



PREVENTION OF COVID-19

WHAT ROLE DOES VENTILATION PLAY?

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EMSD

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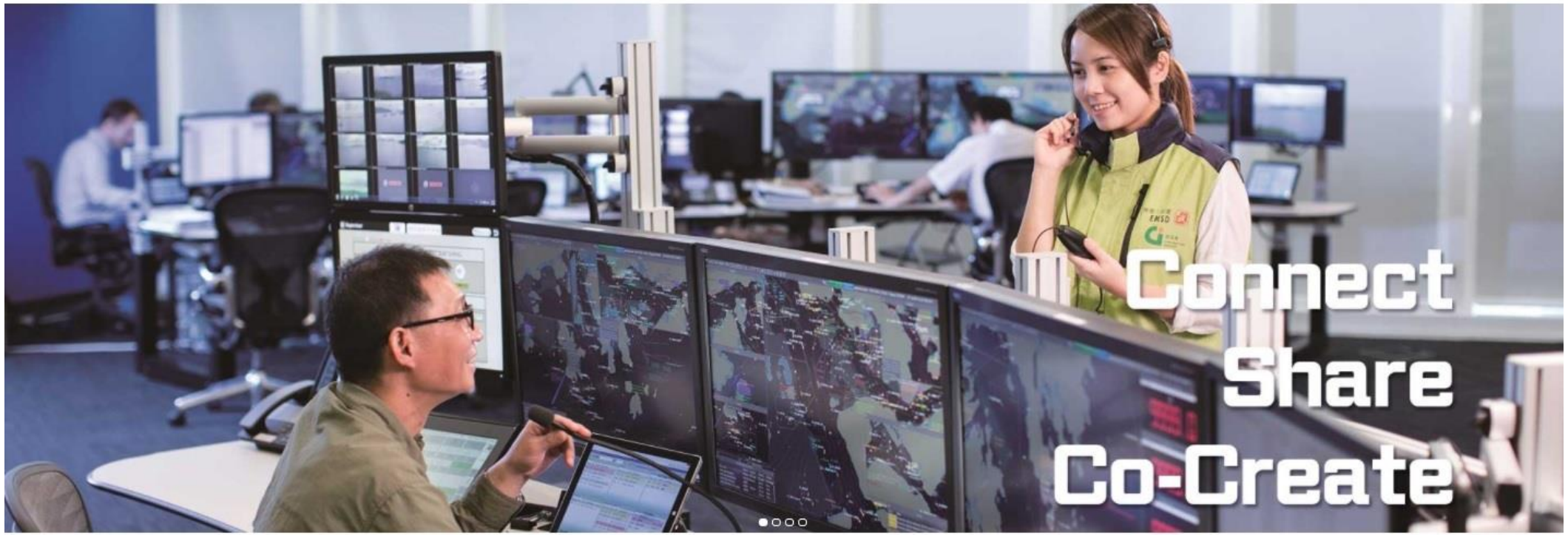

E&M InnoPortal

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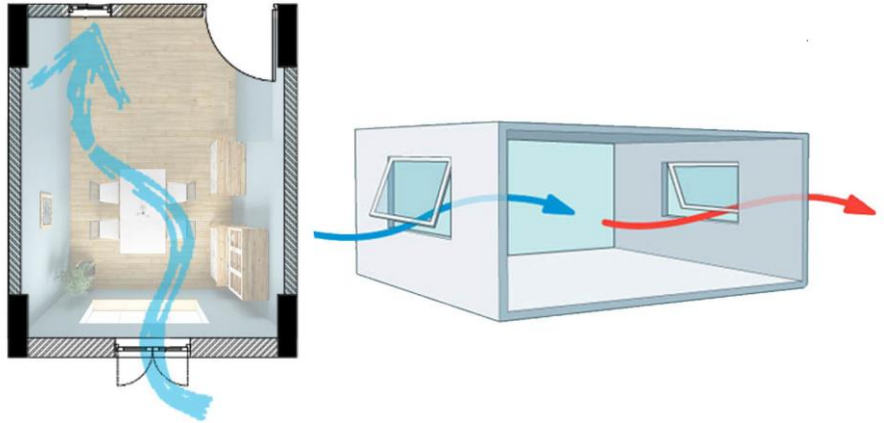
WHAT IS VENTILATION?

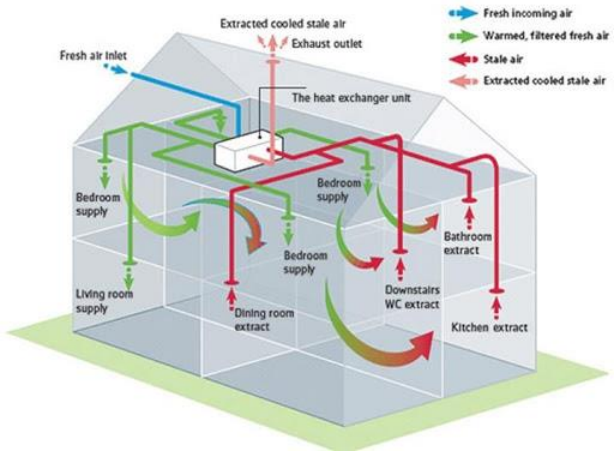
“Ventus” = wind

=> 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.





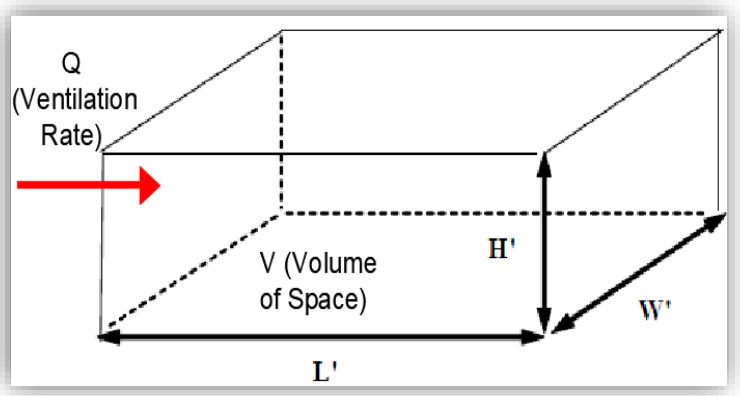
Mechanical Ventilation

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	• Capable of achieving high ventilation rate • Protect the environment due to lower energy consumption	• Weather dependent • Climate dependent (i.e. Wind direction)
Mechanical Ventilation	• Reliable in delivering the required flow rate regardless of ambient conditions • Filtration systems can be installed • Airflow path can be controlled	• 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

