

PREVENTION OF COVID-19

WHAT ROLE DOES VENTILATION PLAY?

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8 December 2020





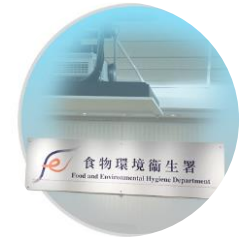
Our Role: Provide operation and maintenance services of **electrical, mechanical, electronic and building services systems and equipment**



Government Offices, Schools, Community Centres, Courts and Specialised Government Buildings, etc.



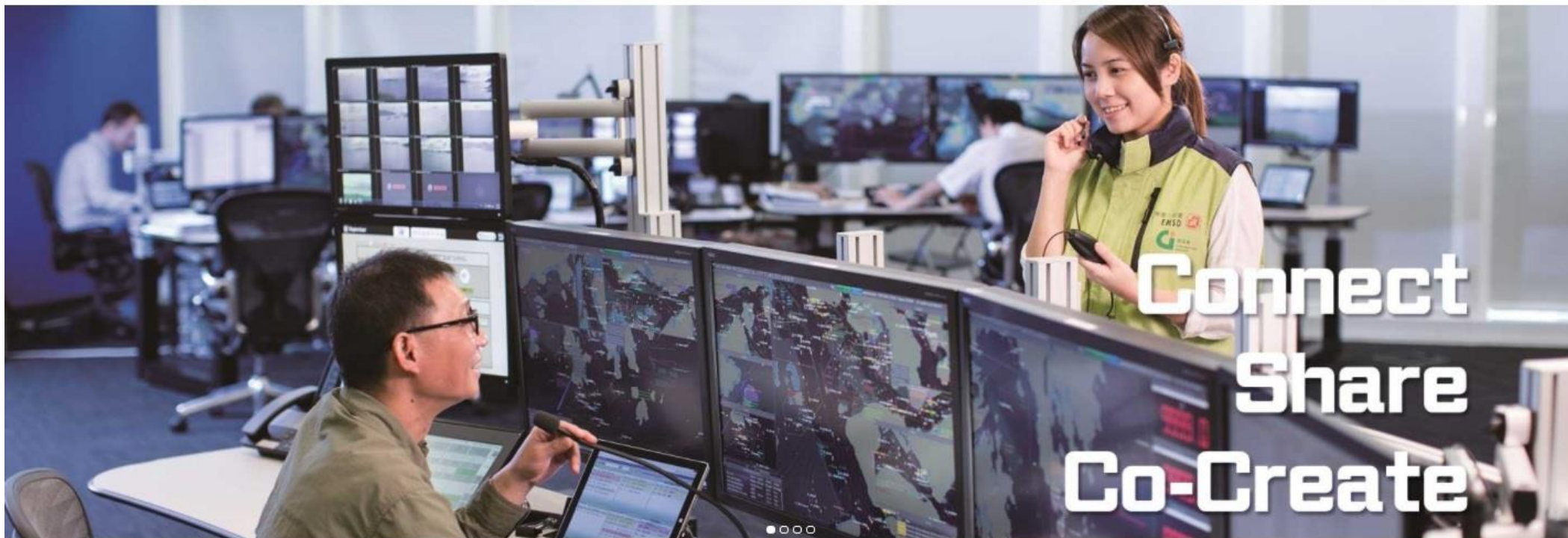
Public Hospitals, Laundries, Laboratories and clinic, etc.



Postal Centres, Ferry Terminals, Cultural Complexes, Parks, Libraries and Market complexes etc.



Border control points, Hong Kong International Airport, etc.



E&M InnoPortal

Electrical and Mechanical Services Department (EMSD) launched the E&M InnoPortal which lists the service wishes of various government departments, public organisations and the E&M trades, and invites the I&T sector, including start-ups and universities to propose relevant I&T solutions for matching. For successfully matched I&T wishes and solutions, EMSD will carry out field trials in a bid to promote and drive the research & development and application of innovative technologies.



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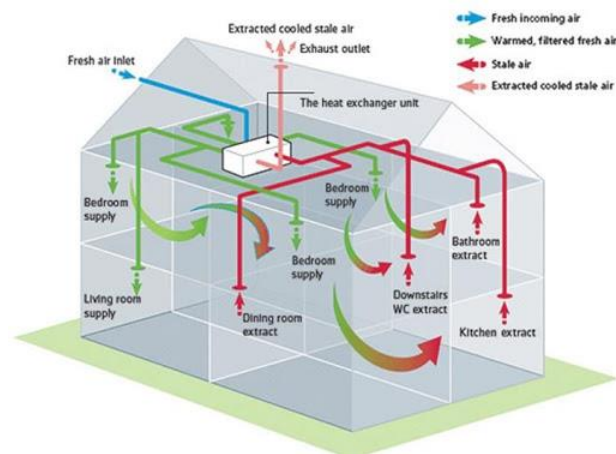
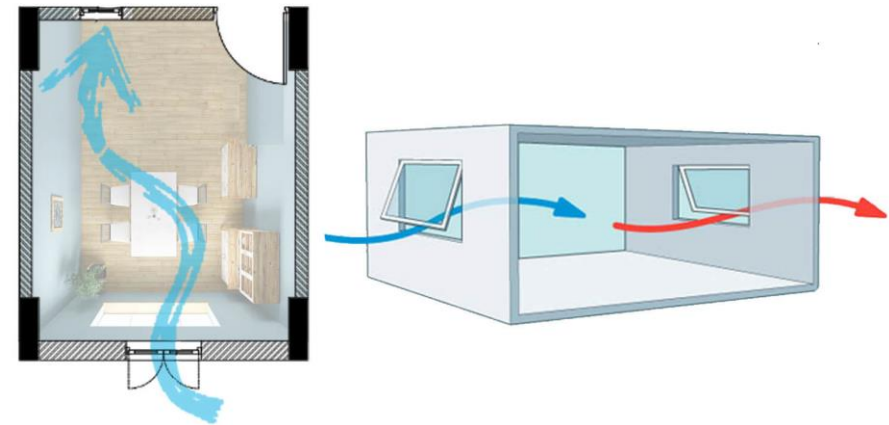
WHAT IS VENTILATION?

“Ventus” = wind

=> *Replacing air in an enclosed space with new and clean air...*

Natural Ventilation

Air from outdoor is being forced indoor due to natural forces such as winds, thermal buoyancy through windows, doors, chimneys, etc.



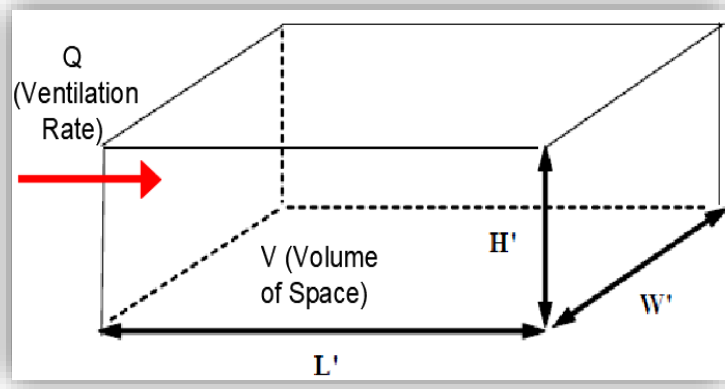
Mechanical Ventilation

Air from outdoor is being forced indoor by mechanical fans via air ducts and / or extracted from indoor to outdoor by exhaust fans

NATURAL VS MECHANICAL VENTILATION

	Pros	Cons
Natural Ventilation	<ul style="list-style-type: none">• Capable of achieving high ventilation rate• Protect the environment due to lower energy consumption	<ul style="list-style-type: none">• Weather dependent• Climate dependent (i.e. Wind direction)
Mechanical Ventilation	<ul style="list-style-type: none">• Reliable in delivering the required flow rate regardless of ambient conditions• Filtration systems can be installed• Airflow path can be controlled	<ul style="list-style-type: none">• Expensive to install• Consumes electricity• Requires proper maintenance

