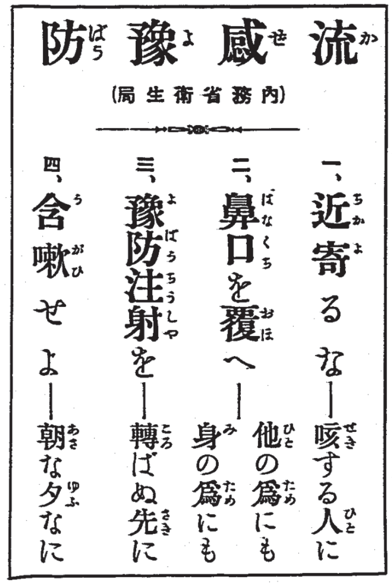
Middle-range (shared room)
Distance, angle,
Method/location of air supply and exhaust

Long-range (well-mixed)
Generation rate of infectious aerosol particles
Ventilation rate
Efficiency
Room volume
Exposure time

100 years ago: Spanish Flue

WASEDA University




流感豫防

(内務省衛生局)

一、近寄るな―咳する人に

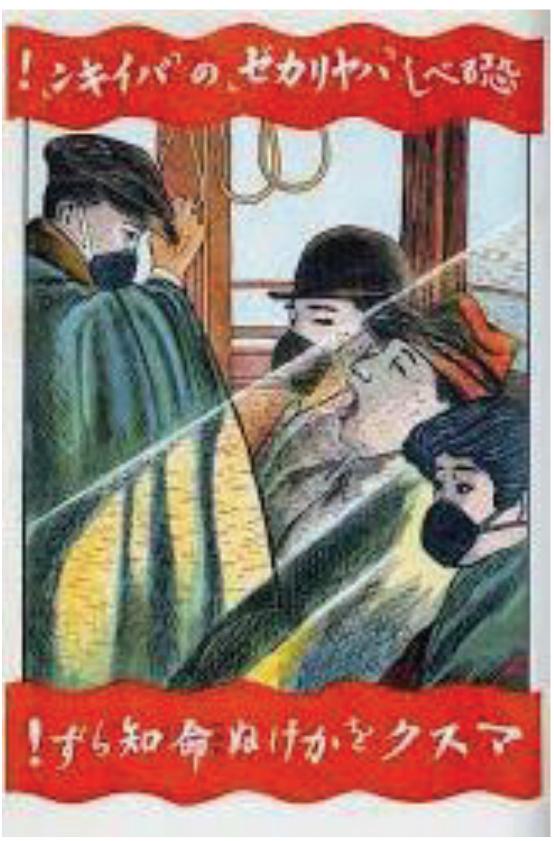
二、鼻口を覆へ―他の爲にも身の爲にも

三、豫防注射を―轉ばぬ先に

四、含嗽せよ―朝な夕なに

1. Avoid Contact
2. Cover mouth and nose (Mask)
3. Vaccinated
4. Gargle **No-description of ventilation**

WASEDA University



No-description of ventilation

Tokyo Governor Koike has regular meeting

WASEDA University

第68回東京都新型コロナウイルス感染症モニタリング会議(令和3年10月21日13時00分～)

公開 2021.10.21 ｜ 視聴回数 4,764回

新型コロナウイルス感染症に関する対応

https://tokyodouga.jp/m7y1zw4udbw.html

TOKYO METROPOLITAN GOVERNMENT

TOKYO iCDC

Tokyo Center for Infectious Diseases Prevention and Control

The expertise that supported Tokyo's COVID-19 response

―A new system adopted by Tokyo to address the threat of infectious diseases―

Review of Tokyo iCDC Activities from October 1, 2020

https://www.metro.tokyo.lg.jp/english/topics/2023/1020_02.html