NATIONAL INSTITUTE FOR OCCUPATIONAL HEALTH

Division of the National Herald Laboratory Service





VENTILATION DURING COVID-19 PANDEMIC:

OCCUPATIONAL HYGIENE PERSPECTIVE

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Healthy, Safe, Happy & Sustainable Workplaces

PROMOTING DECENT WORK THROUGH CUTTING EDGE RESEARCH, SPECIALISED SERVICES, INFORMATION, TEACHING AND TRAINING

INTRODUCTION

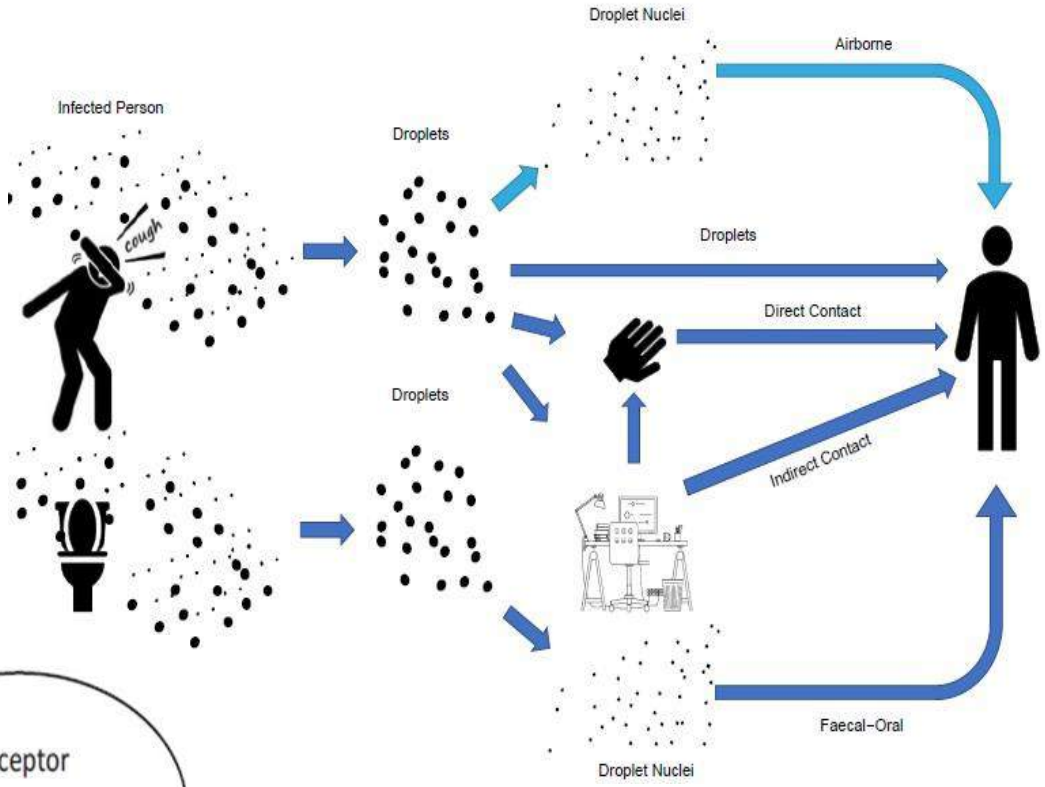
- COVID-19 cases are still increasing_ a year after the outbreak
- Ability to manage COVID-19 has improved, e.g. testing, vaccines, controls
- However, ongoing debate remains about how SARS-CoV-2 is transmitted
- Transmission via droplets, aerosols and fomites identified as main routes
- Initially it was thought that airborne transmission of SARS-CoV-2 was unlikely
- WHO and U.S CDC recently updated their scientific briefs to reflect current knowledge about SARS-CoV-2 transmission
- *Small particles can remain suspended in the air and expose individuals at distances beyond 2m (U.S CDC)*
- *Aerosol transmission can occur in specific settings and circumstances, particularly in indoor, crowded and inadequately ventilated spaces, where infected persons spend long periods of time with others (WHO)*
- Ventilation, one of the important control measures can reduce aerosol transmission risk in indoor spaces