Ventilation Terminology



1. Air Change Per Hour (ACH)

Ratio of Volumetric Flow Rate to Volume of Space



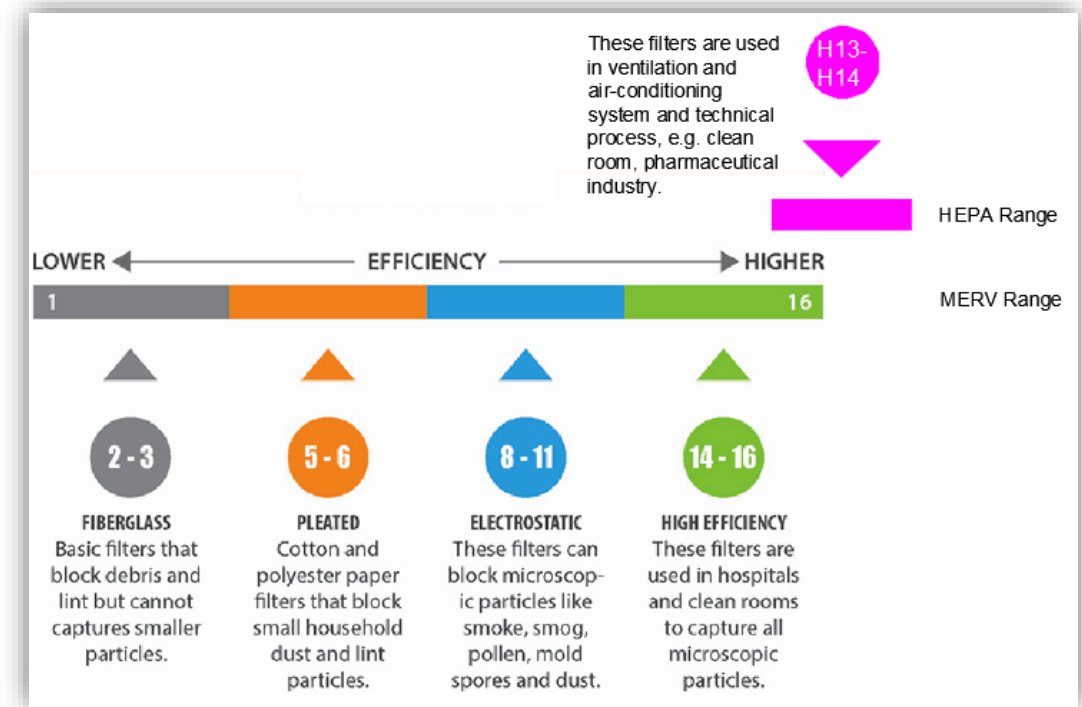
2. Ventilation Rate (L/s)

$$ACH = \frac{\text{ventilation rate} \left(\frac{l}{s}\right) \times 3600 \left(\frac{s}{hr}\right) \times 0.001 \left(\frac{m^3}{s}\right)}{\text{Room Volume} (m^3)}$$



Ventilation Terminology

Negative Air Pressure



3. Negative Pressure Differential & Airflow Direction

4. Filtering Efficiency

➤ Minimum Efficiency Reporting Value (MERV)

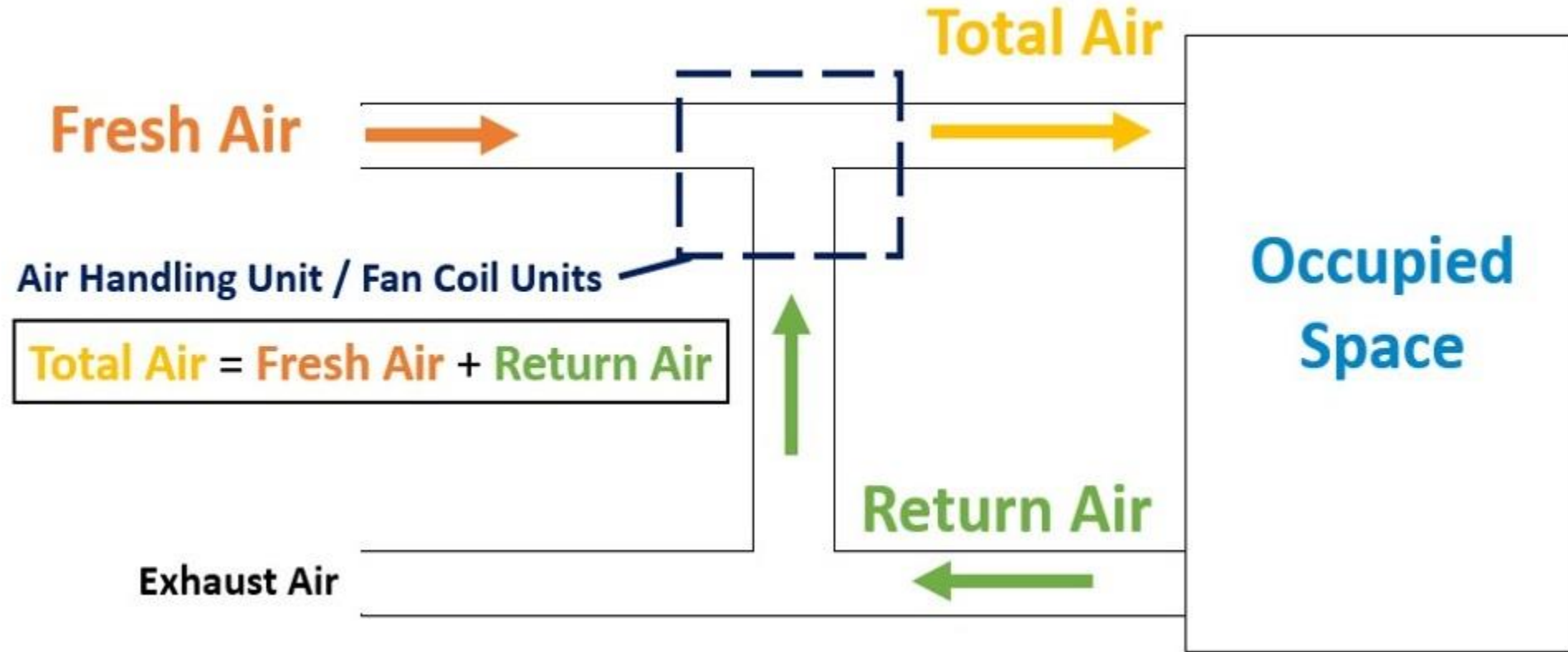
- ◆ By **ASHRAE**
- ◆ Efficiency: 1 (Low) – 16 (High)
- ◆ Hospital: Min. MERV 14

➤ High efficiency particulate filter (HEPA)

- ◆ By **EN1822-1 / ASTM Ff3150-18**
- ◆ Efficiency: (EN1822-1): H13 (0.3um, 99.95%);
H14 (0.3um, 99.995%)
- ◆ Hospital: H13 Grade