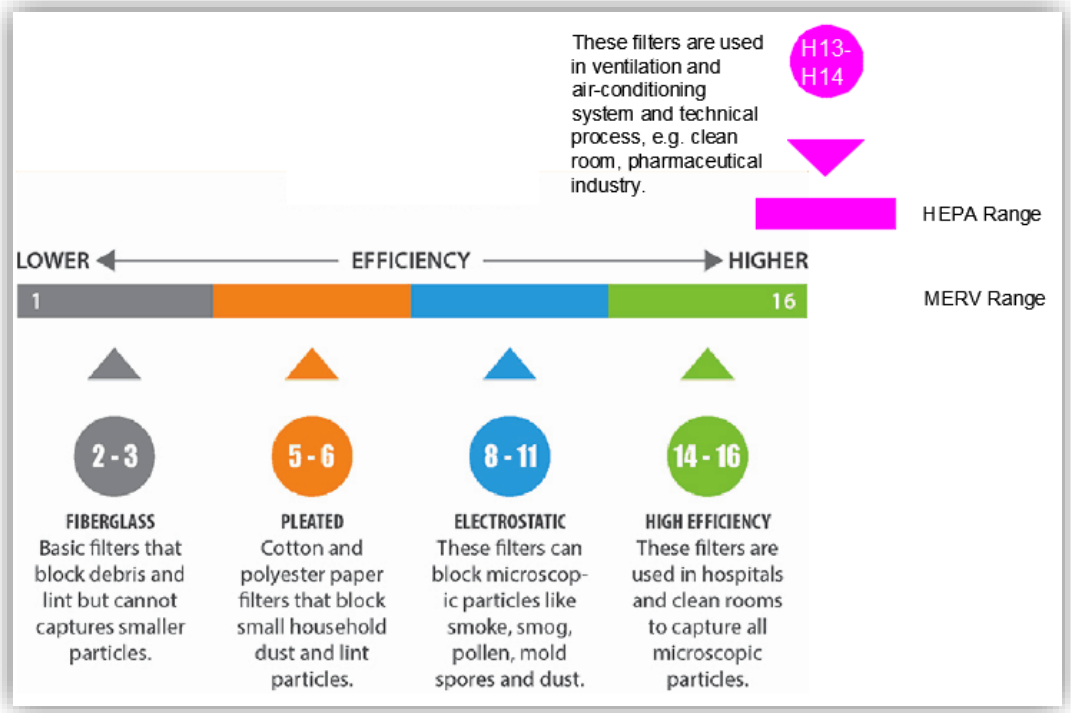
Conversion

2. Ventilation Rate (L/s)

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

Ventilation Terminology

3. Negative Pressure Differential & Airflow Direction

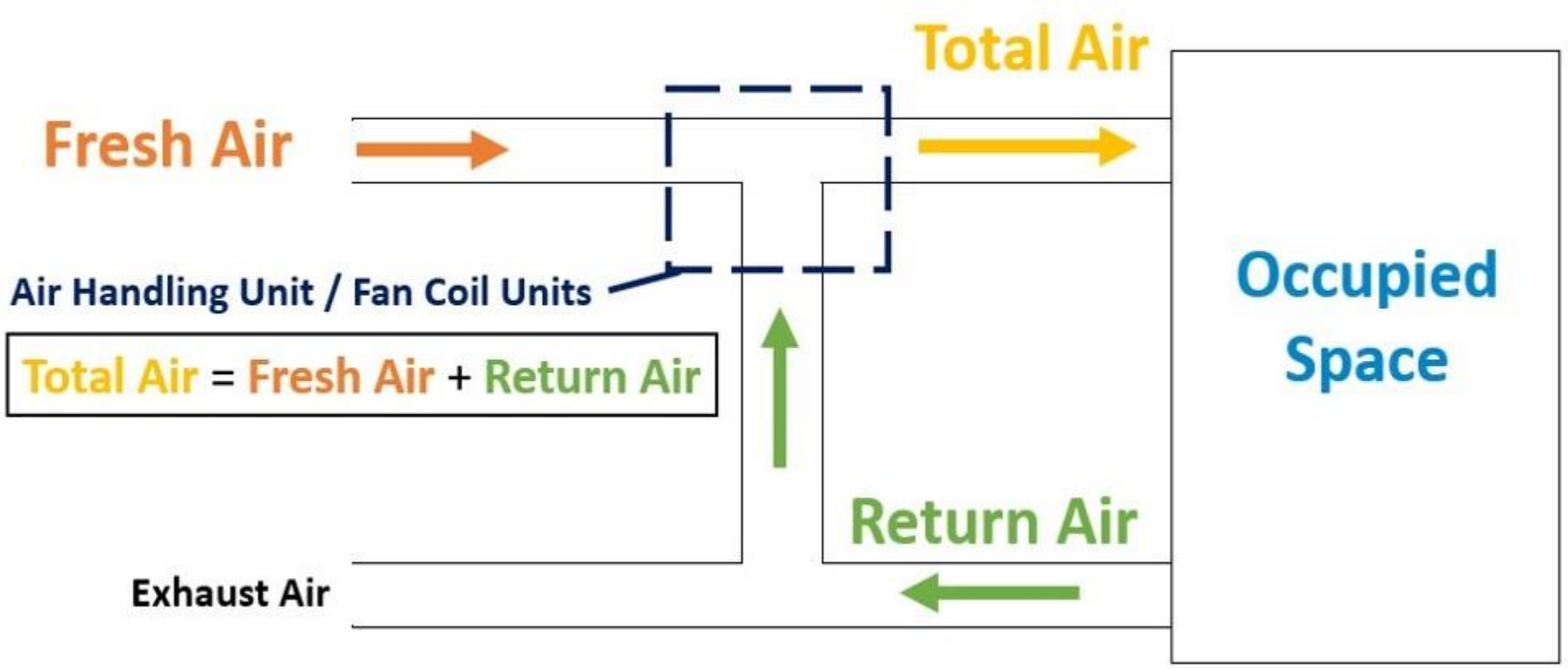


4. Filtering Efficiency

- 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

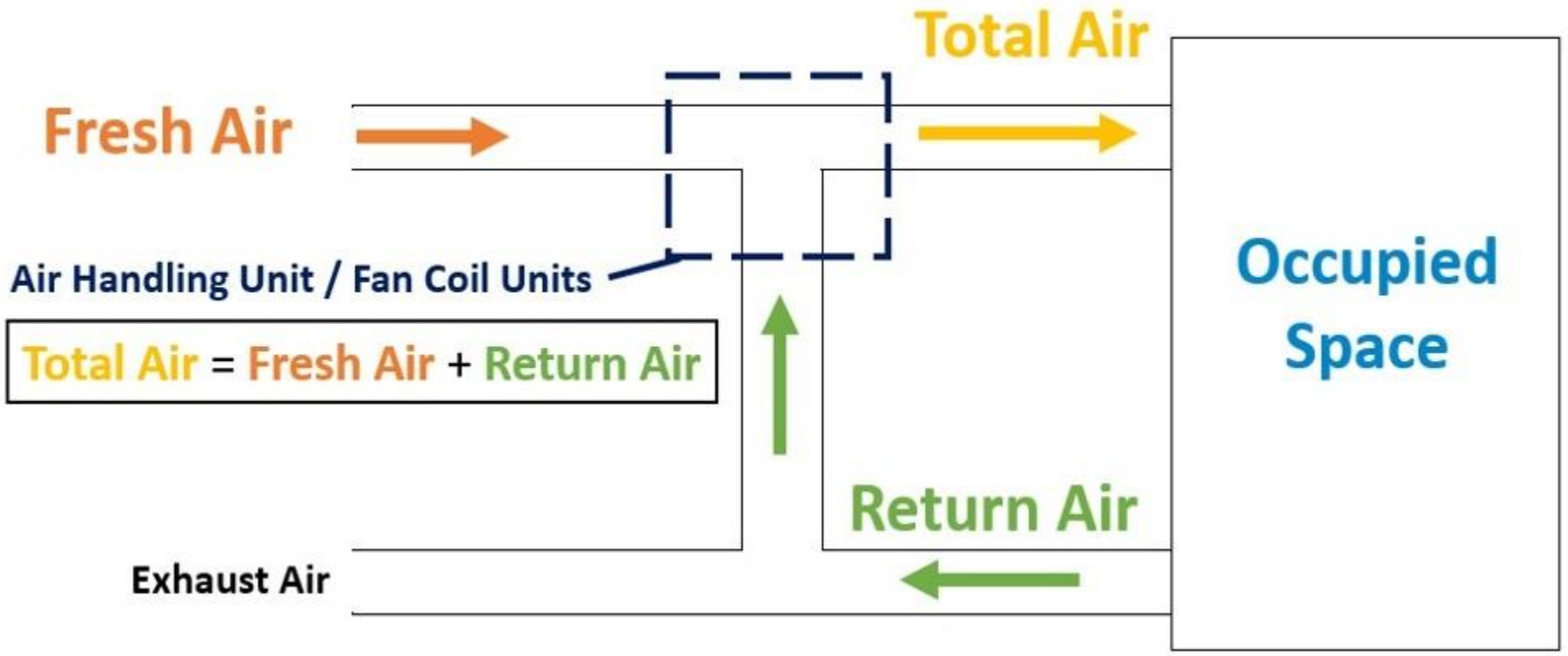
Typical Ventilation System



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

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

Typical Ventilation System



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

Statutory Requirements on Ventilation System

屋宇署
BUILDINGS DEPARTMENT

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

02