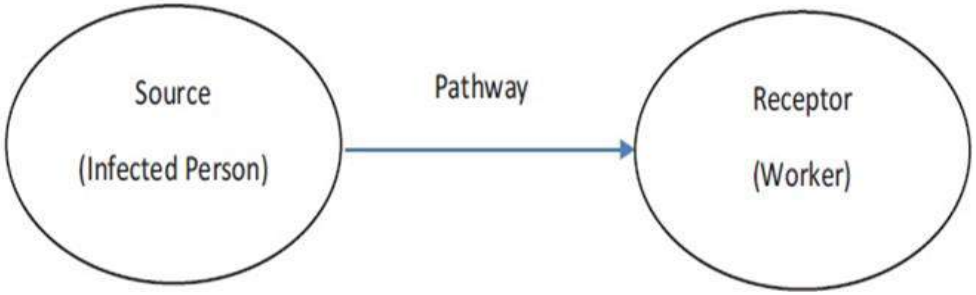
LEGAL REQUIREMENTS AND GUIDELINES

- Department of Employment and Labour consolidated COVID-19 Direction on Health and Safety in the workplace (as amended)
- Regulation 5 of the Environmental Regulations for Workplaces, 1987
- The National Building Regulations (SANS 10400-O-2011)
- World Health Organization: Roadmap to improve and ensure good indoor ventilation in the context of COVID-19, 2021
- International Labour Organization (ILO): Preventing and mitigating COVID-19 at work, 2021
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA)

TRANSMISSION ROUTES

- Large droplets > 10 μm
- Droplet nuclei/ aerosol < 5 μm
- Fomite (contaminated surfaces)
- Faecal-oral/ aerosol route





http://www.buildup.eu/en/practices/publications/how-hvac-systems-help-reduce-airborne-transmission-covid-19

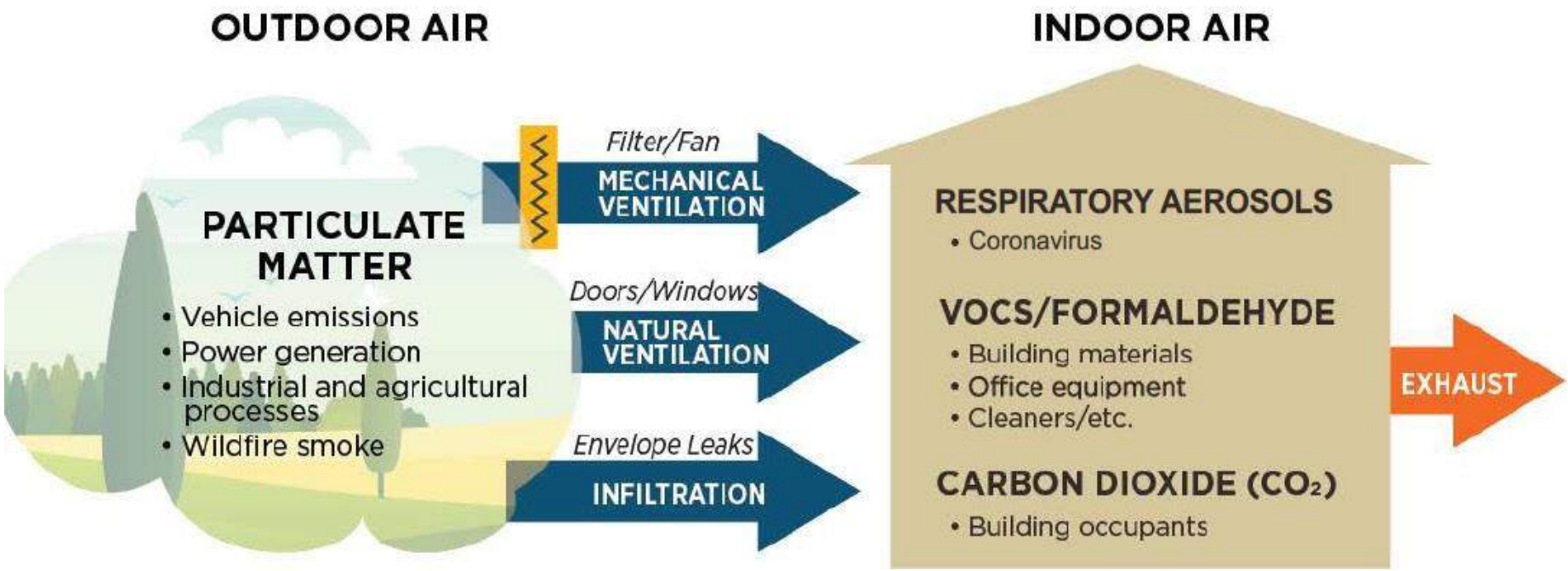
RISK ASSESSMENT

- Assess the risk from aerosol transmission in indoor areas
- Identify poorly ventilated areas
- Risk ranking
- Decide on the steps you can take to improve ventilation – in order of priority