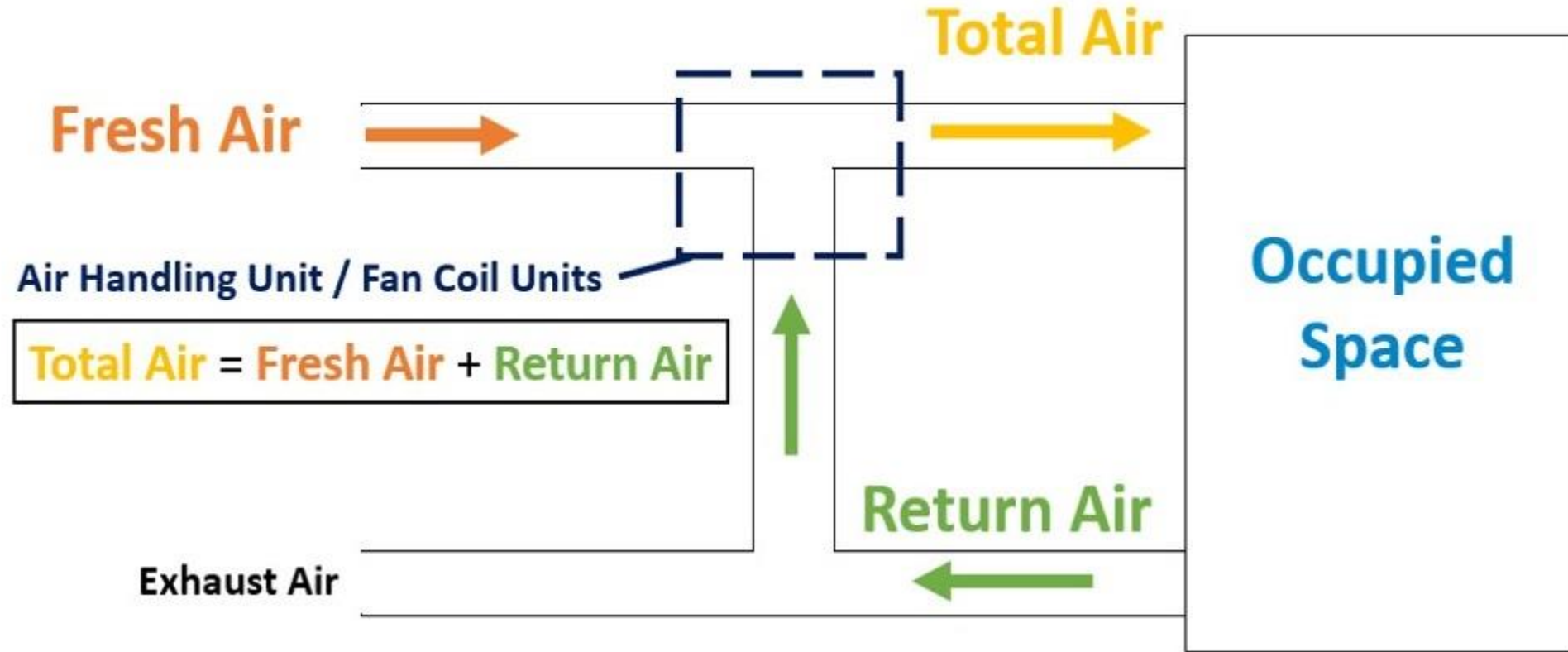
Typical Ventilation System



$$\text{Air Changes Per Hour (Total)} = \frac{\text{Total Air Flow}}{\text{Air Volume in Occupied Space}}$$

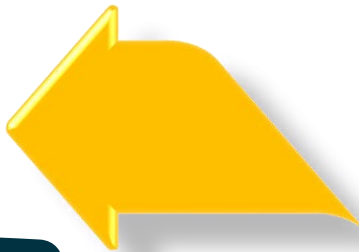
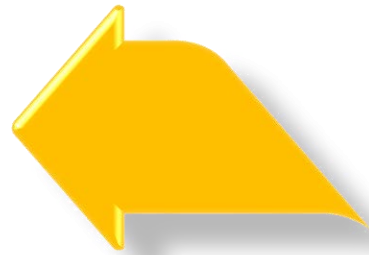
$$\text{Air Changes Per Hour (Fresh air)} = \frac{\text{Fresh Air Flow}}{\text{Air Volume in Occupied Space}}$$

Typical Ventilation System



<i>Fresh Air Flow (L/s) > Exhaust Air Flow (L/s)</i>	<i>Positive pressure</i>
<i>Exhaust Air Flow (L/s) > Fresh Air Flow (L/s)</i>	<i>Negative pressure</i>

Statutory Requirements on Ventilation System



01
Building
(Planning)
Regulation
(Cap.123F)

02
Public Health
and Municipal
Services
Ordinance
(Cap 132)

03
Labour
Department
Guidance
Notes



Statutory Requirements

Building (Planning) Regulations (Cap. 123F)

Premises	Requirements
Office	Supplying fresh air at a rate of not less than 5 changes of air per hour for premises without openable windows

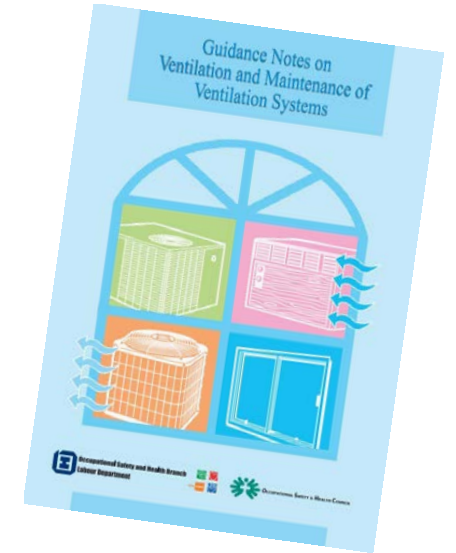
Public Health and Municipal Services Ordinance (Cap. 132)

Scheduled Premises	No. of m ³ / hr for each person who may be accommodated in the premises
Cinemas	13
Dancing establishments	17
Factory canteens	17
Funeral parlours	17
Restaurants	17
Theatres	13



Statutory Requirements

Guidance Notes on Ventilation and Maintenance of Ventilation Systems



Types of work activity	Minimum fresh air supply rate (m ³ / min / person)	Remarks
Open plan offices, schools (non-smoking)	0.43	The normal daily working hours or hours of stay are long, e.g. 8 hours
Private offices (with moderate smoking), laboratories	0.6	
Conference rooms or office (with heavy smoking)	1.0	
Canteens, restaurants	0.3 (based on the seating capacity and the no. of employees)	On average, people may not stay in the area for a long period

Types of Work Activity	Minimum fresh air supply rate (m ³ / m ² floor area / min)	Remarks
Shops, supermarkets, department stores	0.18	Generally no smoking
Kitchen (restaurants)	1.2	Additional exhaust for working areas required



Demonstration: Office

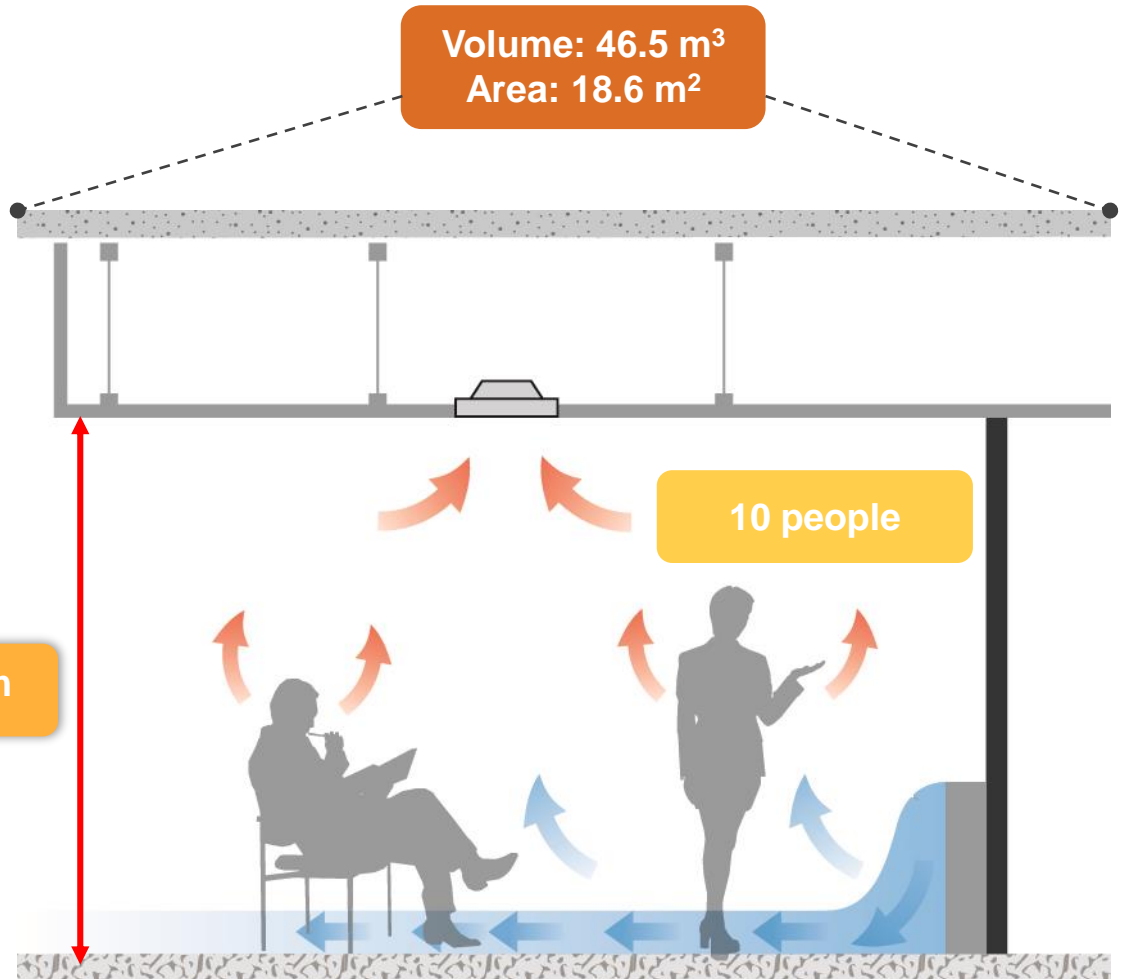
Given Data

- ✓ Area & Volume
- ✓ Minimum Fresh Air Supply Rate (1.0 m³/min/person)
- ✓ Occupants