Public Health and Municipal Services Ordinance (Cap 132)

03
Labour Department Guidance Notes

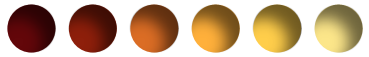
Statutory Requirements

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

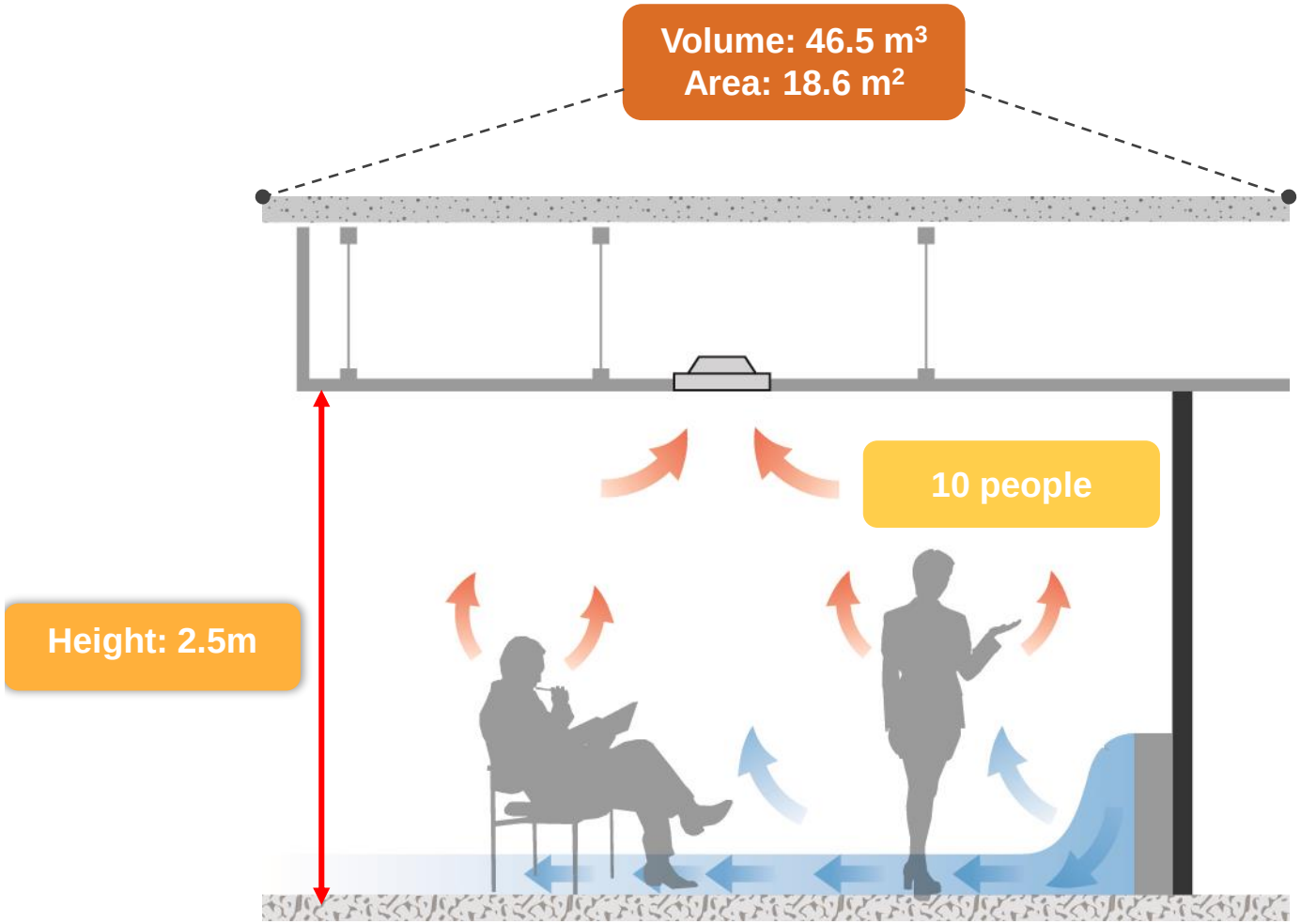
Types of work activity	Minimum fresh air supply rate (m^3 / min / person)	Remarks
Open plan offices, schools (non-smoking)	0.43	The normal daily working hours or hours of stay are long, e.g. 8 hours
Private offices (with moderate smoking), laboratories	0.6	
Conference rooms or office (with heavy smoking)	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

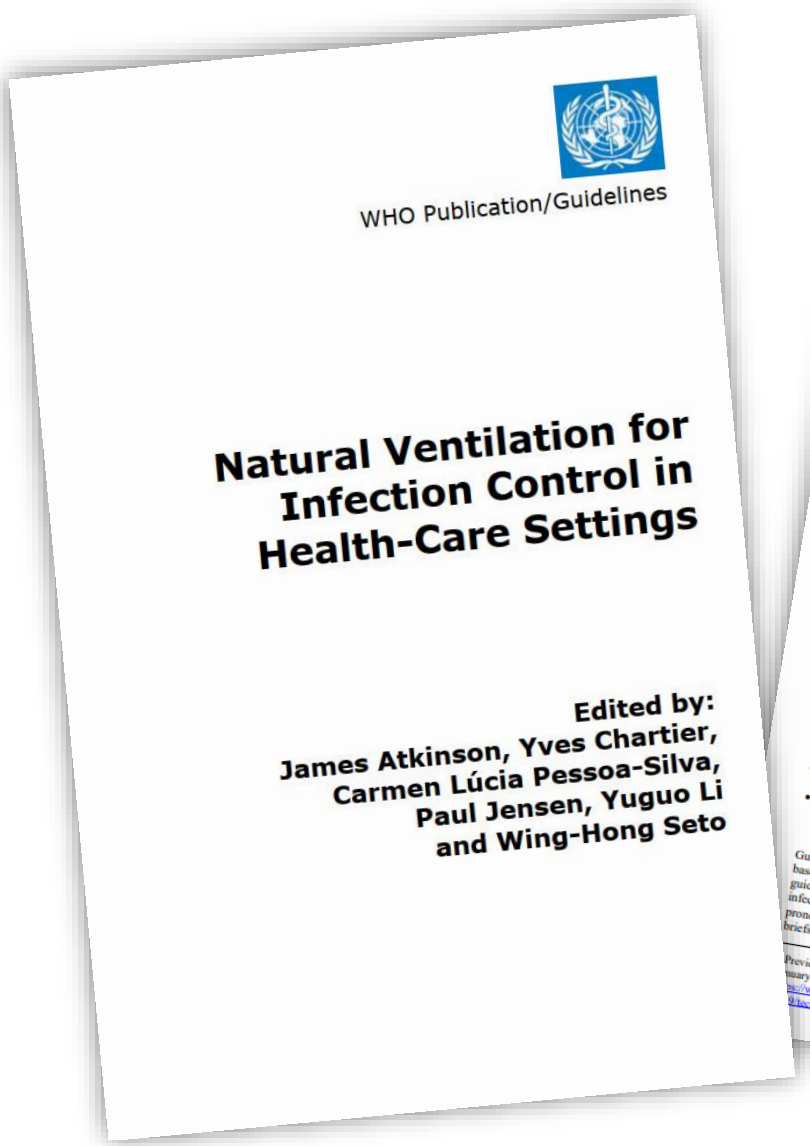
- ☑ Area & Volume
- ☑ Minimum Fresh Air Supply Rate (1.0 m^3/min/person)
- ☑ Occupants

