COVID 19 and
Why Ventilation is so Important
PART ONE

IHEEM

Institute of Healthcare Engineering and Estate Management

Republic of Ireland Branch

The Institute of Healthcare Engineering and Estates Management IHEEM

- Chartered Institute for Professional Engineers, Architects, Technicians and Facility Managers

- Registered as Chartered with the Engineering Council in the UK

- IHEEM were founded in 1943 and are an International Institute

- Republic of Ireland Branch founded in 1989

- Objectives;
  - Provide Regulation of Engineering through registration
  - Support to Healthcare Engineers
  - Education of members on New Technology through technical seminars
  - To Share experiences and common issues
  - Bring Public and Private Sectors together
  - Promote Communication within our Industry

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AGENDA

PART ONE COVID 19 and
Why Ventilation is so Important

13.05 - Mr. Brendan Redington
HSE Quality and Standards

13.30 – Mr. Paul Flanagan
Managing Director of Camfil Ireland

13.50 - Questions to the Speakers

14.00 – Close

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Feidhmeannacht na Seirbhíse Sláinte
Health Service Executive

HSE HBS ESTATES

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Dip Eng.
Dip Project Management.
BSc in Quality & Six Sigma for Industry
MSc in Building Services & Eng Management.
Certified Energy Manager
Over 28 years in Healthcare Engineering Sector

Covid19 and Why Ventilation is so important within a Healthcare setting.

6-07-2021

Disclaimer

- This presentation is based on the knowledge/guidance reviewed at this time . Due to the rapidly evolving nature of the COVID-19 epidemic this presentation should be read in conjunction with the relevant government WHO/ECDC/ Public Health HSE/HPSC National guidance.
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HSE 10th March 2021

- So far, great signs of the impacts of vaccinations. Serial testing in nursing homes at 0.2% positivity. Percentages of cases in healthcare workers down from 16% to 4%. Mortality, infections and transmissions levels down, along with hospitalisations and ICU. @HSELive #COVID19

HSE 6th April 2021(Twitter)

- Over 16,100 tests
- Positivity Rate 0.07% lowest rate since we began testing in nursing homes.

HPSC Cluster data

- Shows that figures have fallen significantly with the vaccine rollout.

- https://www.hpsc.ie/a-z/respiratory/coronavirus/novelcoronavirus/surveillance/covid-19outbreaksclustersinireland/COVID-19%20Weekly%20Outbreak%20Report_Week182021_WebVersion_final.pdf

HSE Higher Risk Groups https://www2.hse.ie/conditions/coronavirus/people-at-higher-risk.html

- COVID-19 (coronavirus) can make anyone seriously ill. But for some people, the risk is higher.
- There are 2 levels of higher risk:
- Very high risk (also called extremely vulnerable)
- High risk

REHVA Guide V4 Nov17th 2020

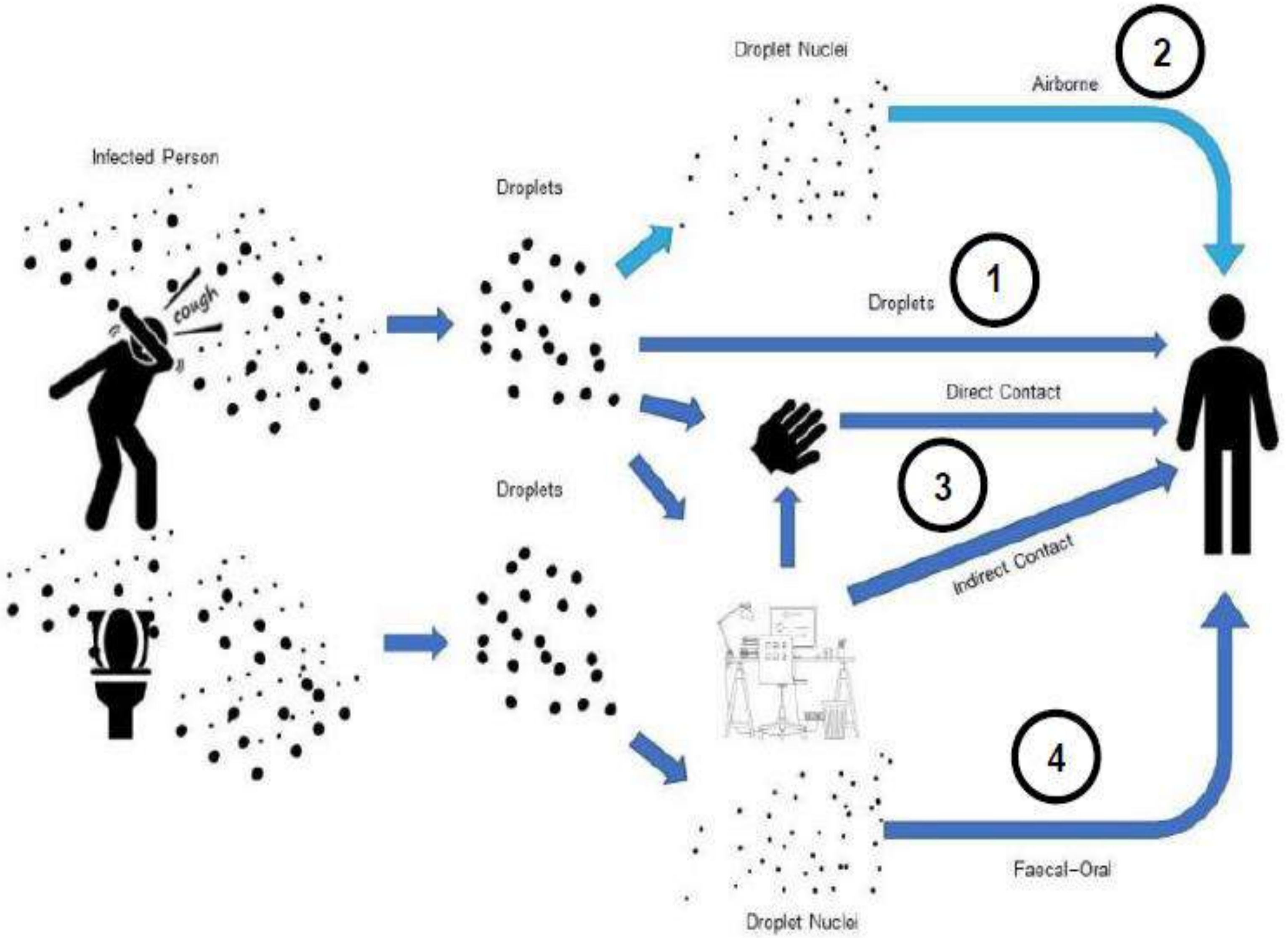
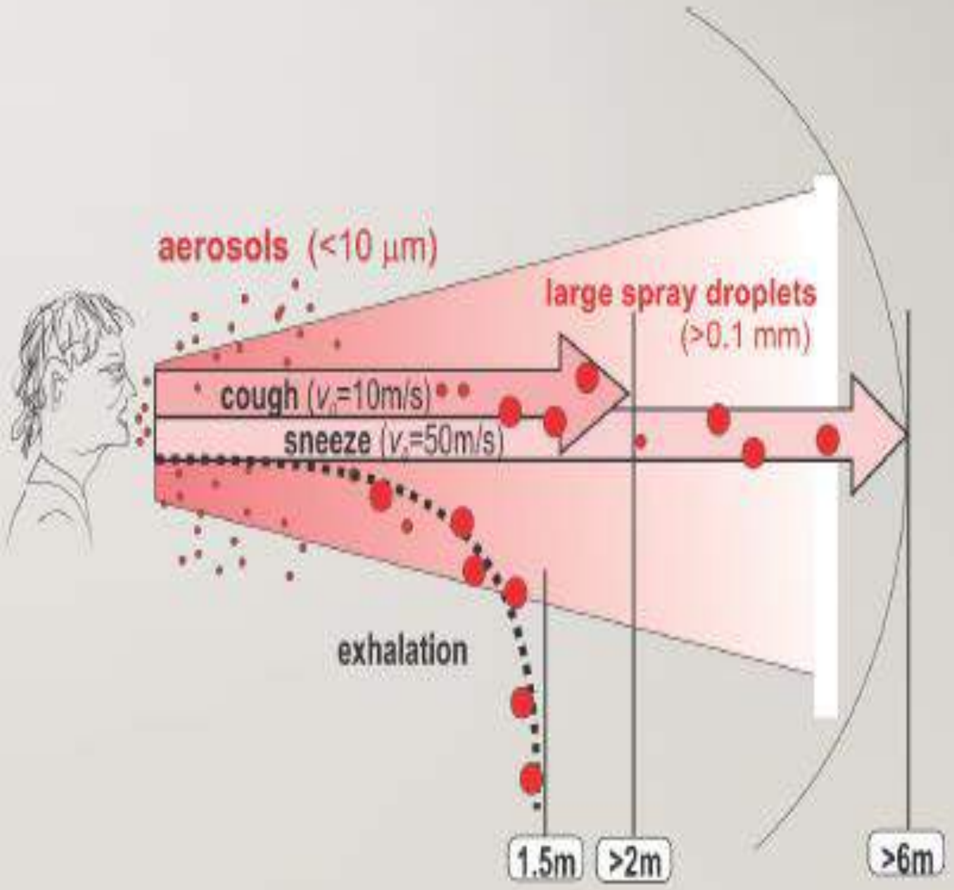


Figure 16. Exposure mechanisms of COVID-19 SARS-CoV-2 droplets. (Figure: courtesy Francesco Franchimon)

RESPIRATORY AEROSOL DYNAMICS

- "Large" droplets settle before travelling long distances
- "Small" droplets/aerosols remain airborne longer, may travel significant distances
- Various definitions of boundary between small and large –~ 60 μm initial diameter, 10 μm final diameter



REHVA Guidance 4.1

- Transmission routes :It is important for every epidemic to understand the transmission routes of the infectious agent. For COVID-19 and for many other respiratory viruses three transmission routes are dominant:
- (1) combined droplet and airborne transmission in 1-2 m close contact region arising from droplets and aerosols emitted when sneezing, coughing, singing, shouting, talking and breathing;
- (2) long-range airborne (aerosol-based) transmission; and
- (3) surface (fomite) contact through hand-hand, hand surface, etc. contacts.
- The means to deal with these routes are physical distance to avoid the close contact, ventilation to avoid airborne transmission and hand hygiene to avoid surface contact.