Volume: 46.5 m³
Area: 18.6 m²

Height: 2.5m

10 people



Calculated ACH 12.9



$$ACH = \frac{1.0 \left(\frac{m^3}{min \ person} \right) \times 10(persons) \times 60(min)}{46.5(m^3)}$$

International Guidelines - WHO



WHO Publication/Guidelines

Natural Ventilation for Infection Control in Health-Care Settings

Edited by:
James Atkinson, Yves Chartier,
Carmen Lúcia Pessoa-Silva,
Paul Jensen, Yuguo Li
and Wing-Hong Seto

Infection prevention and control during health care when coronavirus disease (COVID-19) is suspected or confirmed

Interim guidance
29 June 2020



Background

This is the third edition of WHO's interim guidance on infection prevention and control (IPC) strategies during suspected or confirmed COVID-19. The first edition was adapted from WHO's interim guidance on infection prevention and control during health care for probable or confirmed cases of Middle East respiratory syndrome coronavirus (MERS-CoV) infection, and on infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care.¹ The rationale for this updated edition has been to expand the scope and structure of earlier guidance, bringing together other interim recommendations as well as considerations and advice from subject matter experts.

The main differences and additions compared to the previous versions² include the following:

- all sub-sections in the section "Principles of IPC strategies associated with health care for suspected or confirmed cases of COVID-19" were expanded to include clarifications and additional recommendations;
- new guidance and practical advice for management of visitors especially in areas with COVID-19 community transmission;
- inclusion of a sub-section on ventilation in the section "Environmental and engineering controls";
- new guidance on IPC considerations for surgical COVID-19, as well as those patients whose COVID-19 status is unknown;
- considerations for dead body management in health-care facilities;
- practical advice and available tools to assess health-care facility IPC readiness and to monitor and evaluate IPC measures for COVID-19.

Guidance and considerations included in this document are based on published WHO scientific briefs, guidelines and infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care³, scientific briefs on modes of COVID-19 transmission and

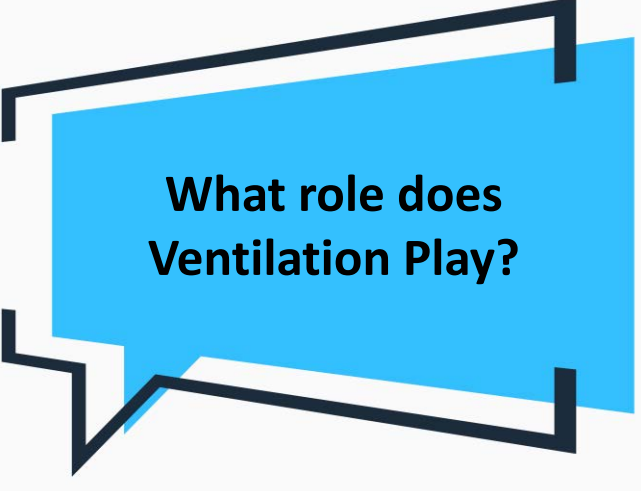
Previous versions of this interim guidance were published on 25 January and on 19 March 2020 at <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance-publications>

discontinuation of isolation, and other WHO COVID-19 interim guidance documents on clinical management, dead body management, and laboratory biosafety available at the WHO Country and Technical Guidance-Coronavirus Disease (COVID-19)⁴. In addition, this IPC guidance has been developed by consulting the WHO ad-hoc COVID-19 IPC Guidance Development Group (COVID-19 IPC GDG) group that meets at least once a week, and an ad-hoc engineer expert group that provided input for the section on ventilation. WHO will continue to update this guidance as new information becomes available. This guidance is intended for health workers, including health care managers and IPC teams at the facility level, but it is also relevant for the national and district/provincial levels.

Principles of IPC strategies associated with health care for suspected or confirmed cases of COVID-19

To mount an optimal response to the COVID-19 outbreak using the strategies and practices recommended in this document, a facility level IPC programme with a dedicated and trained team or at least an IPC focal point should be in place and supported by the national and facility senior management.⁵ In countries where IPC is limited or nonexistent it is critical to start by ensuring that at least basic IPC standards are in place at the national and health-care facility level to provide minimum protection to patients, health workers and visitors. These are known as the *minimum requirements* for IPC that have been developed by WHO in 2019⁶ based on a broad consensus among international experts and institutions to facilitate the implementation of the WHO recommendations on the core components for IPC programmes.⁷ Achieving the IPC minimum requirements as well as more robust and comprehensive IPC programmes according to the WHO core components across the whole health system in all countries is essential to sustain efforts to control the COVID-19 pandemic, other emerging infectious diseases health care-associated infections and antimicrobial resistance.

⁴ WHO Country & Technical Guidance COVID-19: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance-publications>



What role does Ventilation Play?

Table E.1 Decay of droplet nuclei concentration in an isolation room for different ventilation rates and duration of time

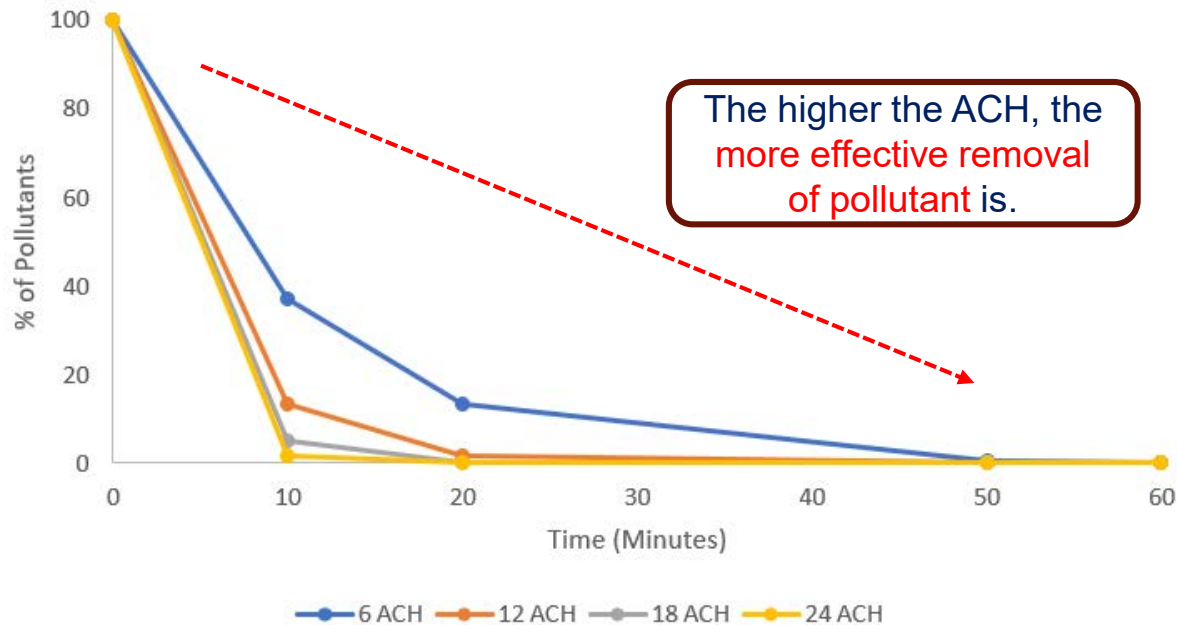
Time (minutes)	Ventilation rate (ACH) (%)			
	6	12	18	24
0	100.00	100.00	100.00	100.00
10	37.00	13.50	4.98	1.83
20	13.50	1.83	0.25	0.03
50	0.67	0.00	0.00	0.00
60	0.25	0.00	0.00	0.00

ACH, air changes per hour.

Implication 1. Pollutant Removal Effectiveness with Different Ventilation Rate

% of Pollutant Remaining in a Space

Decay of Droplet Nuclei Against the Ventilation Rates in a Period of Time



The higher the ACH, the more effective removal of pollutant is.