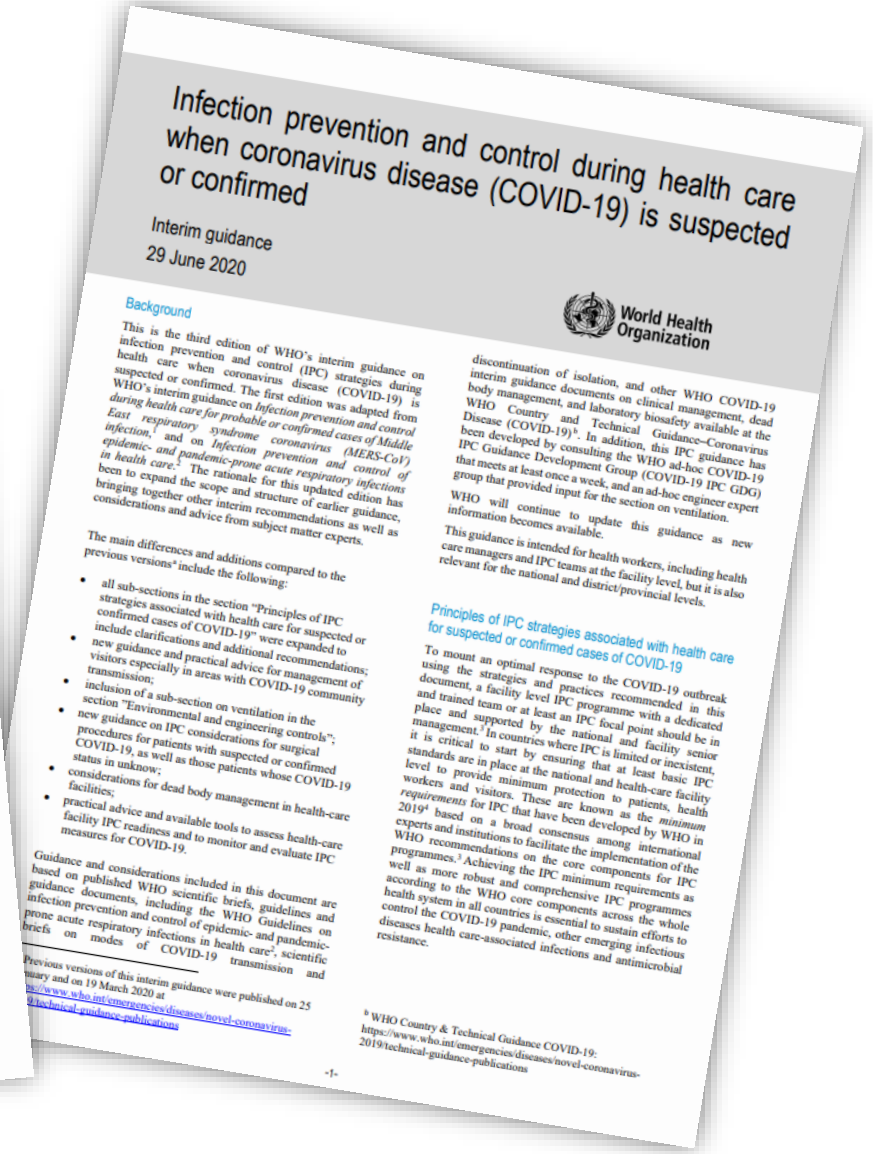


$$ACH = \frac{1.0\left(\frac{m^3}{min \quad person}\right) \times 10(persons) \times 60(min)}{46.5(m^3)}$$

Calculated ACH 12.9

International Guidelines - WHO





What role does Ventilation Play?

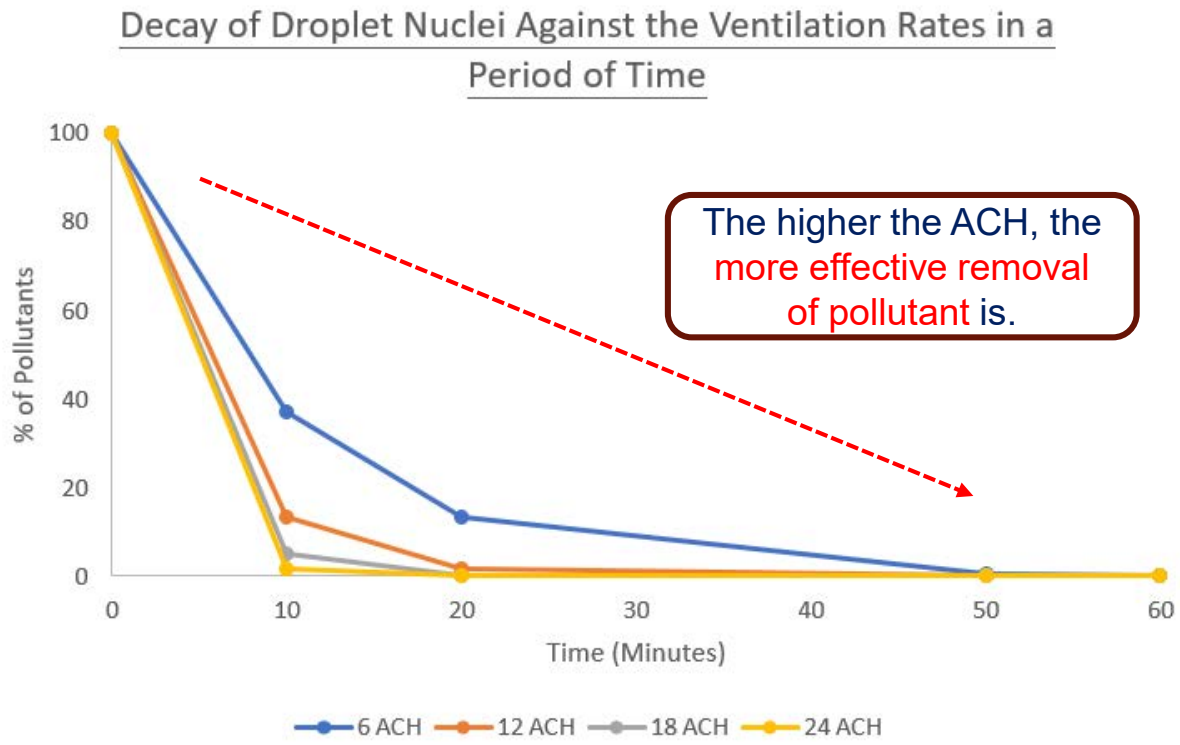
Table E.1 Decay of droplet nuclei concentration in an isolation room for different ventilation rates and duration of time