REHVA Guidance 4.1

The size of a coronavirus particle is 80-160 nanometre[2,i] and it remains active on surfaces for many hours or a couple of days unless there is specific cleaning[ii,iii,iv]. In indoor air SARS-CoV-2 can remain active up to 3 hours and up to 2-3 days on room surfaces at common indoor conditions[v]. An airborne virus is not naked but is contained inside expelled respiratory fluid droplets. Large droplets fall down, but small droplets stay airborne and can travel long distances carried by airflows in the rooms and in extract air ducts of ventilation systems, as well as in the supply ducts when air is recirculated. Evidence suggests that airborne transmission has caused, among others, well known infections of SARS-CoV-1 in the past[vi,vii].

Expelled respiratory droplets that are suspended in air (which means airborne), range from less than 1 µm (micrometre = micron) to more than 100 µm in diameter, which is the largest particle size that can be inhaled. They are also referred to as aerosols, i.e. particles suspended in air, since droplets are liquid particles. The main airborne transmission mechanisms are illustrated in Figure 1.

REHVA Guidance 4.1 Figure 1

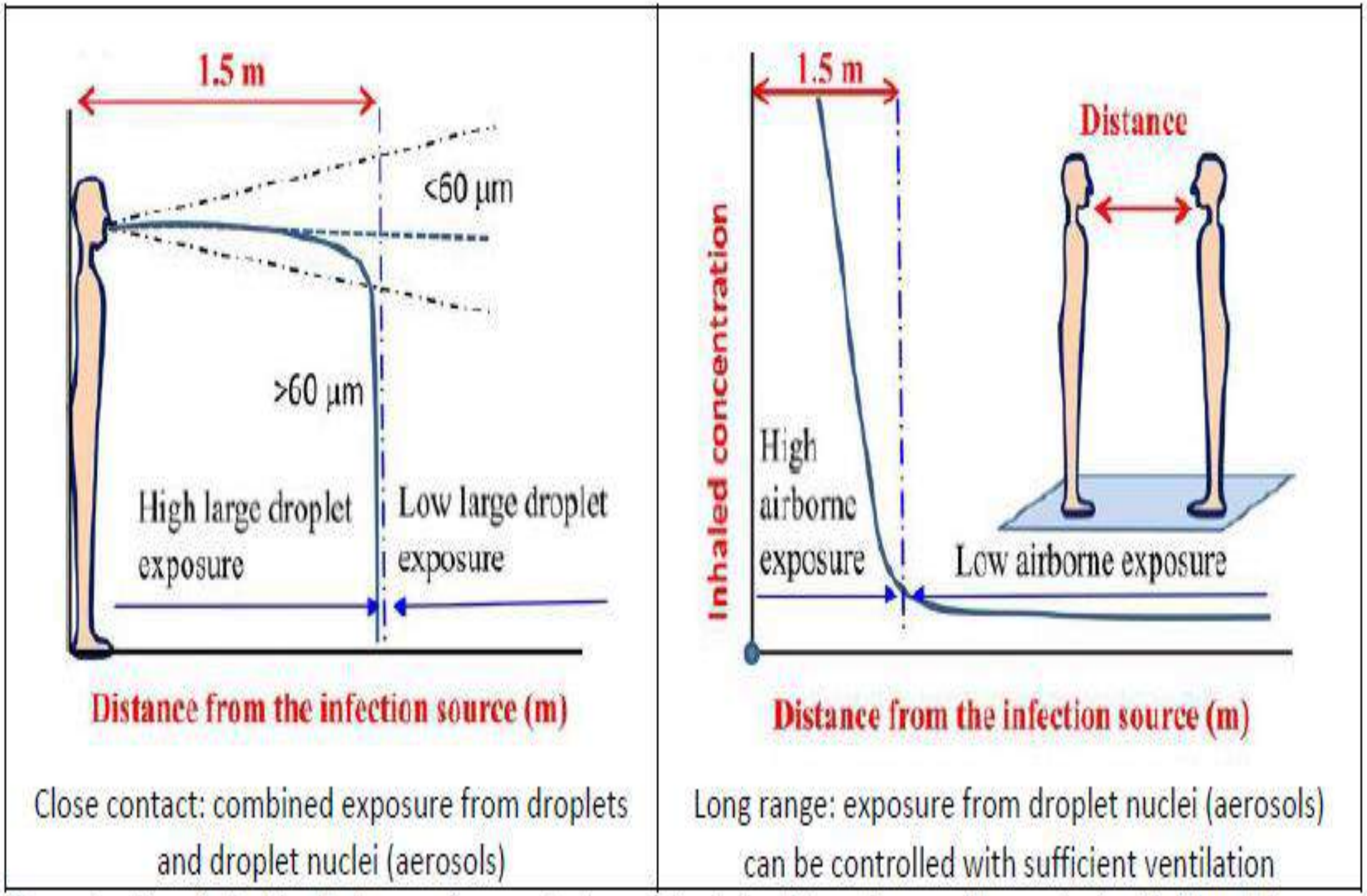


Figure 1. The distinction between close contact combined droplet and aerosol transmission (left) and long-range aerosol transmission (right) which can be controlled with ventilation diluting the virus concentration to a low level. (Figure: courtesy L. Liu, Y. Li, P. V. Nielsen et al.xii)

REHVA Guidance 4.1

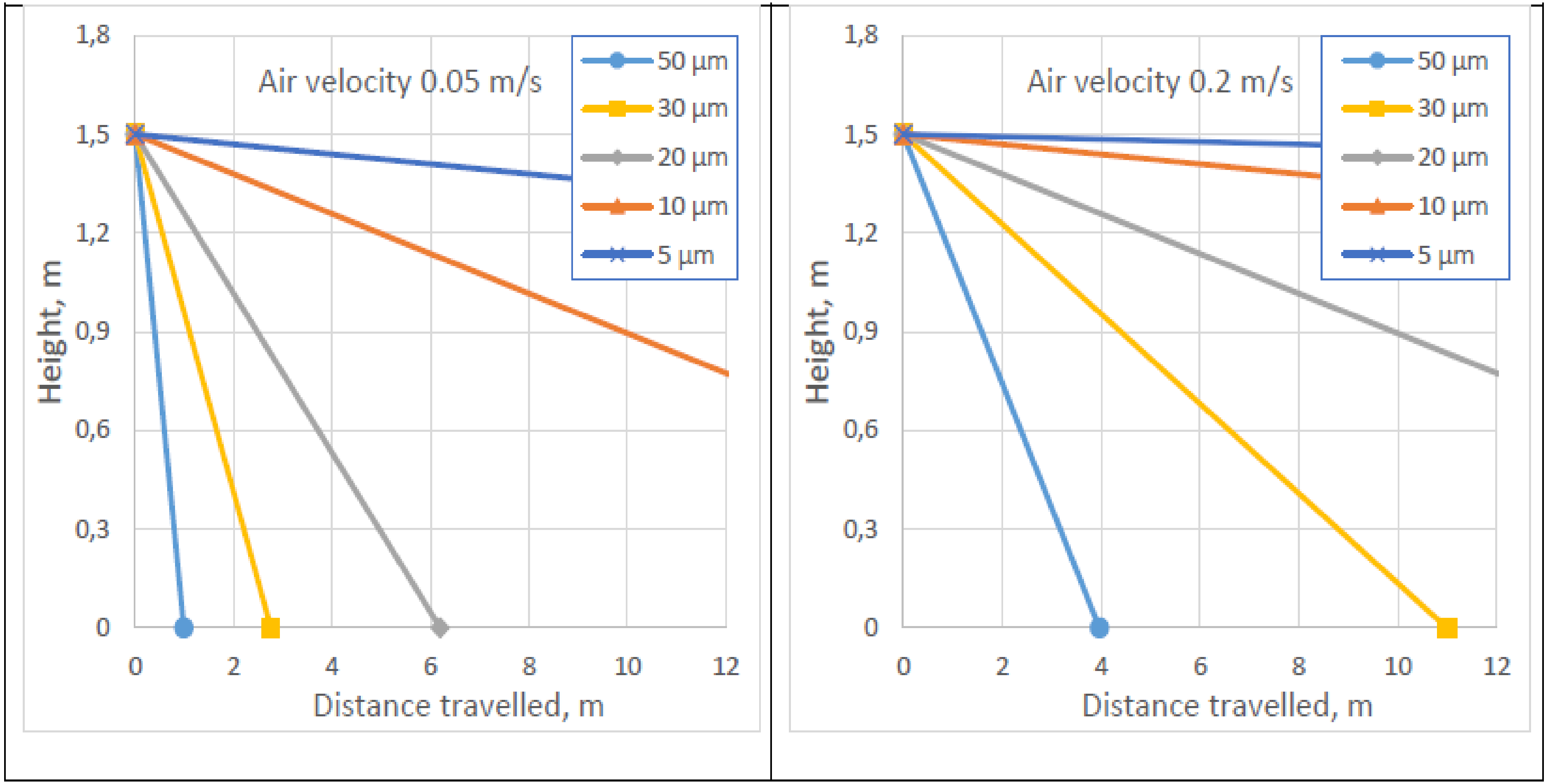


Figure 2. Traveling distance estimates for different sizes of droplets to be carried by room air velocities of 0.05 and 0.2 m/s before settling 1.5 m under the influence of gravity. The travelled distance accounts for movement after the initial jet has relaxed and is calculated with the equilibrium diameter of completely desiccated respiratory droplets (µm values in the figure refer to equilibrium diameters). With turbulence distance travelled is less, but settling time is longer.