Table E.2 Infection risk with 15 minutes exposure with different ventilation rates and quanta generation for an infector entering an enclosed space with a dimension 6 m × 6.7 m × 2.7 m

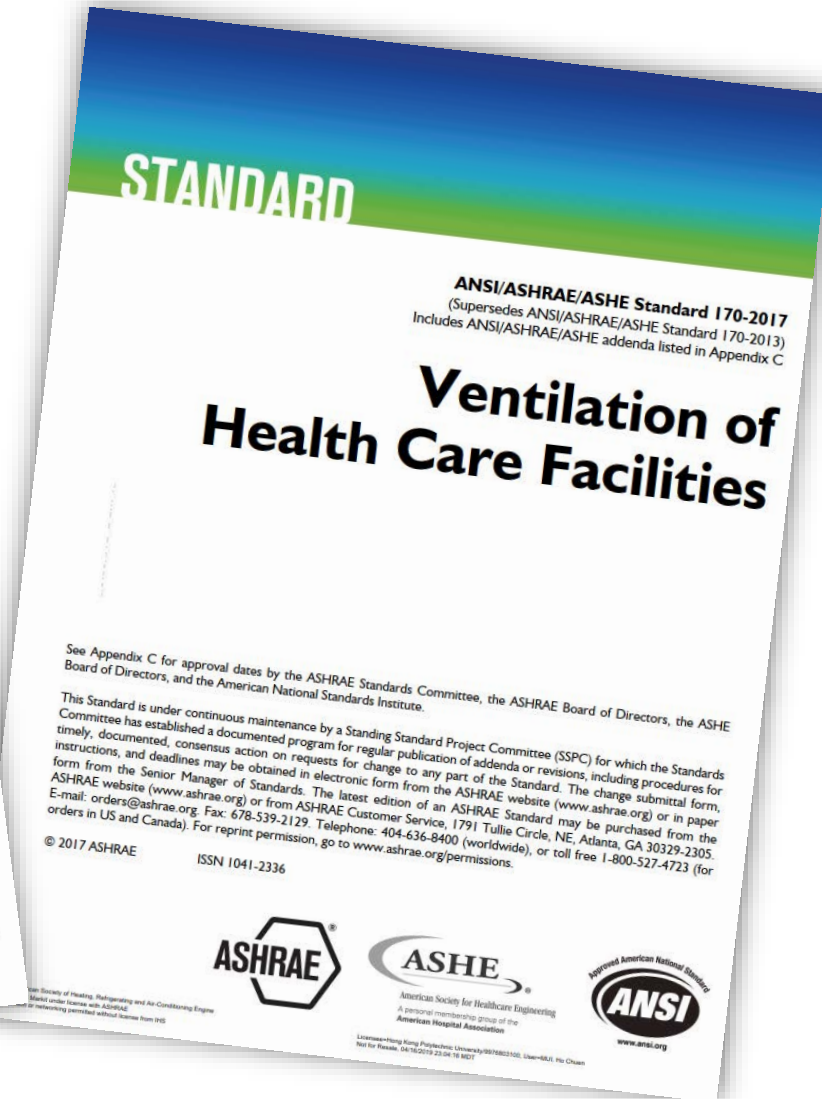
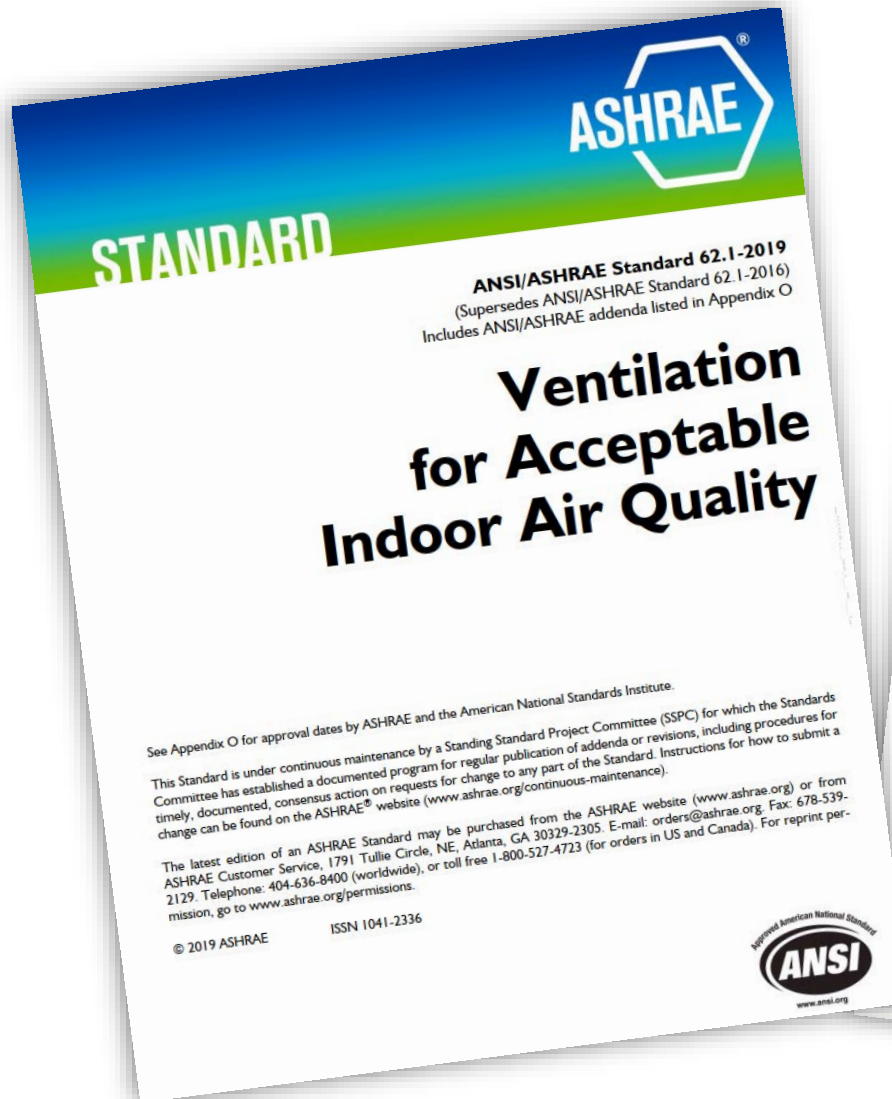
Quanta generation (quanta/min)	Ventilation rate (air changes per hour) (%)							
	1	3	6	12	15	18	24	30
0.05	0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00
0.10	0.10	0.03	0.02	0.01	0.01	0.01	0.00	0.00
0.14	0.14	0.05	0.03	0.01	0.01	0.01	0.01	0.01
0.19	0.19	0.07	0.03	0.01	0.01	0.01	0.01	0.01
0.23	0.23	0.08	0.04	0.02	0.02	0.01	0.01	0.01
0.27	0.27	0.10	0.05	0.03	0.02	0.02	0.01	0.01
0.30	0.30	0.11	0.06	0.03	0.02	0.02	0.01	0.01
0.34	0.34	0.13	0.07	0.03	0.03	0.02	0.02	0.01
0.37	0.37	0.14	0.07	0.04	0.03	0.03	0.02	0.02
0.40	0.40	0.16	0.08	0.04	0.03	0.03	0.02	0.02