Source: OSHA risk pyramid for COVID-19

Source: Health and Safety Authority, Ireland

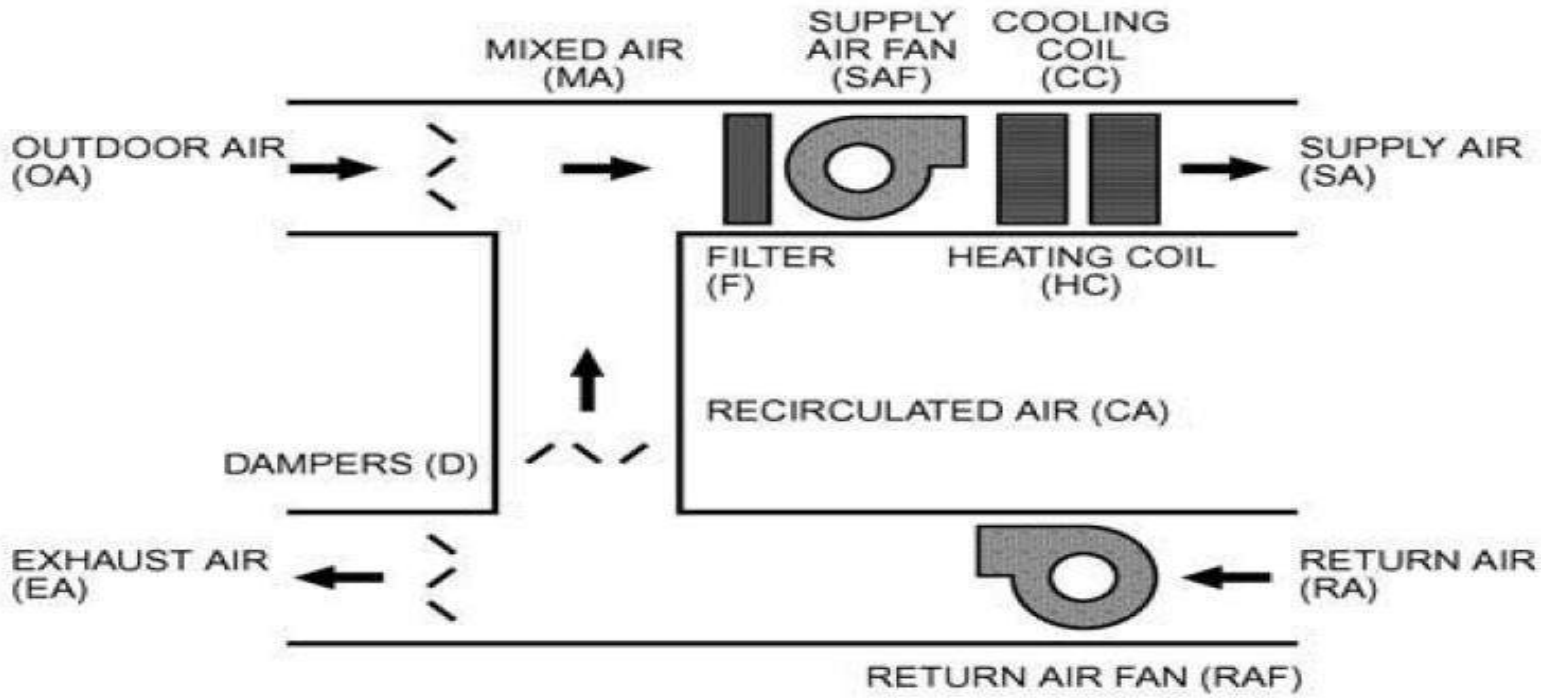
FACTORS AFFECTING INDOOR AIR QUALITY



https://bit.ly/VentilationWebinar2020

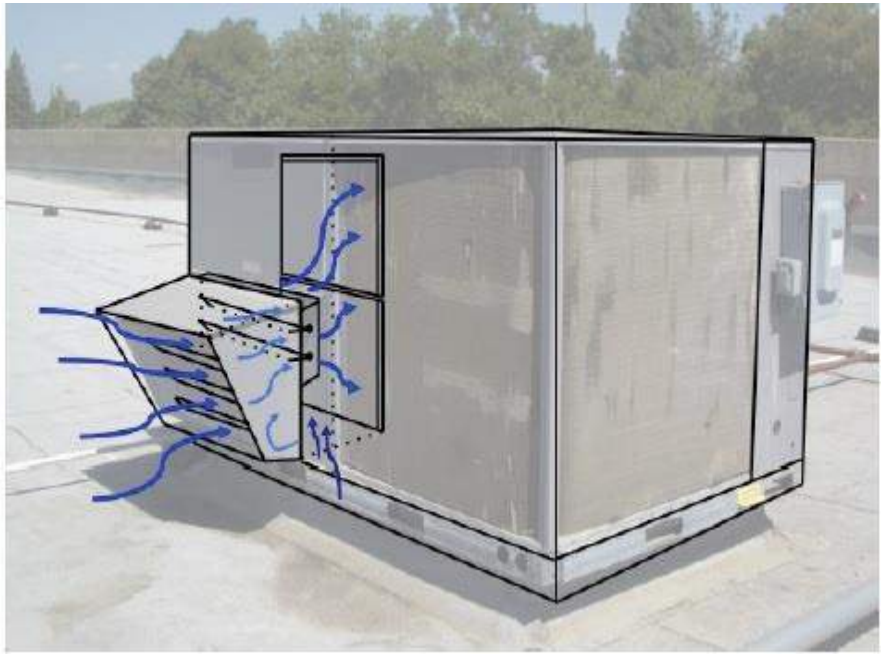
BASIC MECHANICAL VENTILATION SYSTEM

- Supply air = Outdoor air + Return air
- Dilute/ remove airborne pollutants
- Thermal comfort (temperature and relative humidity)
- Odour control



Source: 2013 ASHRAE Handbook

TYPES OF VENTILATION



Mechanical ventilation

- HVAC system
- Split unit air conditioner?
- Allows for filtration
- Reliable
- Requires fan to run (can be automated)
- Energy costs – heating and cooling
- Maintenance

Natural ventilation

- Windows and doors
- Variable, may not provide adequate airflow
- Security concerns, noise
- Comfort concerns – winter/summer
- No fans or other mechanical means

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EVALUATING VENTILATION