1, right, the concentration of droplet nuclei will decrease rapidly within the first 1-1.5 meter from a person's exhalation[xii]. This effect is due to the aerodynamics of the exhalation flow and the flow in the microenvironment around people (plume). The droplet nuclei distribution depends on the position of people, air change rate, the type of air distribution system (e.g., mixing, displacement, or personal ventilation), and other air currents in the space[xiii]. Therefore, close contact within the first 1.5-meter creates high exposure to both large droplets and droplet nuclei that is supported by experimental and numerical studies[xii]. Aerosol concentrations and cross-infection from 1.5 m or more from an infected person can be controlled with adequate ventilation and air distribution solutions. The effect of ventilation is illustrated in Figure 3.

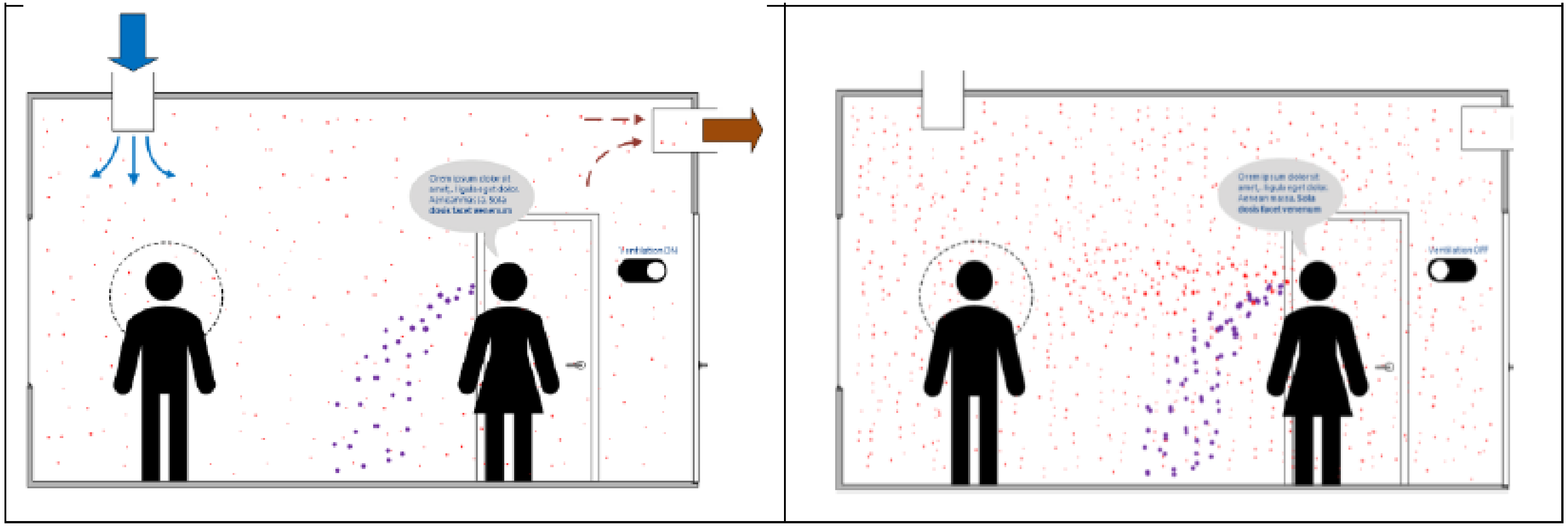


Figure 3. Illustration of how an infected person (speaking woman on the right) leads to aerosol exposure (red spikes) in the breathing zone of another person (man on the left in this case). Large droplet exhalation is marked with purple spikes. When the room is ventilated with mixing ventilation system, the number of virus-laden particles in the breathing zone is much lower than when the ventilation system is off. Left figure: ventilation system on, right figure: ventilation system off.

REHVA Guidance 4.1 15 April 2021

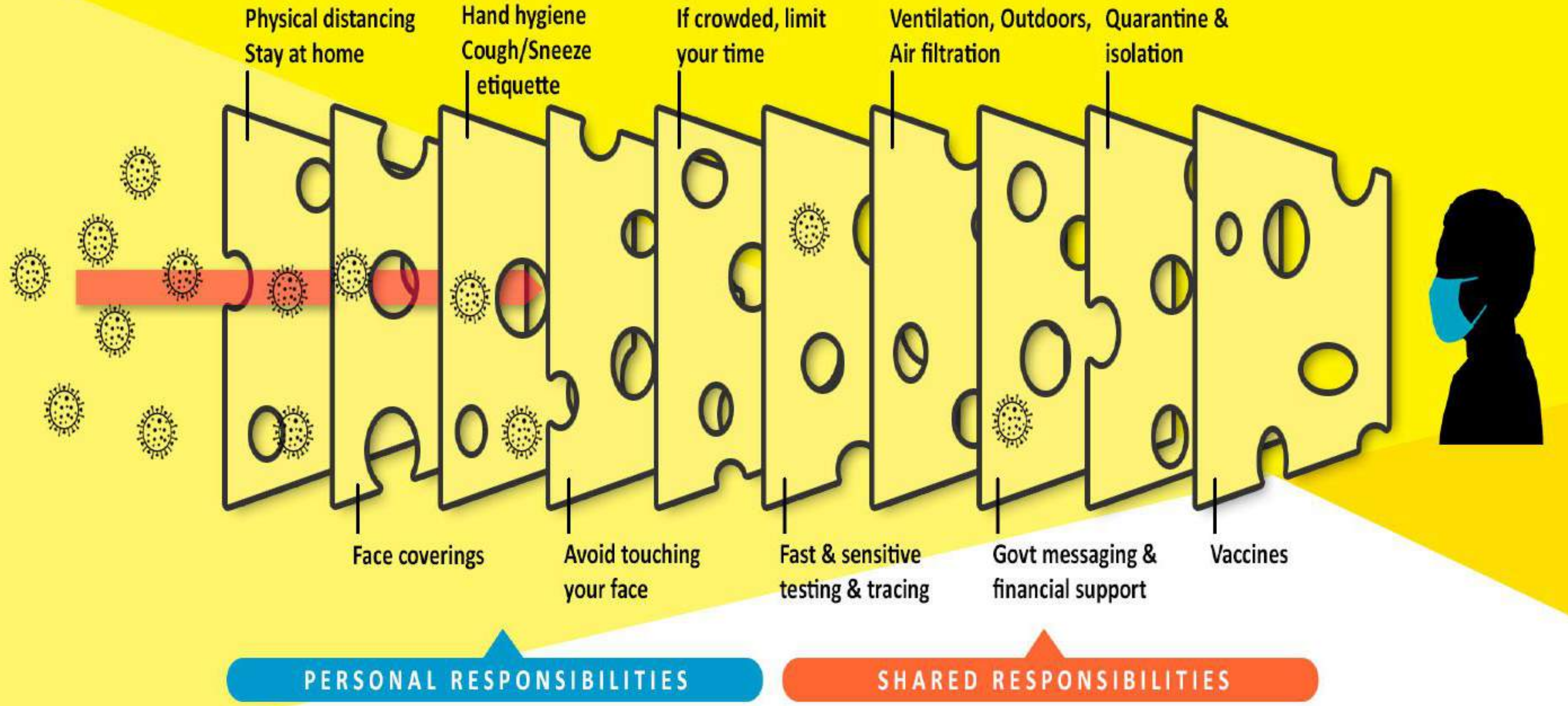
- Conclusion about the aerosol (airborne) transmission route: New evidence and general recognition of the aerosol-based transmission route have been developed recently. When the first version of this document was published on March 17, 2020, REHVA proposed following the ALARP principle (As Low As Reasonably Practicable) to apply a set of HVAC measures that help to control the aerosol route in buildings. To date, there is evidence on SARS-CoV-2 aerosol based transmission, and this route is now recognised worldwide. The relative contribution of different transmission routes in the spread of COVID-19 is still under discussion.
- It also very much situation dependent whether one transmission route or the other is dominant. **For instance in hospitals with an excellent 12 air changes per hour (ACH) ventilation rate, aerosol transmission is mostly eliminated, but in poorly ventilated spaces, it may be dominant.** Transmission routes remain an important research subject, and it has already been reported that the short-range aerosol-based route dominates exposure to respiratory infection during close contact xxxi . Medical literature has started to talk about a new paradigm of infectious aerosols. It is concluded that there is no evidence to support the concept that most respiratory infections are primarily associated with large droplet transmission, and that small particle aerosols are the rule, rather than the exception, contrary to current guidelines xxxii . In the context of buildings and indoor spaces there is no doubt that cross-infection risk may be controlled up to 1.5 m from a person with physical distancing and beyond that distance with ventilation solutions.