No. of Quanta

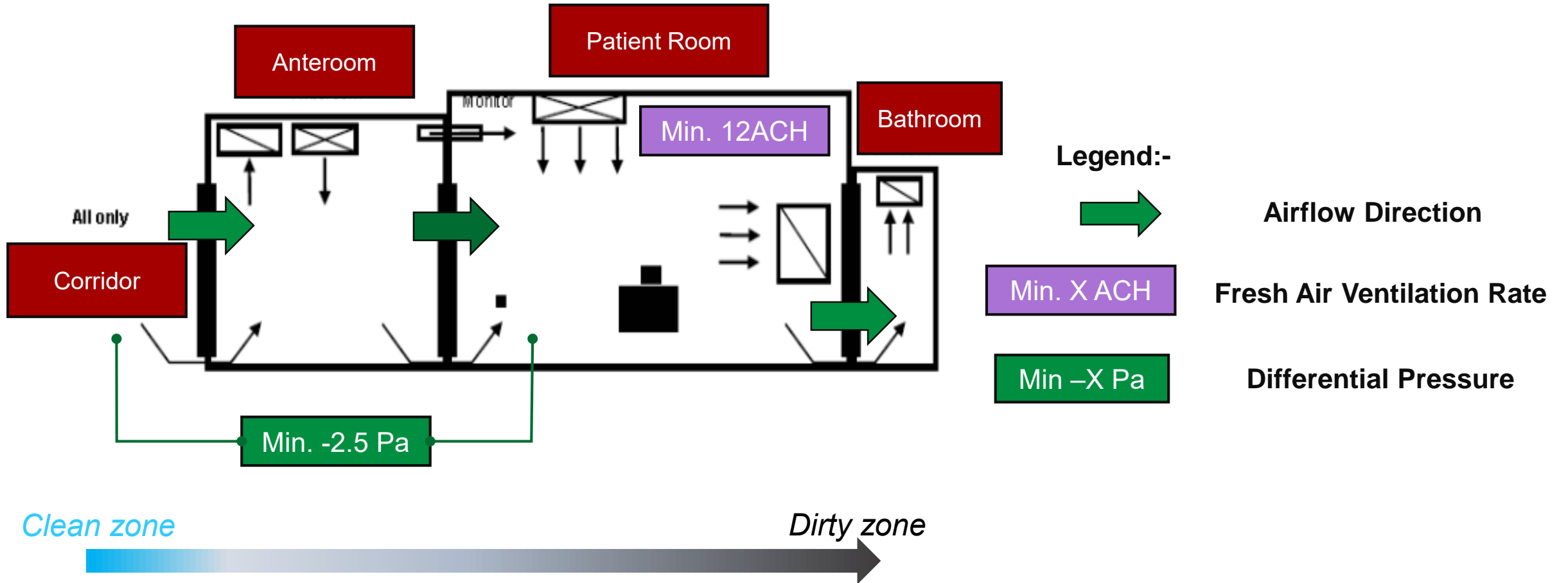
The higher ventilation rate, the lower the infection risk.