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



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

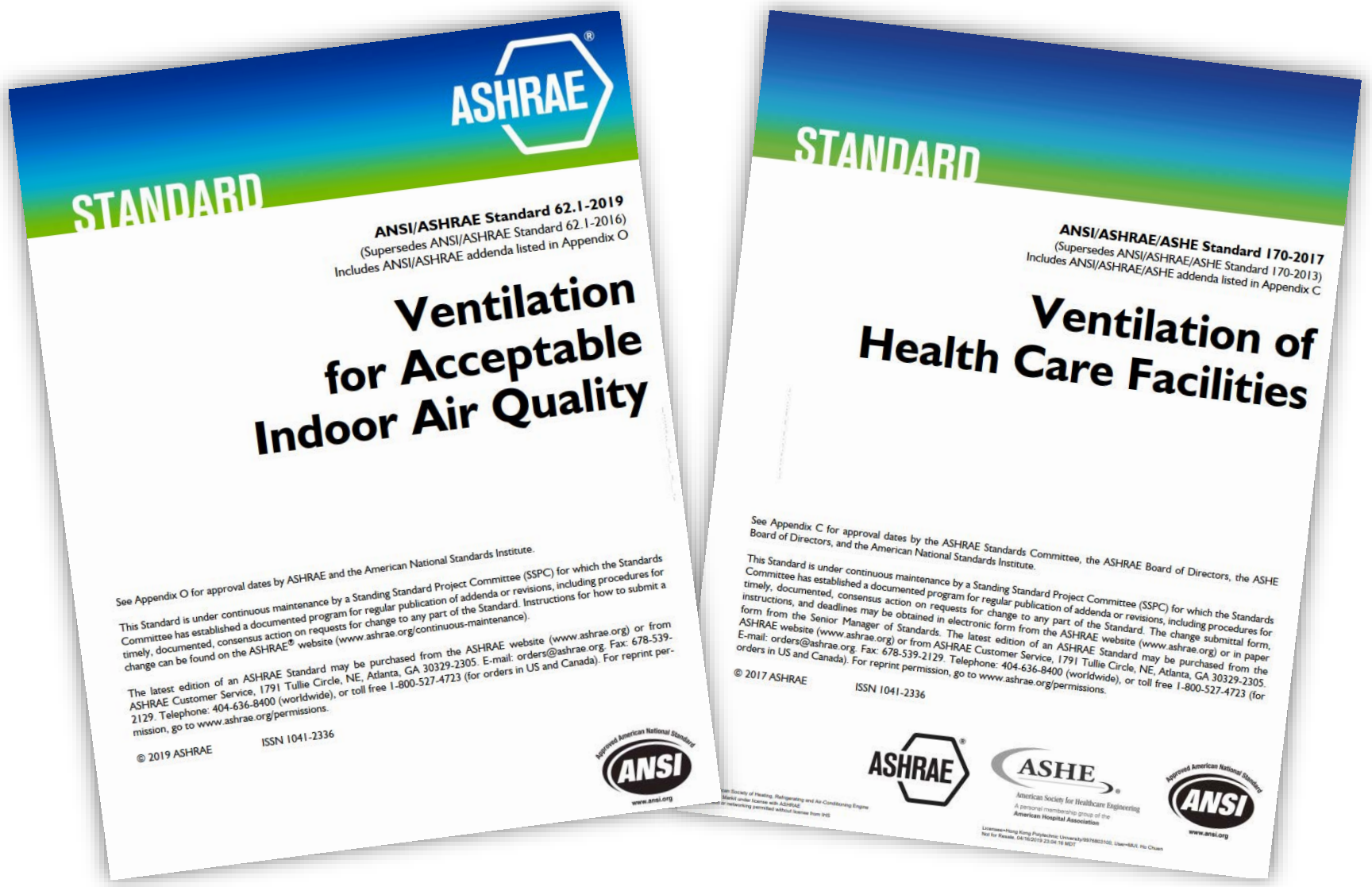
Quanta generation (quanta/min)	Ventilation rate (air changes per hour) (%)							
	1	3	6	12	15	18	24	30
0.05	0.02	0.01	0.00	0.00	0.00	0.00	0.00	
0.10	0.03	0.02	0.01	0.01	0.01	0.00	0.00	
0.14	0.05	0.03	0.01	0.01	0.01	0.01	0.01	
0.19	0.07	0.03	0.01	0.01	0.01	0.01	0.01	
0.23	0.08	0.04	0.02	0.02	0.01	0.01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



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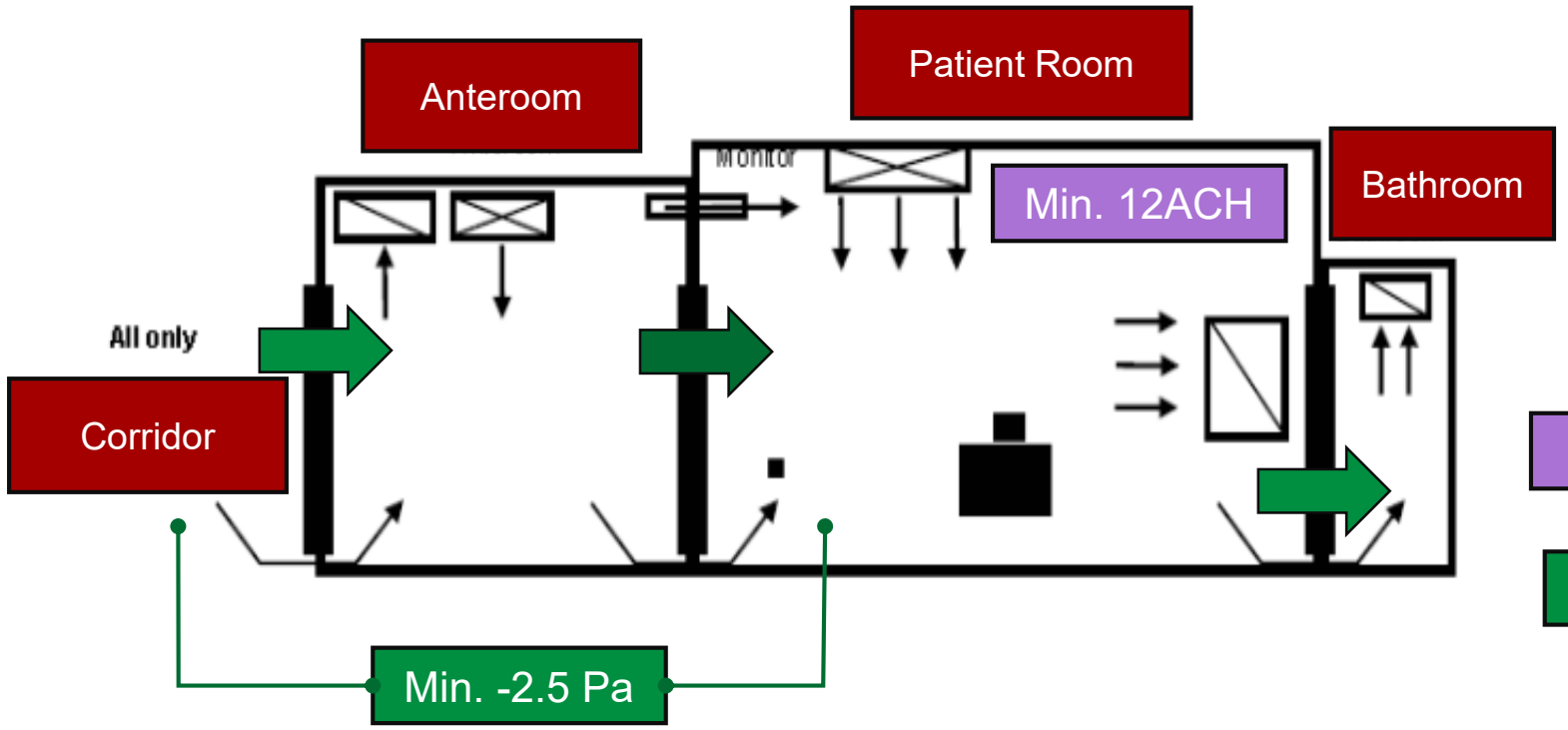
Typical Design of Isolation Room