Coronavirus
COVID-19

'Swiss Cheese' Model to Understand COVID Defence

Coronavirus
Covid-19
Public Health
Advice

- **No single intervention is perfect at preventing spread**
- **Each intervention (layer) has imperfections (holes)**
- **Multiple layers improve success**



Rialtas na hÉireann
Government of Ireland

Graphics repurposed from Ian M. Mackay, virologydownunder.com
Based on the Swiss Cheese Model of Accident Causation by James T. Reason

CDC Update 7th May 2021

Scientific Brief: SARS-CoV-2 Transmission

- This science brief has been updated to reflect current knowledge about SARS-CoV-2 transmission and reformatted to be more concise.
- Modes of SARS-CoV-2 transmission are now categorized as inhalation of virus, deposition of virus on exposed mucous membranes, and touching mucous membranes with soiled hands contaminated with virus.
- Although how we understand transmission occurs has shifted, the ways to prevent infection with this virus have not. All prevention measures that CDC recommends remain effective for these forms of transmission.

CDC Update 7th May 2021

Scientific Brief: SARS-CoV-2 Transmission

- SARS-CoV-2 is transmitted by exposure to infectious respiratory fluids
- **The principal mode by which people are infected with SARS-CoV-2 (the virus that causes COVID-19) is through exposure to respiratory fluids carrying infectious virus. Exposure occurs in three principal ways:**
- **(1) inhalation of very fine respiratory droplets and aerosol particles,**
- **(2) deposition of respiratory droplets and particles on exposed mucous membranes in the mouth, nose, or eye by direct splashes and sprays, and**
- **(3) touching mucous membranes with hands that have been soiled either directly by virus-containing respiratory fluids or indirectly by touching surfaces with virus on them.**

- People release respiratory fluids during exhalation (e.g., quiet breathing, speaking, singing, exercise, coughing, sneezing) in the form of droplets across a spectrum of sizes.[1-9] These droplets carry virus and transmit infection.
- The largest droplets settle out of the air rapidly, within seconds to minutes.
- **The smallest very fine droplets, and aerosol particles formed when these fine droplets rapidly dry, are small enough that they can remain suspended in the air for minutes to hours.**

CDC Update 7th May 2021

- Infectious exposures to respiratory fluids carrying SARS-CoV-2 occur in three principal ways (not mutually exclusive):
- **Inhalation** of air carrying very small fine droplets and aerosol particles that contain infectious virus. Risk of transmission is greatest within three to six feet of an infectious source where the concentration of these very fine droplets and particles is greatest.
- **Deposition** of virus carried in exhaled droplets and particles onto exposed mucous membranes (i.e., "splashes and sprays", such as being coughed on). Risk of transmission is likewise greatest close to an infectious source where the concentration of these exhaled droplets and particles is greatest.
- **Touching** mucous membranes with hands soiled by exhaled respiratory fluids containing virus or from touching inanimate surfaces contaminated with virus.

CDC Update 7th May 2021

- **The risk of SARS-CoV-2 infection varies according to the amount of virus to which a person is exposed**
- Once infectious droplets and particles are exhaled, they move outward from the source. The risk for infection decreases with increasing distance from the source and increasing time after exhalation. Two principal processes determine the amount of virus to which a person is exposed in the air or by touching a surface contaminated by virus:
- **Decreasing concentration of virus in the air** as larger and heavier respiratory droplets containing virus fall to the ground or other surfaces under the force of gravity and the very fine droplets and aerosol particles that remain in the airstream progressively mix with, and become diluted within, the growing volume and streams of air they encounter**. This mixing is not necessarily uniform and can be influenced by thermal layering and initial jetting of exhalations.**
- **Progressive loss of viral viability and infectiousness** over time influenced by environmental factors such as temperature, humidity, and ultraviolet radiation (e.g., sunlight).

CDC Update 7th May 2021

- **Transmission of SARS-CoV-2 from inhalation of virus in the air farther than six feet from an infectious source can occur.**
- With increasing distance from the source, the role of inhalation likewise increases. Although infections through inhalation at distances greater than six feet from an infectious source are less likely than at closer distances, the phenomenon has been repeatedly documented under certain preventable circumstances.[10-21] These transmission events have involved the presence of an infectious person exhaling virus indoors for an extended time (more than 15 minutes and in some cases hours) leading to virus concentrations in the air space sufficient to transmit infections to people more than 6 feet away, and in some cases to people who have passed through that space soon after the infectious person left. Per published reports, factors that increase the risk of SARS-CoV-2 infection under these circumstances include:

CDC Update 7th May 2021

- **Enclosed spaces with inadequate ventilation or air handling** within which the concentration of exhaled respiratory fluids, especially very fine droplets and aerosol particles, can build-up in the air space.
- **Increased exhalation** of respiratory fluids if the infectious person is engaged in physical exertion or raises their voice (e.g., exercising, shouting, singing).
- **Prolonged exposure** to these conditions, typically more than 15 minutes.

CDC Update 7th May 2021

- Prevention of COVID-19 transmission
- The infectious dose of SARS-CoV-2 needed to transmit infection has not been established. Current evidence strongly suggests transmission from contaminated surfaces does not contribute substantially to new infections. Although animal studies[22-24] and epidemiologic investigations[25] (in addition to those described above) indicate that inhalation of virus can cause infection, the relative contributions of inhalation of virus and deposition of virus on mucous membranes remain unquantified and will be difficult to establish.
- Despite these knowledge gaps, the available evidence continues to demonstrate that existing recommendations to prevent SARS-CoV-2 transmission remain effective.
- These include physical distancing, community use of well-fitting masks (e.g., barrier face coverings, procedure/surgical masks), adequate ventilation, and avoidance of crowded indoor spaces. These methods will reduce transmission both from inhalation of virus and deposition of virus on exposed mucous membranes. Transmission through soiled hands and surfaces can be prevented by practicing good hand hygiene and by environmental cleaning.

WHO Update 30th April 2021

- The virus can spread from an infected person's mouth or nose in small liquid **particles** when they cough, sneeze, speak, sing or breathe. These particles range from larger respiratory droplets to smaller aerosols.
- Current evidence suggests that the virus spreads mainly between people who are in close contact with each other, typically within 1 metre (short-range). A person can be infected when aerosols or droplets containing the virus are inhaled or come directly into contact with the eyes, nose, or mouth.
- The virus can also spread in poorly ventilated and/or crowded indoor settings, where people tend to spend longer periods of time. This is because aerosols remain suspended in the air or travel farther than 1 metre (long-range).

Lots of Guidance

- IHEEM
- CIBSE
- ASHRAE
- REVHA
- CDC
- WHO
- ECDC
- HSE/HPSC/HIQA/Public Health/HSA
- Specialist Ventilation for Healthcare Society Document SVHSoc.03-V4. 27th April 2020(DRAFT)

Other useful reference documents are as follows

- Other useful reference documents are as follows:
- PHE Website
- Role of Ventilation in Controlling SARS-CoV-2 Transmission SAGE-EMG UK.
- SAGE Environment and Modelling Group" updated 18th December (EMG: Simple summary of ventilation actions to mitigate the risk of COVID-19, 1 October 2020 - GOV.UK (www.gov.uk)),
-
- UK Scientific Advisory Group for Emergencies (SAGE UK), Minutes and papers from the meetings held in October 2020 https://www.gov.uk/government/publications/emg-role-of-ventilation-in-controlling-sars-cov-2-transmission-30-september-2020
- NHS National Service COVID19 Summary of advice and information
- NHS Scotland SBAR Ventilation, water and environmental cleaning in dental surgeries relating to COVID-19.
- UK HTM03 for Ventilation Engineering Guidance and HBN Guidance as appropriate.

SAGE Report May 2021

EMG-SPI-B: Application of CO_2 monitoring as an approach to managing ventilation to mitigate SARS-CoV2 transmission

Key points :

• Ventilation is an important COVID-19 mitigation measure but as air is invisible, individuals and organisations can struggle to manage ventilation effectively

• CO_2 is in exhaled breath and therefore represents the fraction of air that has been exhaled by individuals in the space. It is an effective proxy for occupancy and/or ventilation but it is not a direct proxy for infection risk.

• CO_2 monitoring can be a cost-effective way of helping to identify spaces with high occupancy and/or poor ventilation and for actively managing ventilation in a space. It can be used to enable a good balance between ventilation, thermal comfort, and energy use.

• Introducing CO_2 monitoring is technically straightforward but requires clear guidance that is co-designed with users to enable monitors to be used effectively to sustain better ventilation and occupancy behaviours.

CO_2 monitoring is not a direct mitigation; it is a means to guide additional actions to manage ventilation.

SAGE Report May 2021

- **Effectiveness of Ventilation as a COVID-19 mitigation**
- **Ventilation can effectively reduce airborne transmission of SARS-CoV-2 beyond 2m but does not reduce transmission via close range aerosols and droplets or via fomites *(high confidence).*** *Airborne transmission beyond 2m has been indicated as a risk factor for super spreading outbreaks (medium confidence).*

- Spaces with ventilation that meets current and recent UK building standards are likely to pose a lower risk for airborne transmission *(medium confidence). Although some variants are more transmissible, there is not currently any epidemiological evidence to suggest that ventilation rates should be increased beyond those previously indicated (low confidence).*

- Public and business understanding of ventilation as a COVID-19 mitigation is lower than measures such as cleaning and hand hygiene, even though it may be as important to controlling transmission *(medium confidence).*

- The quality of ventilation across UK building stock is unknown. There is evidence to suggest that a wide range of building types are not adequately ventilated, especially in the winter months; this may be due to operation, maintenance, or design *(medium confidence).*

- Business understanding of their ventilation approach and systems is low *(medium confidence). Many organisations are unaware of their ventilation provision and lack the tools and knowledge to effectively manage it. It may be more of a challenge in organisations which do not have dedicated facilities managers, those without control over their buildings (eg. PFI, rented), and those with fewer resources to invest in assessing and improving ventilation (medium confidence).*

- There are multiple barriers to individuals being able to manage ventilation including: balancing ventilation with thermal comfort and health requirements, noise, security and energy use; inadequate ventilation provision; lack of agency to make changes in their environments; lack of understanding about how well ventilated an environment is or the actions that can be taken to manage it; challenges to negotiating or agreeing actions with others *(high confidence). These challenges are more likely in settings and communities with higher levels of deprivation (medium confidence).*

The ASHRAE Epidemic Task Force released an updated, unequivocal statement on the airborne transmission of SARS-CoV-2 in buildings. ATLANTA (April 5, 2021)

- ASHRAE has released the following statement:
- ***"Airborne transmission of SARS-CoV-2 is significant and should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning systems, can reduce airborne exposures."***
- It replaces the April 2020 statement that said airborne transmission was "sufficiently likely" that airborne precautions should be taken. At that time both, the World Health Organization (WHO) and the Centers for Diseases Control (CDC), contended that transmission of SARS-CoV2 was by droplet and fomite modes, not airborne. Subsequently, both have acknowledged the risk of airborne transmission indoors.
- "This may seem like a small step, but we feel it is important to leave no doubt about our position, given the muted support for ventilation and filtration as important tools in the effort to stop the pandemic, from some organizations that should be leading more strongly," said William P. Bahnfleth, Ph.D., P.E., ASHRAE Epidemic Task Force chair.