Air capture hood

CO_2 Monitor

Air velocity meter

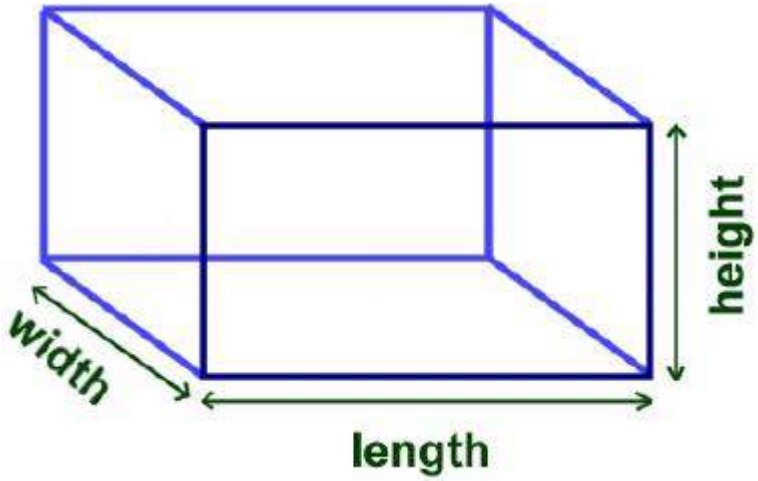
Smoke tube

Distance measure

Step ladder

TAKING MEASUREMENTS

- Follow instrument manual
- Detailed description of the ventilation system
- Measure room volume (LxWxH)
- Use smoke test to visualize airflow patterns
- Measure air ventilation rate in m^3/h



Supply air diffuser

Return air Grille

OTHER MEASUREMENT TECHNIQUES

- Carbon dioxide (CO_2) levels can be used as proxy for ventilation rates
  - ✓Building should be occupied
  - ✓CO_2 concentration > 1000 ppm indicate poor ventilation
  - ✓CO_2 indoor level not exceed roughly 700 ppm more than outside ambient conditions (ASHRAE)
- Air temperature and CO_2 can be used to estimate ventilation rates
- Tracer gas methods - involves the use of a nontoxic, nonreactive tracer gas material with a concentration small enough that the tracer gas does not interfere with the motion of the air itself