Implication 2: Infection Risk with No. of Quanta under Various Ventilation Rates

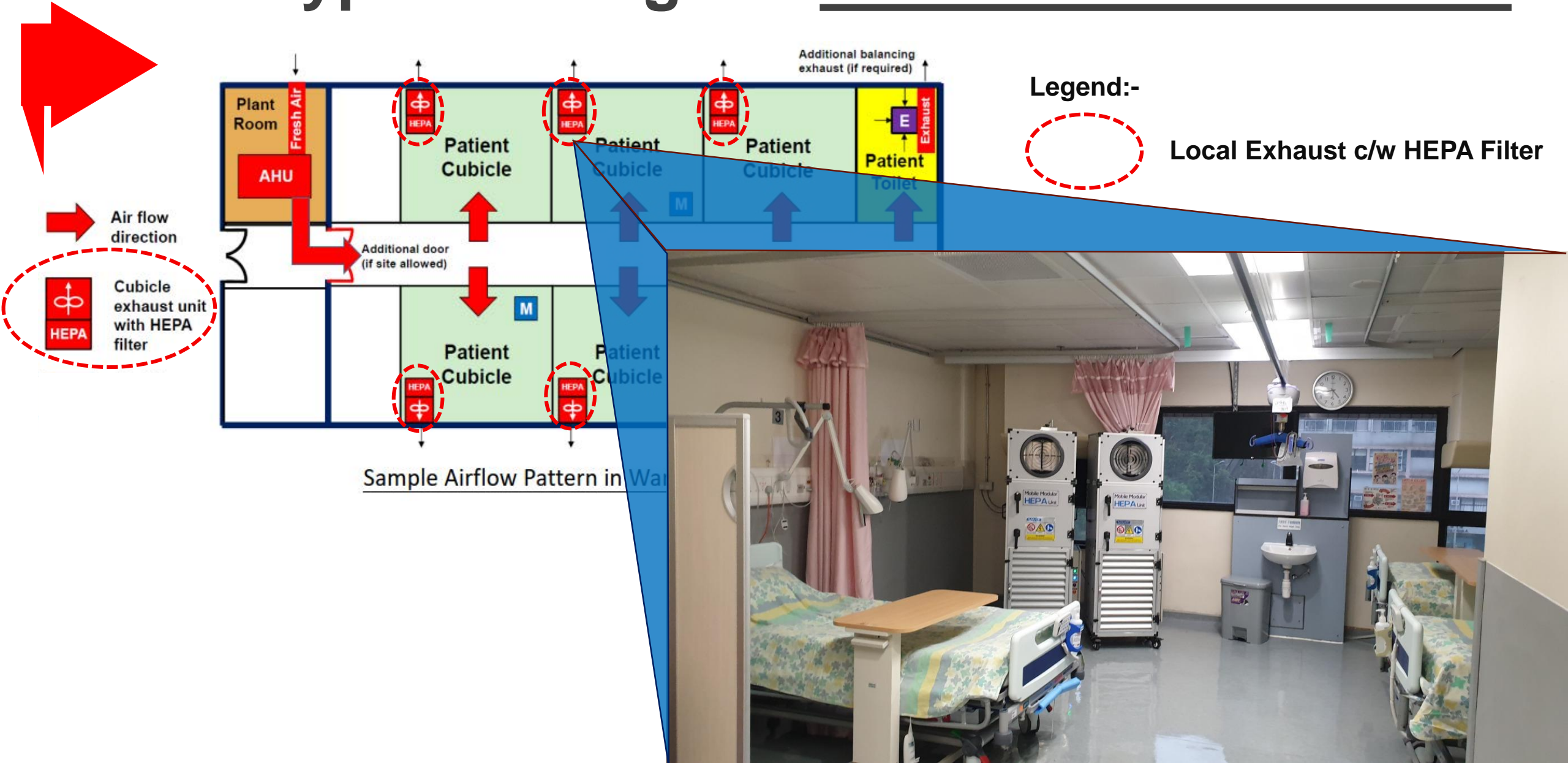
International Guidelines - ASHRAE



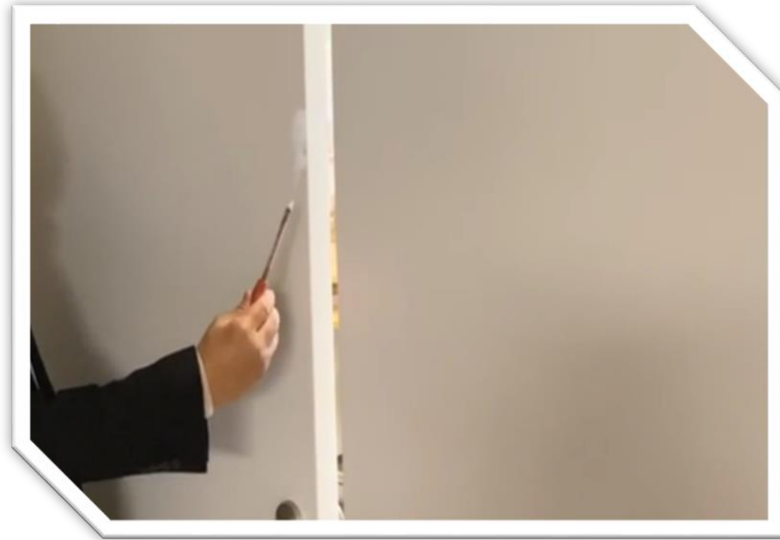
Typical Design of Isolation Room



Typical Design of 2nd Tier Isolation Ward



General Ward Negative Pressure Ward

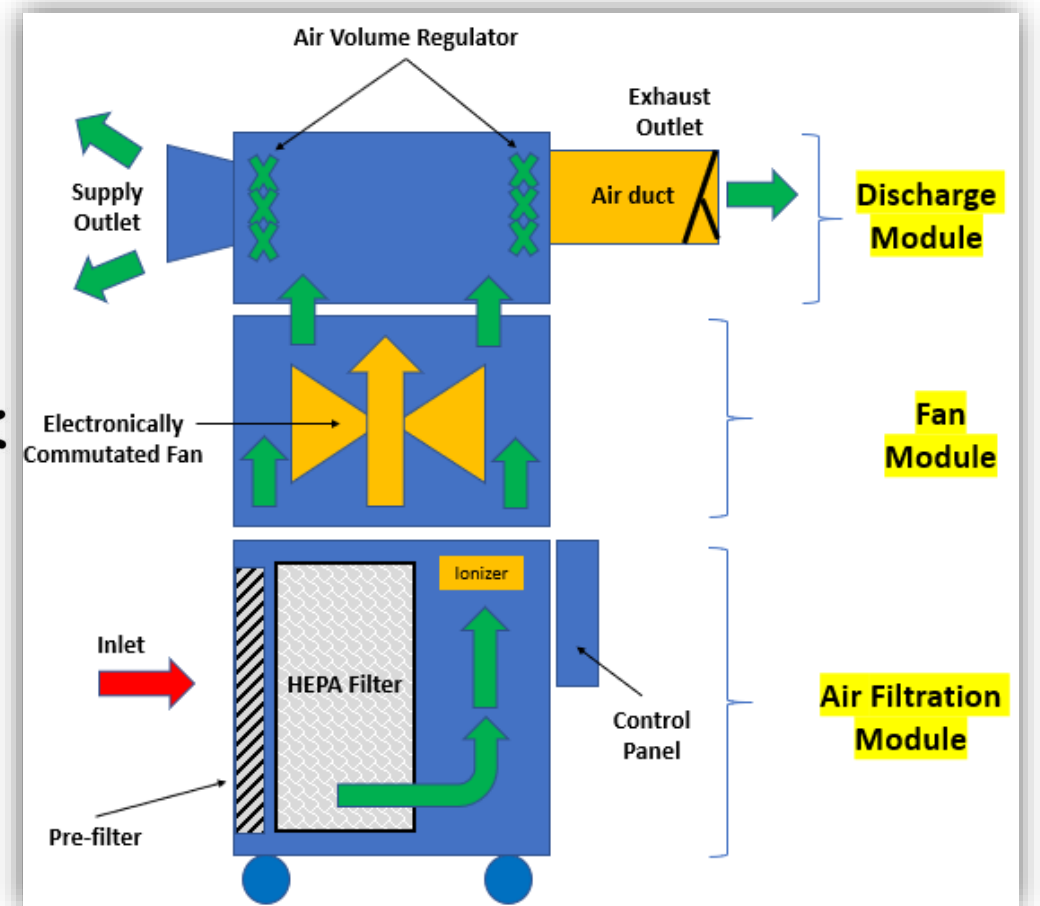


Smoke Flow Test

MMHU Sectional View



Room Pressure Measurement



Three Main Design Criteria:

- ✓ Achieve 12 ACH
- ✓ Maintain -2.5 Pa Differential
- ✓ 100% Fresh Air Supply

Asia World Expo
Community Treatment Facilities



Ventilation
Assessment on
Community Treatment
Facilities and Testing
Centres

Sports Centres for Universal
Community Testing Programme



Ventilation Assessment in Hotel

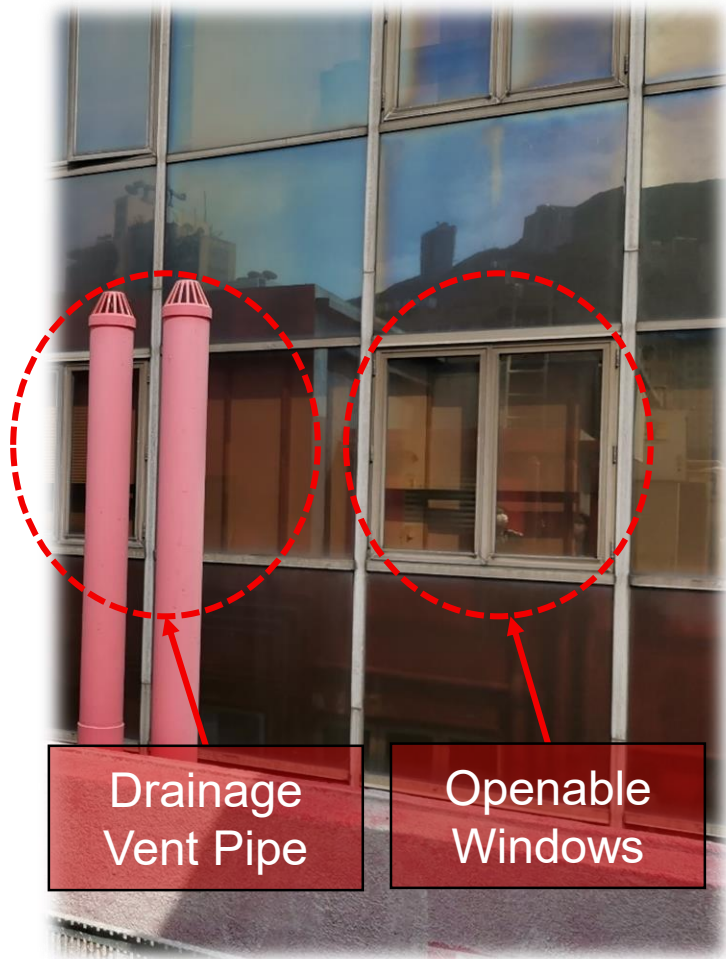
EMSD Role



Review the ventilation setup at various hotels as a quarantine facilities



Ventilation Assessment in Hotel



Site Inspection



Ventilation Assessment Against Vent Pipe



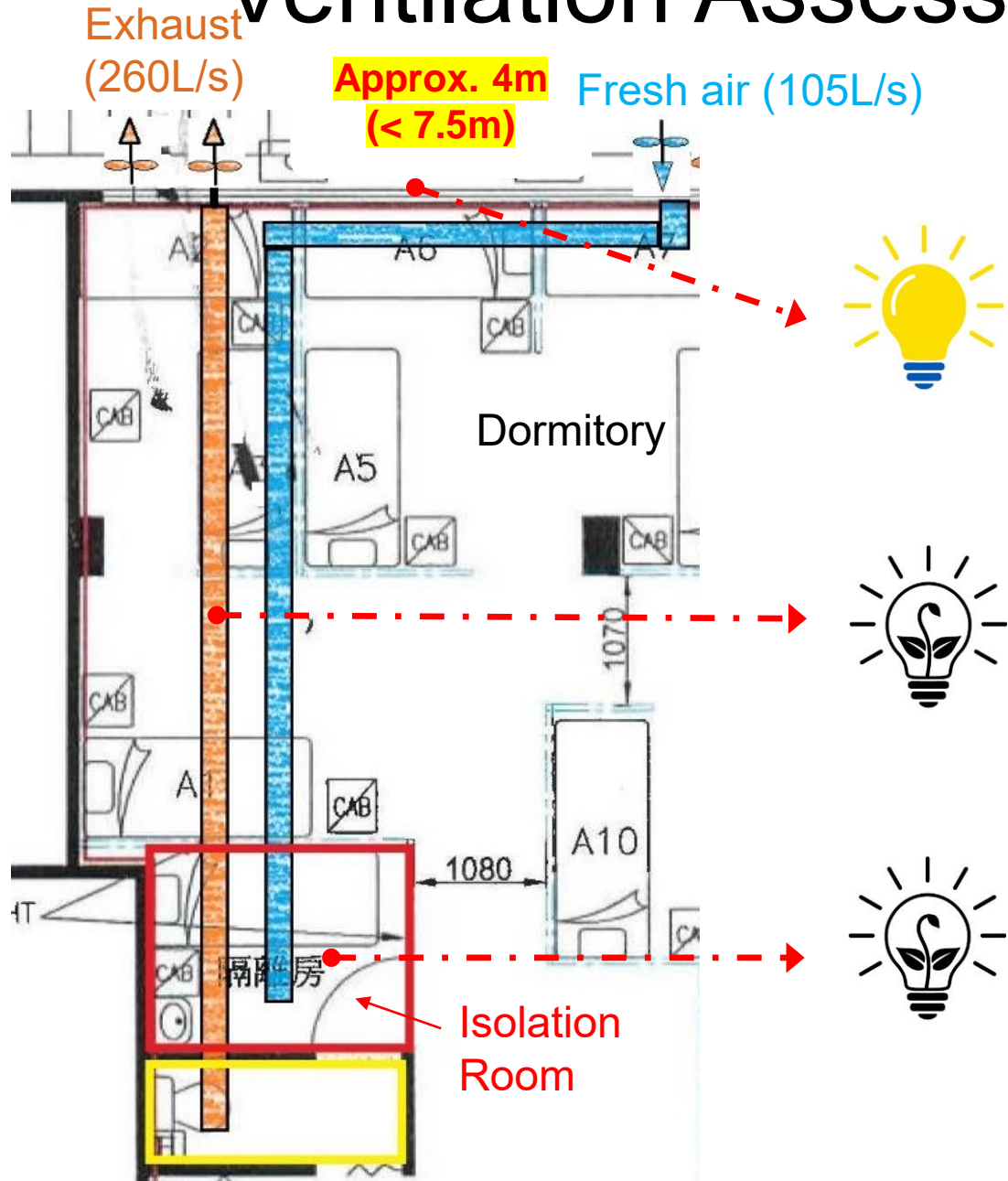
EMSD Role
Review the ventilation setup at various hotels as a quarantine facilities