Ten scientific reasons in support of airborne transmission
Published Online April 15, 2021 https://doi.org/10.1016/ S0140-6736(21)00869-2 of SARS-CoV-2
Heneghan and colleagues' systematic review, funded by WHO, published in March, 2021.

- In conclusion, we propose that it is a scientific error to use lack of direct evidence of SARS-CoV-2 in some air samples to cast doubt on airborne transmission while overlooking the quality and strength of the overall evidence base. There is consistent, strong evidence that SARS-CoV-2 spreads by airborne transmission. Although other routes can contribute, we believe that the airborne route is likely to be dominant. The public health community should act accordingly and without further delay

Ten scientific reasons in support of airborne transmission Published Online April 15, 2021 https://doi.org/10.1016/ S0140-6736(21)00869-2 of SARS-CoV-2

Heneghan and colleagues' systematic review, funded by WHO, published in March, 2021

- **Tenth**, there is limited evidence to support other dominant routes of transmission—ie, respiratory droplet or fomite.9,24 Ease of infection between people in close proximity to each other has been cited as proof of respiratory droplet transmission of SARS-CoV-2. However, close-proximity transmission in most cases along with distant infection for a few when sharing air is more likely to be explained by dilution of exhaled aerosols with distance from an infected person.9 The flawed assumption that transmission through close proximity implies large respiratory droplets or fomites was historically used for decades to deny the airborne transmission of tuberculosis and measles.15,25 This became medical dogma, ignoring direct measurements of aerosols and droplets which reveal flaws such as the overwhelming number of aerosols produced in respiratory activities and the arbitrary boundary in particle size of 5 µm between aerosols and droplets, instead of the correct boundary of 100 µm.15,25 It is sometimes argued that since respiratory droplets are larger than aerosols, they must contain more viruses. However, in diseases where pathogen concentrations have been quantified by particle size, smaller aerosols showed higher pathogen concentrations than droplets when both were measured.15

THE *LANCET COVID-19 COMMISSION*

TASK FORCE ON SAFE WORK,
SAFE SCHOOL, AND SAFE TRAVEL
Six Priority Areas
FEBRUARY 2021

- Additionally, **the airborne transmission route dominates in short-range exposures in close contact range (1.5-2m range);** this fact was disregarded by many who assumed large droplet transmission to dominate over short distances.8,9 The reluctance to acknowledge airborne transmission of COVID-19 persisted even as additional evidence accumulated, including air sampling data and evidence from outbreak investigations.10,11,12 It was only by October 2020, ten months into the pandemic, that health authorities such as the US CDC and WHO finally recognized the role of airborne transmission.13,14

- https://static1.squarespace.com/static/5ef3652ab722df11fcb2ba5d/t/60381fe6acff51132a03173d/1614290919198/Safe+Work%2C+Safe+School%2C+Safe+Travel+%28Feb+2021%29.pdf

HTM03 2007

Reasons for ventilation

The Building Regulations require that all enclosed workspaces be ventilated by either natural or mechanical means. The following are some of the factors that determine the ventilation requirements of a workspace:

- human habitation (minimum fresh-air requirement);
- the activities of the department, that is, extraction of odours, aerosols, gases, vapours, fumes and dust – some of which may be toxic, infectious, corrosive, flammable, or otherwise hazardous (see the Control of Substances Hazardous to Health (COSHH) Regulations);
- dilution and control of airborne pathogenic material;
- thermal comfort;
- the removal of heat generated by equipment (for example catering, wash-up, sterilizing areas, electrical switchrooms, and some laboratory areas);
- the reduction of the effects of solar heat gains;
- the reduction of excessive moisture levels to prevent condensation (for example hydrotherapy pools);
- combustion requirements for fuel burning appliances;
- "make-up supply air" where local exhaust ventilation (LEV) etc is installed.

Mechanical ventilation systems are expensive in terms of capital and running costs, and planning solutions should be sought which take advantage of natural ventilation, provided the above criteria are met.

Appendix 2 – Recommended air-change rates

Application	Ventilation	AC/hr	Pressure (Pascals)	Supply filter	Noise (NR)	Temp (°C)	Comments (for further information see Chapter 6)
General ward	S/N	6	–	G4	30	**18–28**	
Communal ward toilet	E	6	–ve	–	40	–	
Single room	S/E/N	6	0 or –ve	G4	30	**18–28**	
Single room WC	E	3	–ve	–	40	–	
Clean utility	S	6	+ve	G4	40	**18–28**	
Dirty utility	E	6	–ve	–	40	–	
Ward isolation room	–	–	–	–	–	–	See Health Building Note 04-01 (Supplement 1)
Infectious diseases isolation room	E	10	–5	G4	30	**18–28**	Extract filtration may be required
Neutropenic patient ward	S	10	+10	H12	30	**18–28**	
Critical care areas	S	10	+10	F7	30	*18–25*	Isolation room may be –ve pressure
Birthing room	S & E	15	–ve	G4	40	*18–25*	Provide clean air-flow path
SCBU	S	6	+ve	F7	30	*18–25*	Isolation room may be –ve pressure
Preparation room (lay-up)	S	>25	35	F7	40	*18–25*	
Preparation room/bay (sterile pack store)	S	10	25	F7	40*	*18–25*	*50 NR if a bay is a UCV theatre
Operating theatre	S	25	25	F7	40	*18–25*	
UCV operating theatre	S	25*	25	H10 or greater	50	*18–25*	*Fresh-air rate; excludes recirculation
Anaesthetic room	S & E	15	>10	F7	40	*18–25*	Provide clean air-flow path
Theatre sluice/dirty utility	E	>20	–5	–	40	–	
Recovery room	S & E	15	0	F7	35	*18–25*	Provide clean air-flow path
Catheterisation room	S	15	+ve	F7	40	*18–22*	
Endoscopy room	S	15	+ve	F7	40	*18–25*	
Endoscopy cleaning	E	>10	–ve	–	40	–	
Day-case theatre	S	15	+ve	F7	40	*18–25*	
Treatment room	S	10	+ve	F7	35	*18–25*	
Pharmacy aseptic suite	S	20	#	H14	–	*18–22*	# See EGGMP (Orange guide) a
Category 3 or 4 containment room	#	>20	#	H14*	–	*18–22*	# See ACDP guide; *Filter in extract
Post-mortem room	S & E	S = 10 E = 12	–ve	G4	35	**18–22**	Provide clean air-flow path
Specimen store	E	–	–ve	–	–	–	Fan accessible from outside of store

Notes: **18–22°C** indicates the range over which the temperature may float.
18–22°C indicates the range over which the temperature should be capable of being controlled.
S = supply
E = extract
N = natural ventilation
a – European guidelines on good manufacturing practice published by the Medicines and Healthcare products Regulatory Agency (MHRA)

PHE Guidance: **Ventilation of indoor spaces to stop the spread of corona virus (COVID-19)**Updated 23 April 2021

- **What ventilation is and why it is important**
- Ventilation is the process of introducing fresh air into indoor spaces while removing stale air. Letting fresh air into indoor spaces can help remove air that contains virus particles and prevent the spread of coronavirus (COVID-19).
- When someone with COVID-19 breathes, speaks, coughs or sneezes, they release particles (droplets and aerosols) containing the virus that causes COVID-19. While larger droplets fall quickly to the ground, smaller droplets and aerosols containing the virus can remain suspended in the air. If someone breathes in virus particles that are suspended in the air, they can become infected with COVID-19. This is known as airborne transmission.
- In poorly ventilated rooms the amount of virus in the air can build up, increasing the risk of spreading COVID-19, especially if there are lots of infected people in the room. The virus can also remain in the air after an infected person has left.
- Bringing fresh air into a room and removing older stale air that contains virus particles reduces the chance of spreading COVID-19. The more fresh air that is brought inside, the quicker any airborne virus will be removed from the room.
- Ventilation is most important if someone in your household has COVID-19 or if you are indoors with people you do not live with.
- Good ventilation has also been linked to health benefits such as better sleep and fewer sick days off from work or school.
- Ventilation does not prevent COVID-19 from spreading through close contact and is only one of the actions you should take to reduce the spread of COVID-19. This is why it is important that everybody follows the guidance on how to stop the spread of COVID-19 all of the time, especially as it is possible to have COVID-19 with no symptoms. You can pass COVID-19 on to others if you only have mild symptoms or even no symptoms at all.