Legend:-

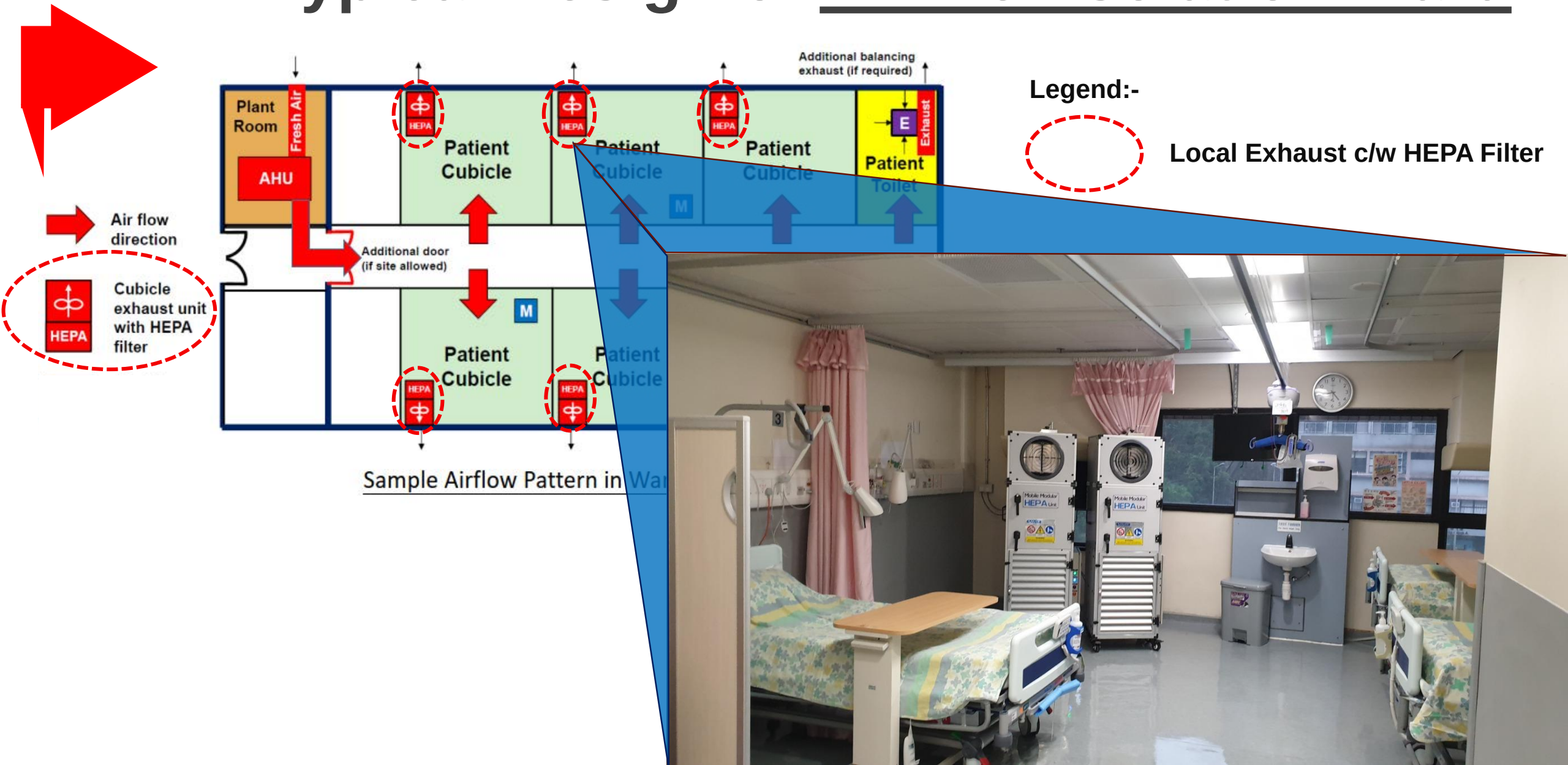
Airflow Direction

Min. X ACH — **Fresh Air Ventilation Rate**

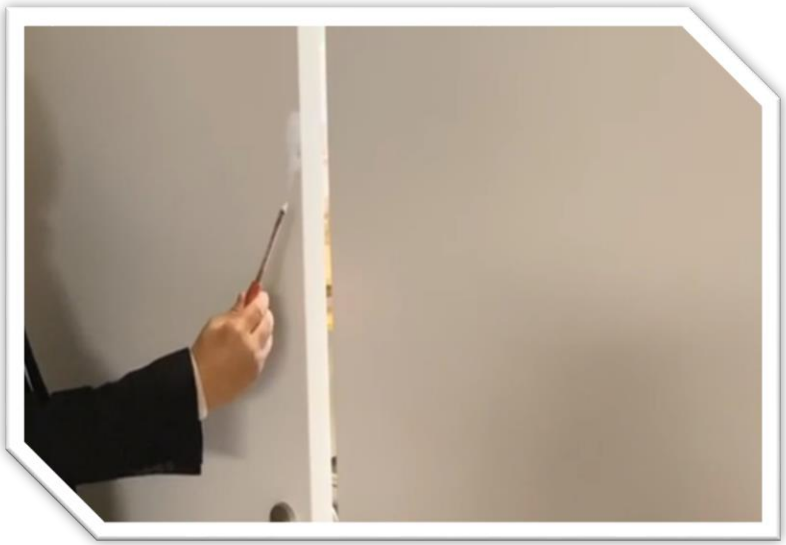
Min –X Pa — **Differential Pressure**

Clean zone → *Dirty zone*

Typical Design of 2nd Tier Isolation Ward

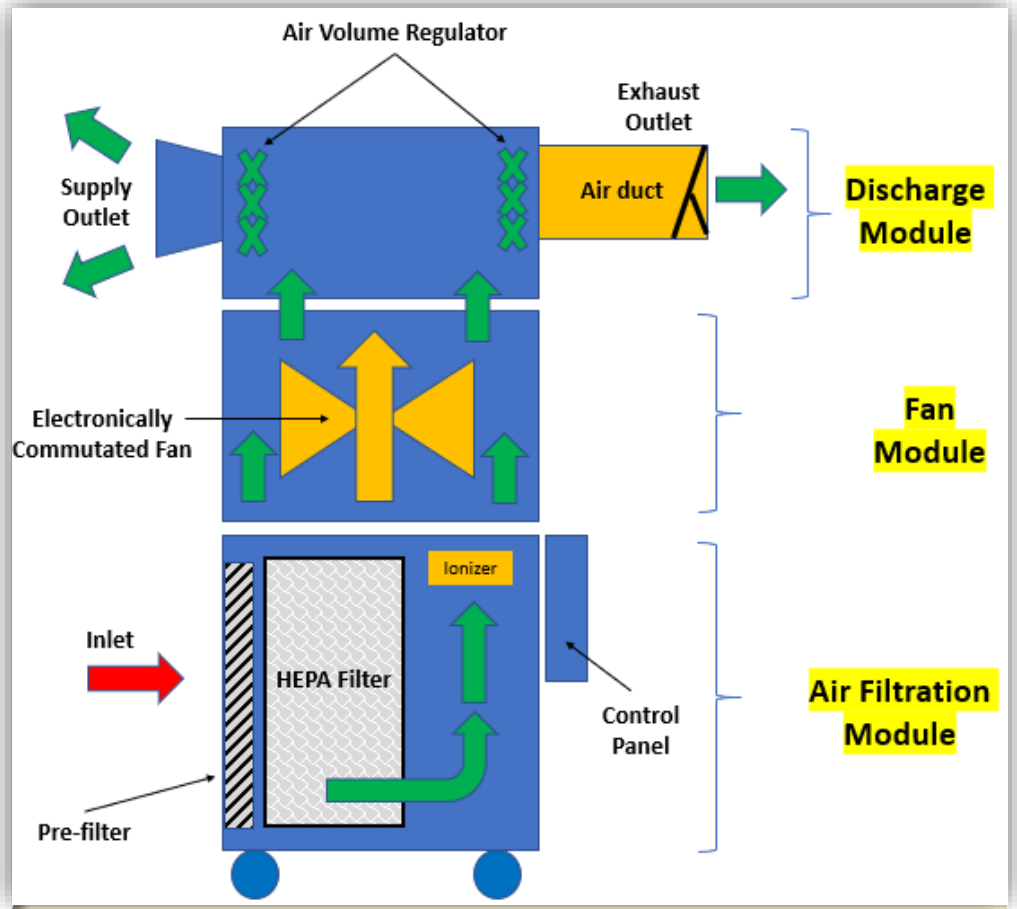


General Ward → Negative Pressure Ward