Tracer gas	Density (Air is 1,2 kg/m^3)	Threshold limit value (TLV) 8h	Chemical stability
SF_6	6,3	1000 ppm	Slightly soluble in water
CO_2	1,9	5000 ppm	Soluble in water
N_2O	1,9	50 to 100 ppm	

Source: REHVA Guidebook

$$\%\,\text{outside air} = \frac{\text{return air measuremen t}^* - \text{supply air measuremen t}^*}{\text{return air measuremen t}^* - \text{outside air measuremen t}^*} \times 100$$

* measurement refers to either CO_2 or temperature

Source: TSI HVAC Assessment Handbook

HOW TO WORK OUT VENTILATION RATES

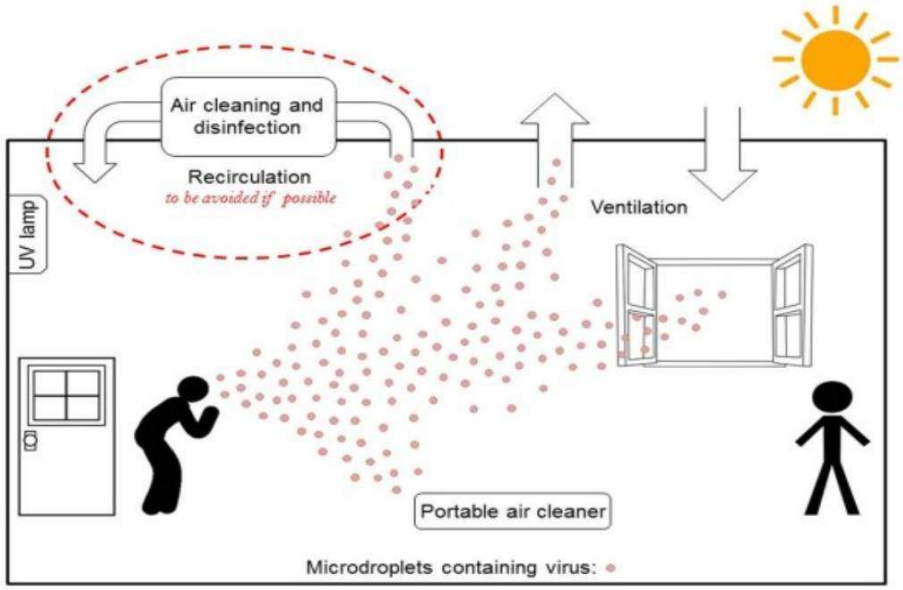
- ACH = Fresh outdoor air (OA) (m^3/hr) / room volume (m^3)
- Litres per second per person = Fresh outdoor air / 3.6 (convert m^3/h to L/s) / number of people
- WHO - 160 L/s/patient or 12 ACH where AGP are performed (healthcare settings)
- WHO - 10 L/s/person (non-healthcare settings)

Table 2 — Air requirements for different types of occupancies

1	2	3	4
Type of occupancy	**Minimum outdoor air requirements**		**Requirement**
	Air changes per hour	**L/s per person**	
Public halls			
Assembly halls	10	7,5	Air supply required per person with required minimum air changes per hour
Churches	10	7,5	
Theatres (including lobbies and auditoriums)	10	7,5	
Cinemas	10	7,5	

GENERAL CONTROL MEASURES

- Increase ventilation rate (to 100% outdoor air, if possible)
- Reduce air recirculation
- Enhanced filtration, if recirculating air
- Operate bathroom fans 24/7
- Open windows and doors if it is safe and weather allows
- Reduce occupancy in areas where outdoor ventilation cannot be increased to the optimal amount
- Use fans to increase the effectiveness of open windows
- A professional engineer or HVAC specialist should be consulted to determine the best way to maximize the system's ventilation and air filtration capabilities



Source: Annals of Work Exposures and Health, 2021,

TAKE HOME MESSAGE

Due to the complexity of evaluating ventilation systems, it is important to follow the accepted occupational hygiene principles such as identification, evaluation and control to its fullest extent.

As buildings become more energy efficient, there should be a balance between adequate ventilation rates and thermal comfort.


THANK YOU FOR LISTENING
ANY QUESTIONS?
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