HPSC Acute Hospital Infection Prevention and Control Precautions for Possible or Confirmed COVID-19 in a Pandemic Setting V.2.1 26.04.2021

- **Ventilation**
- Airborne transmission of COVID-19 is an accepted risk in the context of AGPs associated with an increased risk of infection. Recent accounts from hospitals in Ireland since the dissemination of the B.1.1.7 variant have increased concern regarding the risk of airborne transmission in particular in the context of use of high flow oxygen devices (an aerosol generating procedure associated with increased risk of transmission). Airborne transmission may also be a factor in certain other circumstances. Transmission of COVID-19 has been associated with closed poorly ventilated spaces in which many people stay for long periods of time and SARS-CoV-2 can be detected in the air. A recent update from the European Centre for Disease Control provides a perspective on ventilation and air conditioning in the context of COVID-19 at the following link.
- https://www.ecdc.europa.eu/sites/default/files/documents/Heating-ventilation-air-conditioning-systems-in-the-context-of-COVID-19-first-update.pdf **ECDC Guidance 10th November 2020**

HPSC Ventilation Guidance on Non Healthcare Buildings 13th May 2021

- **Now references the Ventilation Guidance documents noted earlier.**

- **World Health Organization (WHO)**
- *Roadmap to improve and ensure good indoor ventilation in the context of COVID-19. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO.*
- Corrigenda, 13 April 2021: Roadmap to improve and ensure good indoor ventilation in the context of COVID-19
- https://apps.who.int/iris/handle/10665/339857
- **Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA)**
- *How to operate HVAC and other building service systems to prevent the spread of the coronavirus (SARS-CoV-2) disease (COVID-19) in workplaces. V1.4 15/April/2021.* **Institute of Healthcare Engineering and Estate Management (IHEEM)**
- https://www.iheem.org.uk/iheem-experts/technical-platforms/iheem-ventilation-technical-platform/
- **European Centre for Disease Control (ECDC)**
- *Heating, Ventilation and Air Conditioning Systems in the context of COVID-19, first update 10 November, 2020*
- https://www.ecdc.europa.eu/en/publications-data/heating-ventilation-air-conditioning-systems-covid-19
- **The Chartered Institution of Building Services Engineers (CIBSE)** *COVID-19 Guidance: Ventilation v4 (23rd October 2020)*
- https://cibse.org/coronavirus-covid-19
- https://www.cibse.org/knowledge/knowledge-items/detail?id=a0q3Y00000HsaFtQAJ

HPSC Acute Hospital Infection Prevention and Control Precautions for Possible or Confirmed COVID-19 in a Pandemic Setting
V.2.1 26.04.2021

- In the general clinical environment strict adherence to contact and droplet precautions is generally effective in managing the risk of transmission in the absence of AGPs. However while the significance of long-range (airborne) transmission remains unclear in other settings it is prudent to maximise ventilation to the greatest extent that is practical consistent with comfort and without introducing other potentially greater risks.
- There is little or no clinical evidence that deployment of novel air cleaning methods in the healthcare environment effectively reduces the risk of transmission of COVID-19. In the absence of such evidence deployment of such systems is not generally recommended but may be a consideration in certain settings subject to risk assessment.

HPSC Acute Hospital Infection Prevention and Control Precautions for Possible or Confirmed COVID-19 in a Pandemic Setting
V.2.1 26.04.2021

- In this context the following is recommended
- 1. In clinical areas where there is established mechanical ventilation that has been appropriately commissioned, meets current standards for the healthcare environment and is well maintained no modification of the operation of this system is required
- 2. In areas where there is no mechanical ventilation it is appropriate to increase natural ventilation in clinical area by opening windows and doors in so far as practical and consistent with comfort of patients and staff
- 3. In circumstances where entry of unfiltered external air is assessed as associated with a high risk for introduction of aspergillus spores into an environment where there are vulnerable patients the exclusion of aspergillus spores takes priority over increasing natural ventilation with a view to reducing the risk of transmission of COVID-19
- 4. If exhaust fans are used they must be installed so that the air is released directly outdoors. The number and technical specification of exhaust fans must take account of the size of the room and the desired ventilation rate. Positioning the exhaust fan should be done so that it is not close to a ventilation air intake.
- 6. When appropriately selected, deployed and maintained, single-space air cleaners with HEPA filters (either ceiling mounted or portable) can be effective in reducing/lowering concentrations of infectious aerosols in a single space however they have not been shown to reduce the risk of transmission of COVID-19 in a healthcare setting.

Covid-19 has redefined airborne transmission

BMJ 2021; 373 doi: https://doi.org/10.1136/bmj.n913 (Published 14 April 2021)Cite thisas: *BMJ* 2021;373:n913

- **Improving indoor ventilation and air quality will help us all to stay safe.**
- Over a year into the covid-19 pandemic, we are still debating the role and importance of aerosol transmission for SARS-CoV-2, which receives only a cursory mention in some infection control guidelines.
- The confusion has emanated from traditional terminology introduced during the last century. This created poorly defined divisions between “droplet,” “airborne,” and “droplet nuclei” transmission, leading to misunderstandings over the physical behaviour of these particles.
- **Essentially, if you can inhale particles—regardless of their size or name—you are breathing in aerosols**. Although this can happen at long range, it is more likely when close to someone, as the aerosols between two people are much more concentrated at short range, rather like being close to someone who is smoking.

- People infected with SARS-CoV-2 produce many small respiratory particles laden with virus as they exhale. Some of these will be inhaled almost immediately by those within a typical conversational “short range” distance (<1 m), while the remainder disperse over longer distances to be inhaled by others further away (>2 m).
- Traditionalists will refer to the larger short range particles as droplets and the smaller long range particles as droplet nuclei, **but they are all aerosols because they can be inhaled directly from the air.**

- Why does it matter? For current infection control purposes, most of the time it doesn't. Wearing masks, keeping your distance, and reducing indoor occupancy all impede the usual routes of transmission, whether through direct contact with surfaces or droplets, or from inhaling aerosols. **One crucial difference, however, is the need for added emphasis on ventilation because the tiniest suspended particles can remain airborne for hours, and these constitute an important route of transmission**.

- If we accept that someone in an indoor environment can inhale enough virus to cause infection when more than 2 m away from the original source—even after the original source has left—then air replacement or air cleaning mechanisms become much more important.
- This means opening windows or installing or upgrading heating, ventilation, and air conditioning systems, as outlined in a recent WHO document.
- People are much more likely to become infected in a room with windows that can’t be opened or lacking any ventilation system.

- If the virus is transmitted only through larger particles (droplets) that fall to the ground within a metre or so after exhalation, then mask fit would be less of a concern. As it is, healthcare workers wearing surgical masks have become infected without being involved in aerosol generating procedures. As airborne spread of SARS-CoV-2 is fully recognised, our understanding of activities that generate aerosols will require further definition. Aerosol scientists have shown that even talking and breathing are aerosol generating procedures.

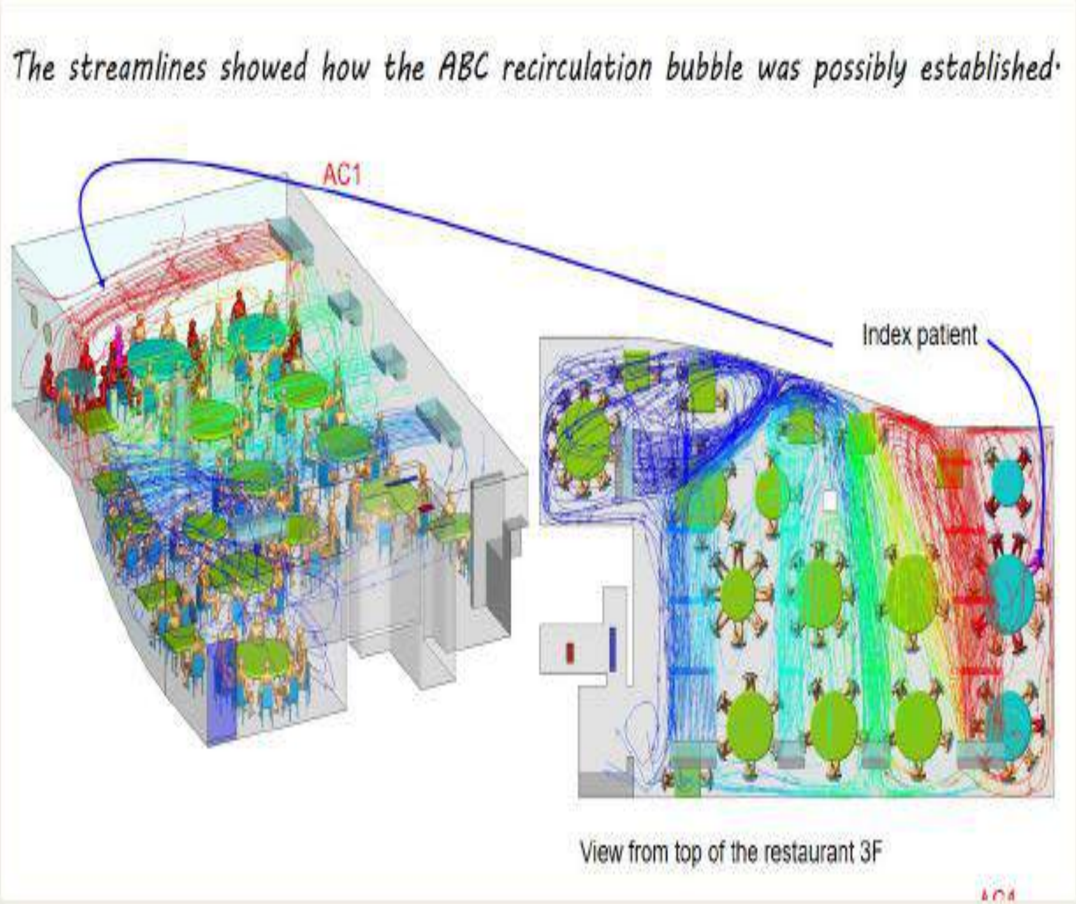
- It is now clear that SARS-CoV-2 transmits mostly between people at close range through inhalation. This does not mean that transmission through contact with surfaces or that the longer range airborne route does not occur, but these routes of transmission are less important during brief everyday interactions over the usual 1 m conversational distance. In close range situations, people are much more likely to be exposed to the virus by inhaling it than by having it fly through the air in large droplets to land on their eyes, nostrils, or lips. The transmission of SARS-CoV-2 after touching surfaces is now considered to be relatively minimal.