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

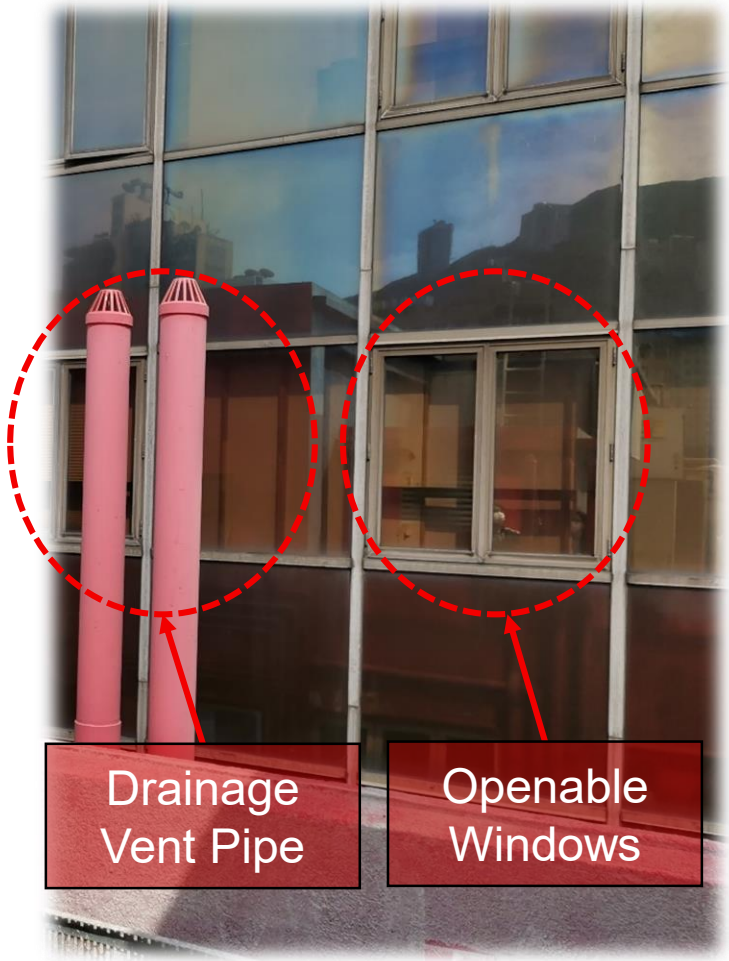
Ventilation Assessment on Community Treatment Facilities and Testing Centres

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

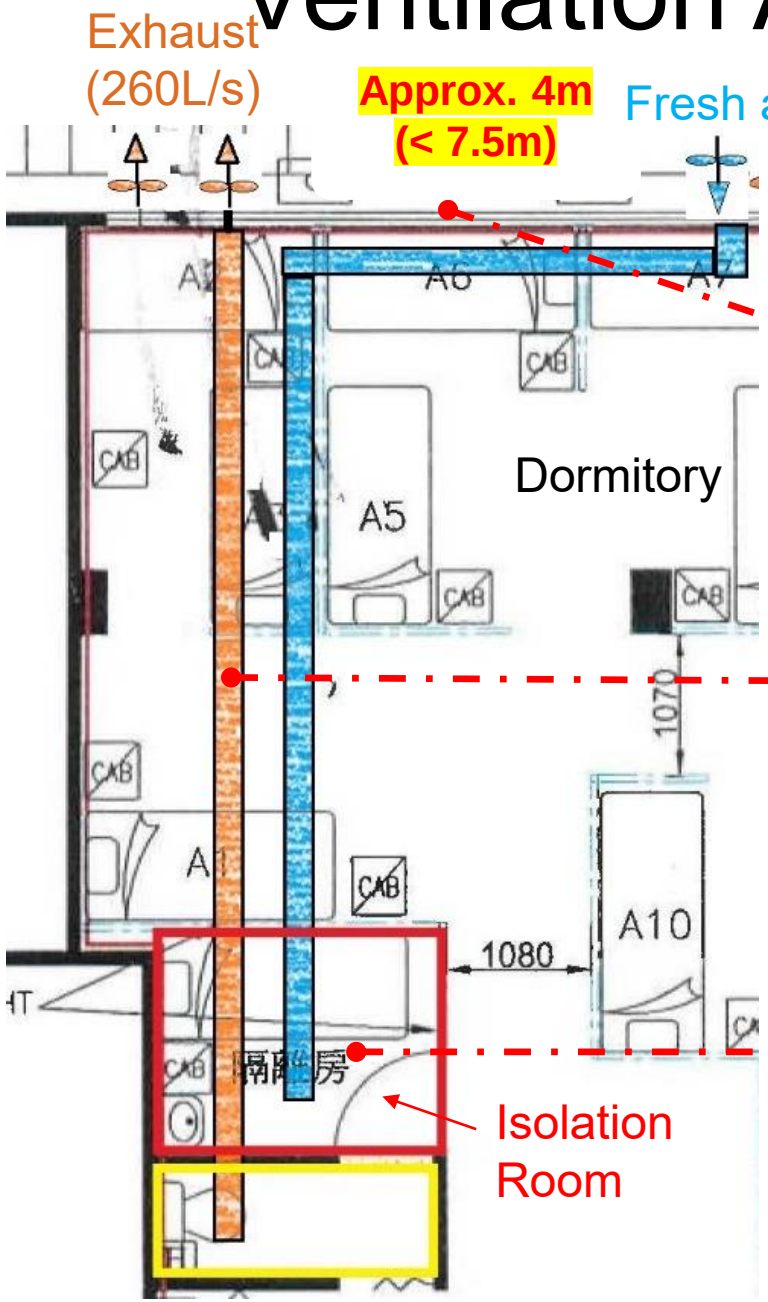
EMSD Role

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:

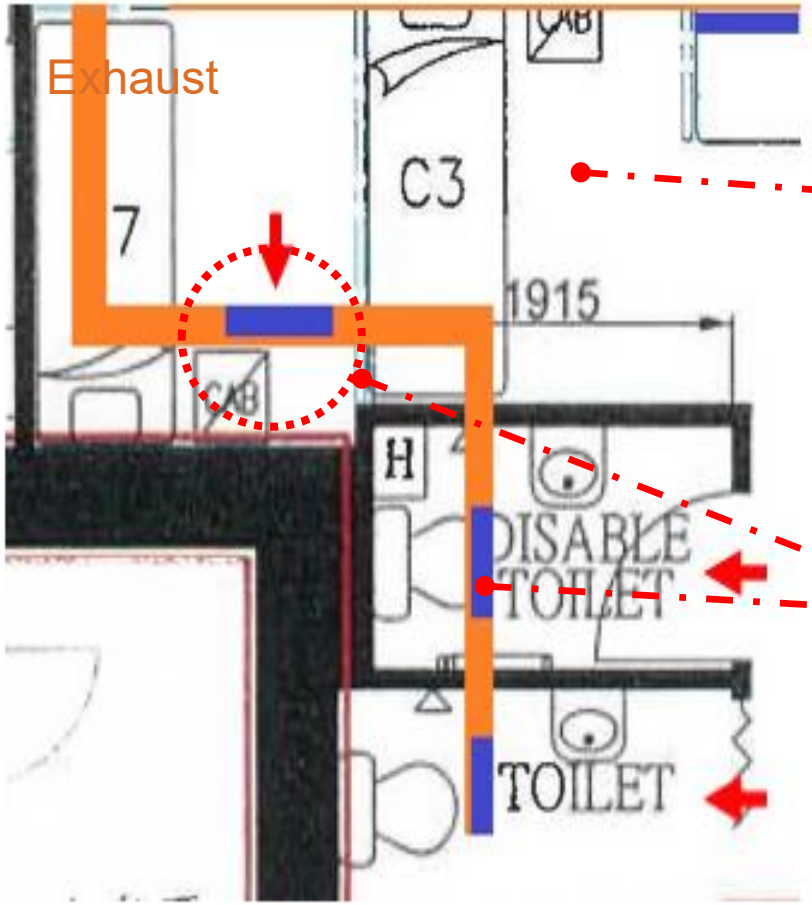
Finding 1: Possibility of Short Circuit between Supply and Exhaust Ductworks (<7.5m separation)

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

Finding 3: +ve pressure isolation room

Ventilation Assessment of Dormitory

Case 2:



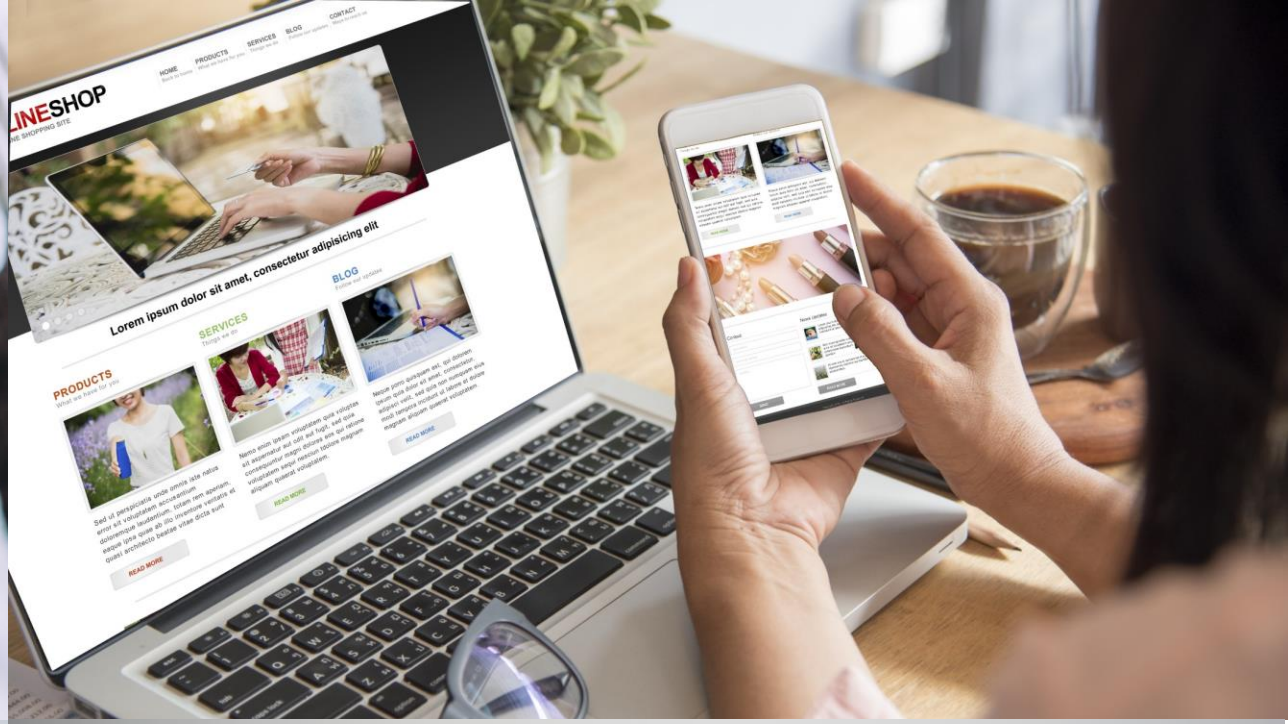
Finding 1:
No mechanical air intake and windows for fresh air intake were closed.

Finding 2:
Possible mixing between toilet exhaust and dormitory

Ventilation Assessment of Fitness Centre and Public Market

Fitness Centre

Public Market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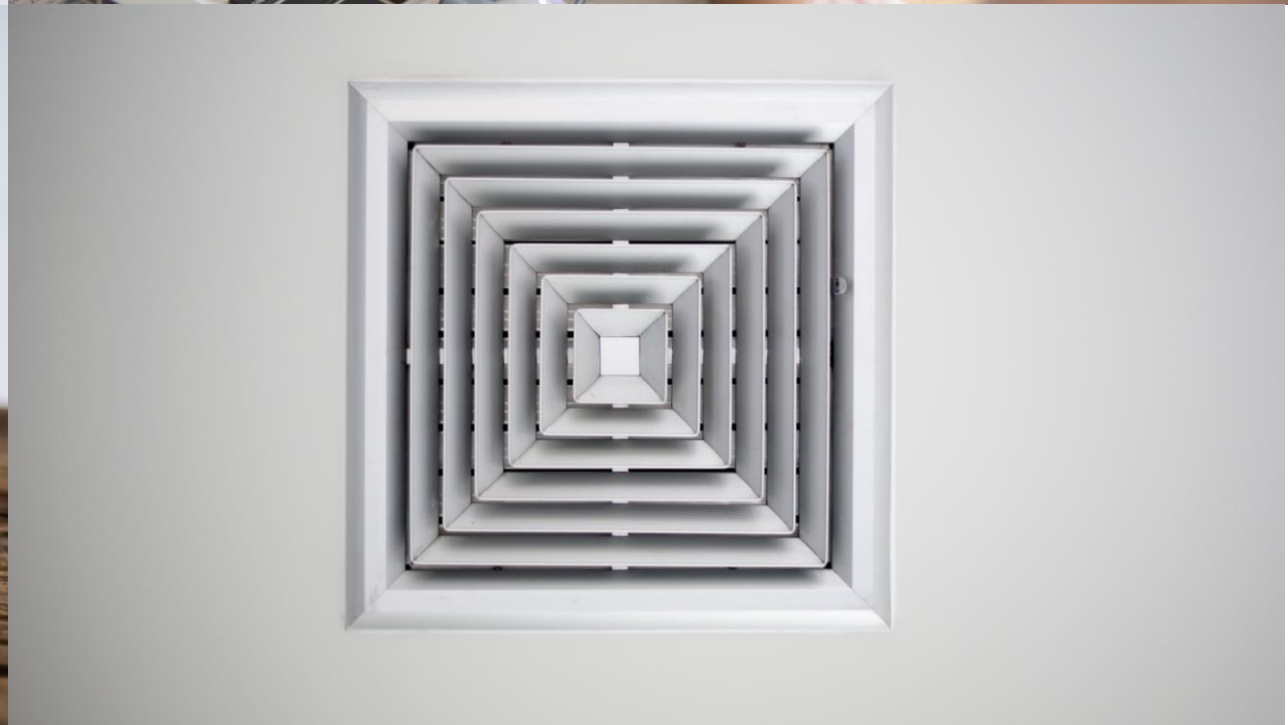

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