Guiding Principle for Assessment on Elderly Homes

Items	Requirements
Fresh Air Supply at Dormitory	Min. 10L/s/person
Distance between fresh air intake and other sources of contamination	7.5m
Distance between fresh air intake / openable window and cooling tower	7.5m
Air Flow Pattern	Clean Zones  Dirty Zones  Exhaust
Isolation Room Ventilation	Negative Air Pressure (Inward Air Flow)
Toilet / Bathroom Ventilation	10 ACH (Exhaust)
Kitchen Ventilation (separate system)	5 ACH (Exhaust)
Dining Area Ventilation (separate system)	4 ACH (Fresh Air)
Laundry Ventilation	10 ACH (Exhaust)

Ventilation Assessment of Elderly Homes



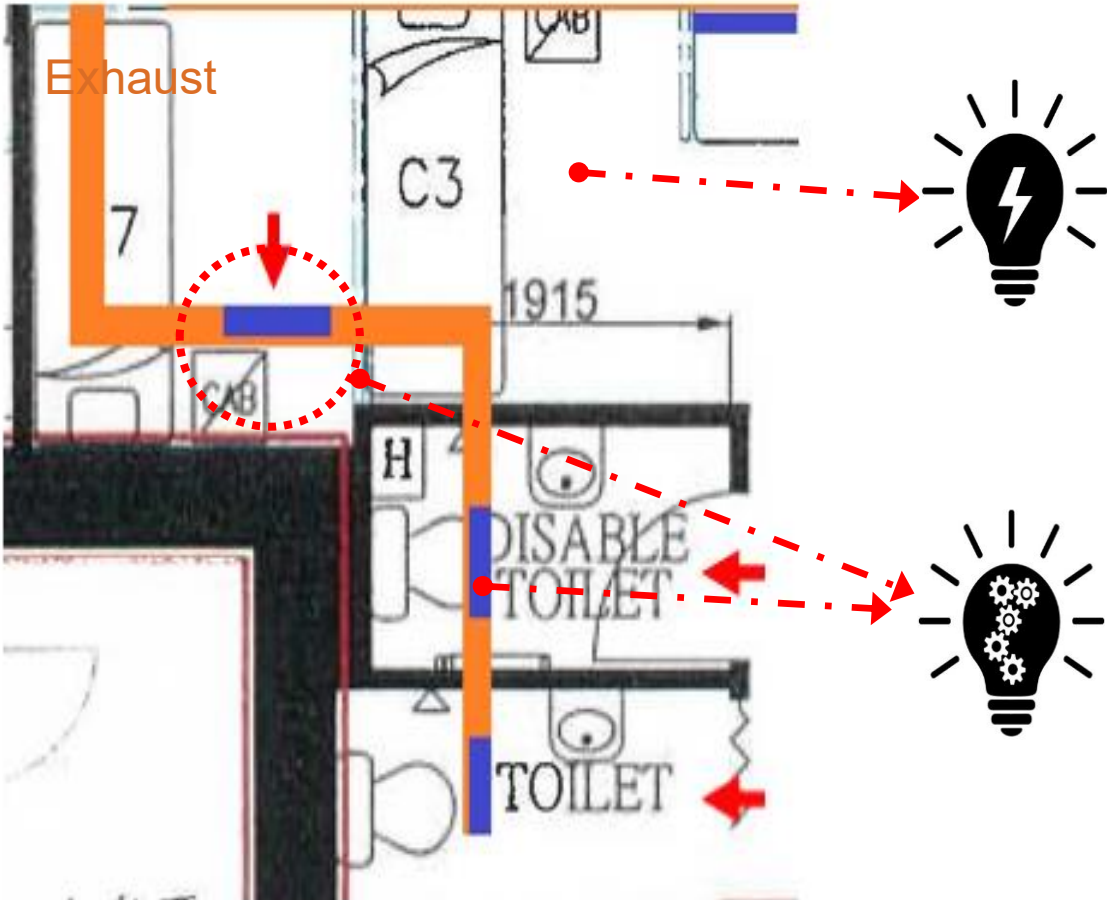
Case 1:

Finding 1: Possibility of Short Circuit between Supply and Exhaust Ductworks (<7.5m separation)

Finding 2: Air intake less than that of exhaust -> -ve pressure environment

Finding 3: +ve pressure isolation room

Ventilation Assessment of Dormitory



Case 2:

Finding 1:

No mechanical air intake and windows for fresh air intake were closed.

Finding 2:

Possible mixing between toilet exhaust and dormitory

Ventilation Assessment of Fitness Centre and Public Market

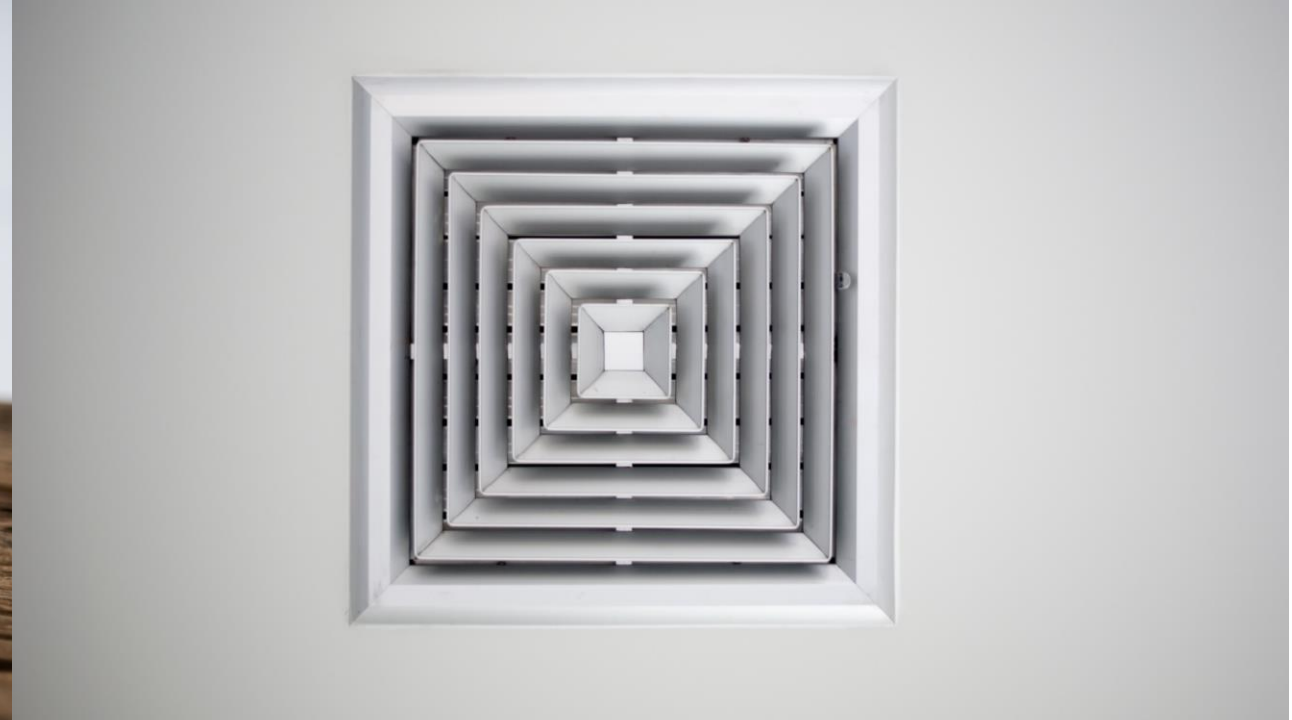


Fitness
Centre



Public Market







Thank You