- Improved indoor air quality through better ventilation will bring other benefits, including reduced sick leave for other respiratory viruses and even environmentally related complaints such as allergies and sick building syndrome. Less absenteeism—with its adverse effect on productivity—could save companies significant costs, which would offset the expense of upgrading their ventilation systems. Newer systems, including air cleaning and filtration technologies, are becoming ever more efficient.

- Covid-19 may well become seasonal, and we will have to live with it as we do with influenza.
- So governments and health leaders should heed the science and focus their efforts on airborne transmission.
- Safer indoor environments are required, not only to protect unvaccinated people and those for whom vaccines fail, but also to deter vaccine resistant variants or novel airborne threats that may appear at any time. Improving indoor ventilation and air quality, particularly in healthcare, work, and educational environments, will help all of us to stay safe, now and in the future.

The Guangzhou restaurant incident was the most influential evidence of airborne spread

- No mechanical ventilation
- Measured air change rate: ~0.75 – 1 L/s per patron
- No close contact observed on video
- Split system air-conditioning – airflow patterns a secondary factor
- Conclusions: "*aerosol transmission of SARS-CoV-2 due to poor ventilation may explain the community spread of COVID-19.*"



Li, et al. (2020) https://doi.org/10.1101/2020.04.16.20067728

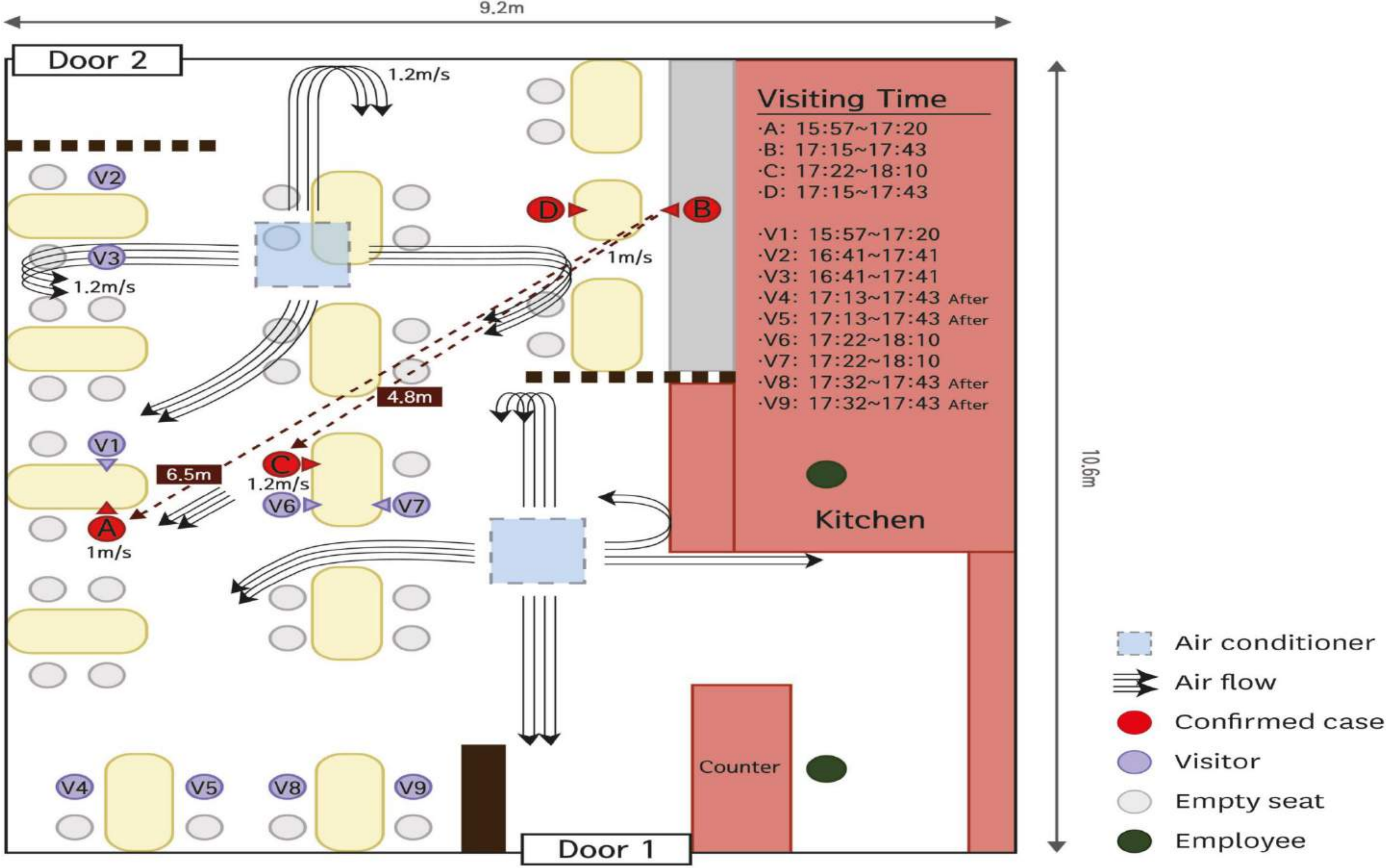
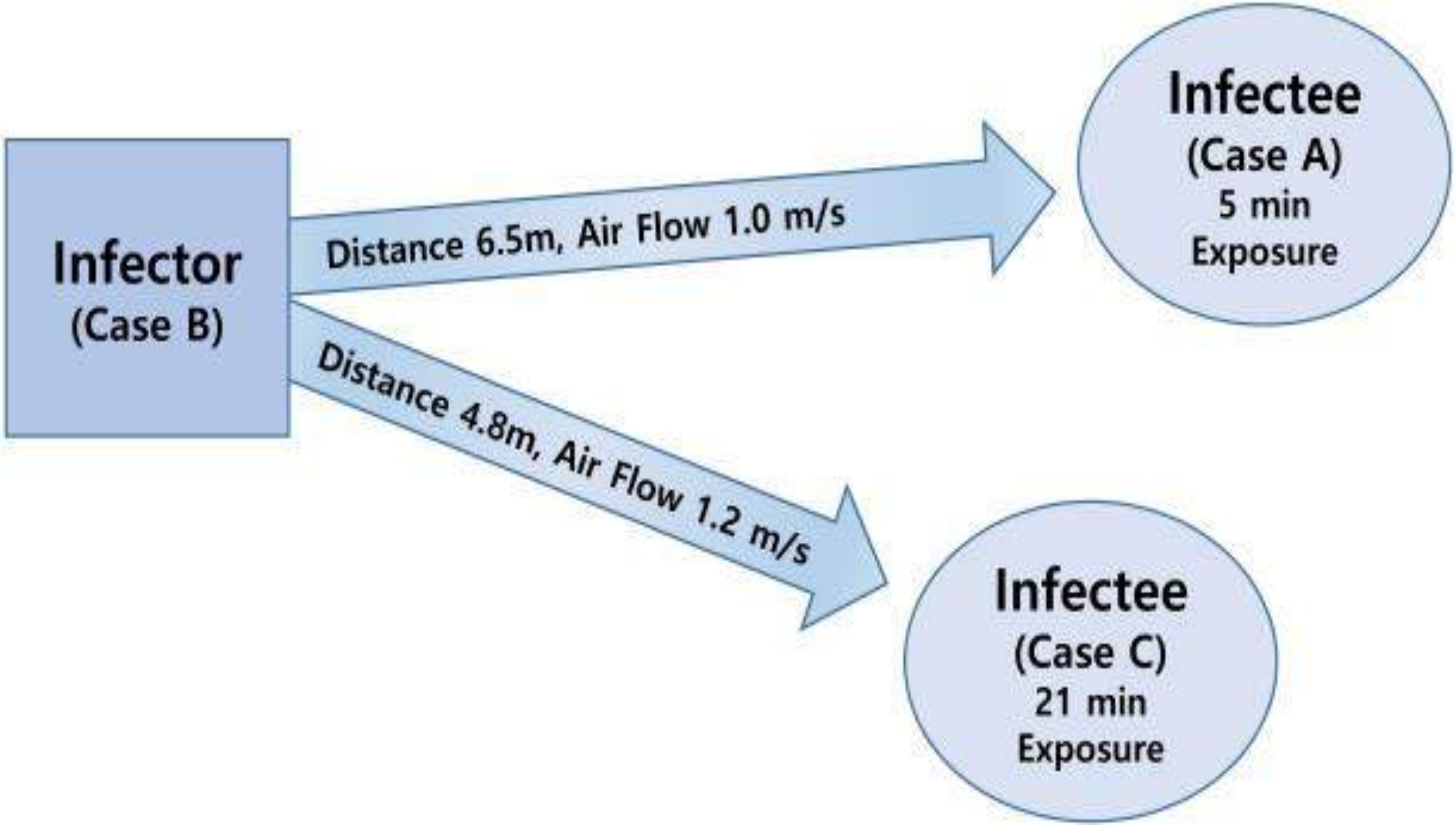


Fig. 3. Schematic diagram of the outbreak restaurant equipped with ceiling-type air conditioners. The arrowed solid streamlines represent the air flow directions in the restaurant. Curved air streamlines represent that air streams from the ceiling air conditioners are reflected from the wall or barrier, and move downward toward the floor.

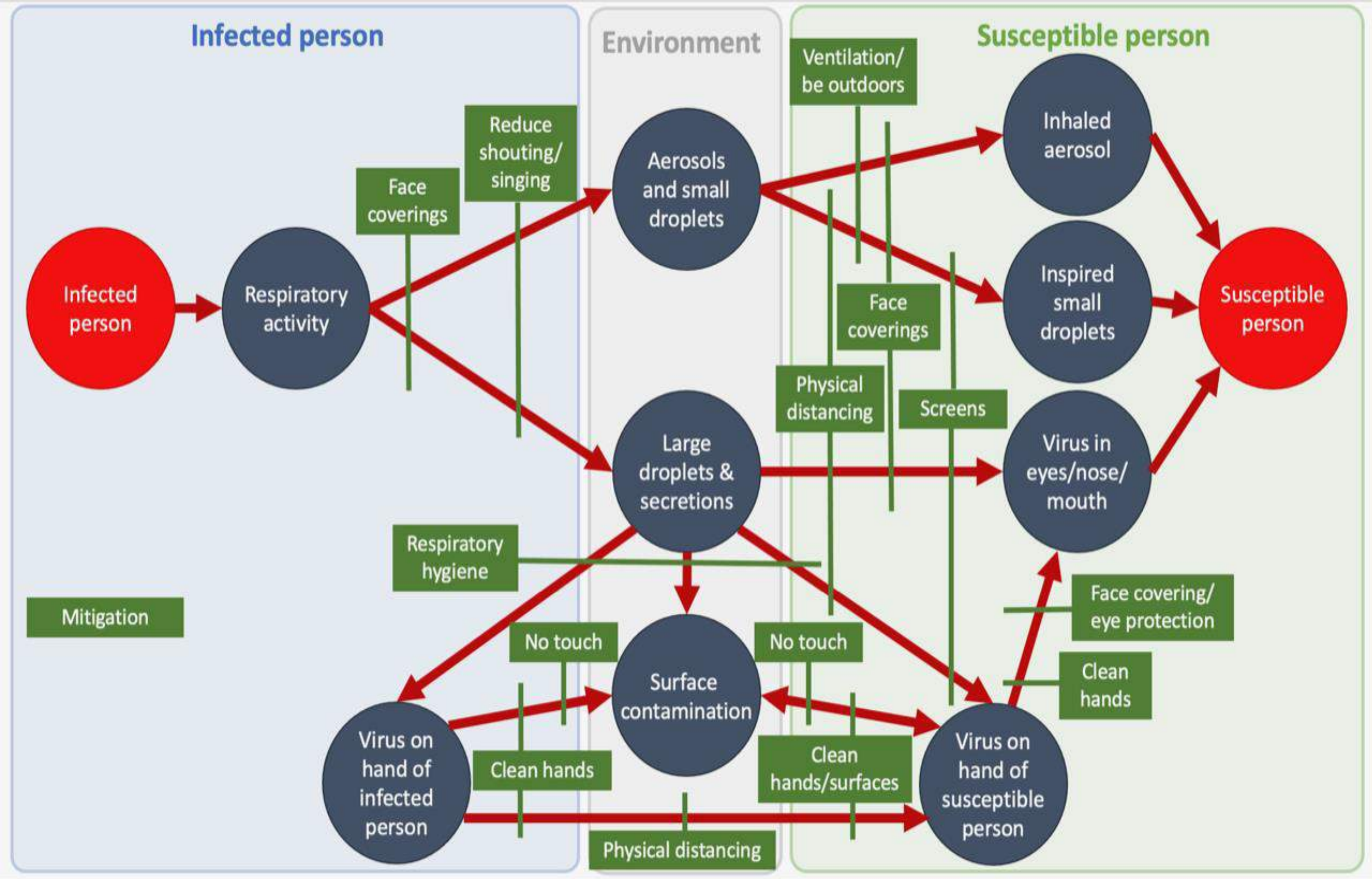
J Korean Med Sci. 2020 Nov;35(46):e415.
https://doi.org/10.3346/jkms.2020.35.e415

Graphical Abstract

COVID-19 transmission by droplets can occur over a greater than 2 m distant with a short period of exposure when combined with air flow.



Schematic showing potential routes of transmission for all SARS-CoV-2 variants, together with where personal, procedural and engineering mitigation measures can disrupt the transmission pathway Source SAGE EMG



For a surgery with no additional mitigation measures the relationship between PAGPFT and air changes per hour is as given in Figure 1: https://www.scottishdental.org/ventilation-water-and-environmental-cleaning-in-dental-surgeries-relating-to-covid-19/

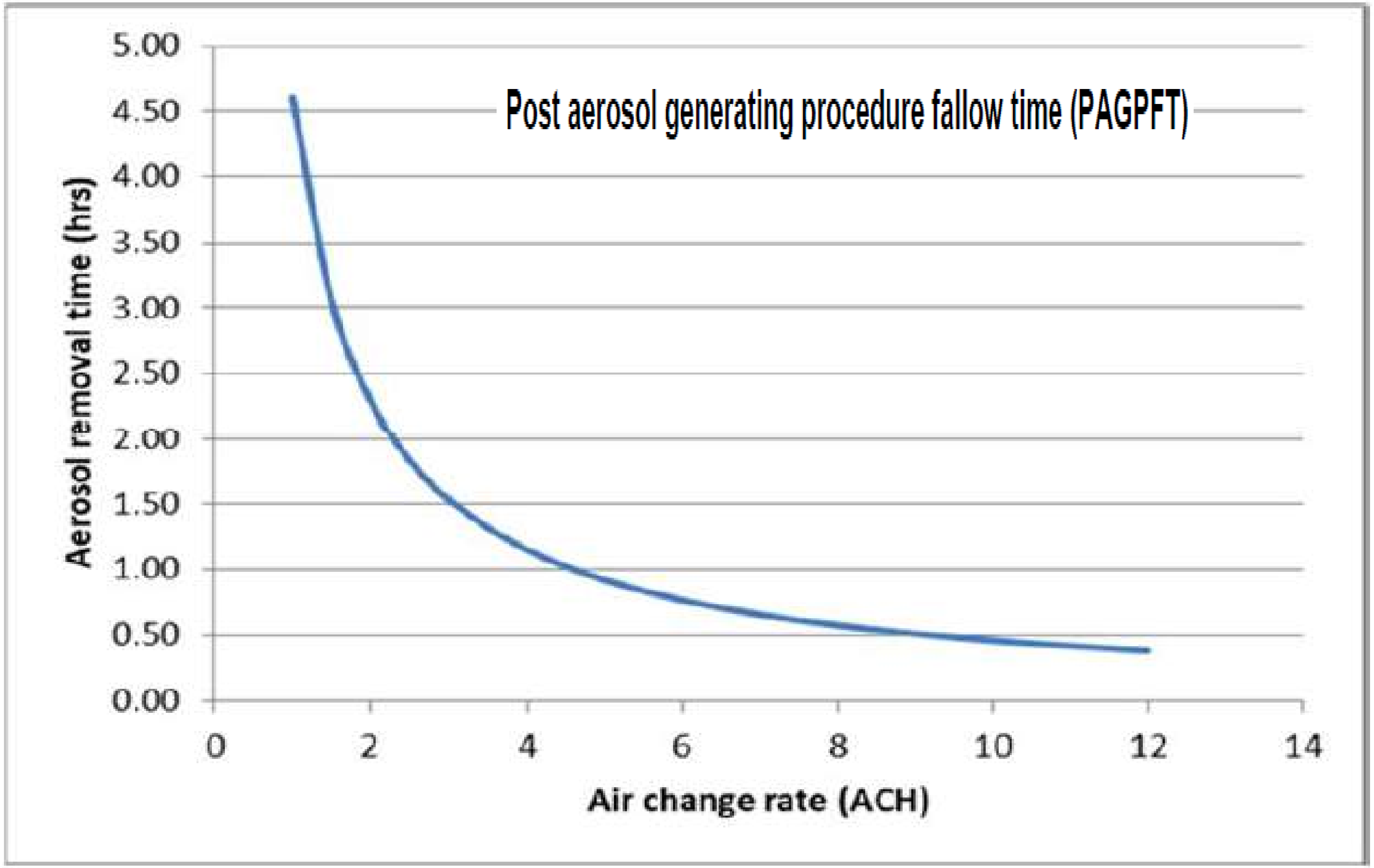


FIGURE 1: Relationship between time to remove 99% of aerosol with ventilation air change rate.

ECDC HVAC Guidance 10th November 2020
useful general guidance table response from Belgium

- If possible, windows should be kept opened for at least 15 minutes at least three times a day, especially after space occupancy.

Setting	Air changes per hour (ACH)*	Time to decrease contamination by 90%
Closed windows without mechanical ventilation	0.1-0.5	5-25 hrs
Window tilted (one side)	1-2	1 h15 min-2hrs
Windowless room with mechanical ventilation	4	37 min
Windowless room with increased mechanical ventilation	8	20 min
Windows wide open	± 10	15 min
Windows wide open, in opposite walls	± 40	5 min

* At least 2.5 ACH are needed to change at least 90% of the air in a room

ASHRAE CDC

https://www.ashrae.org/image%20library/main%20nav/technical%20resources/ach.png

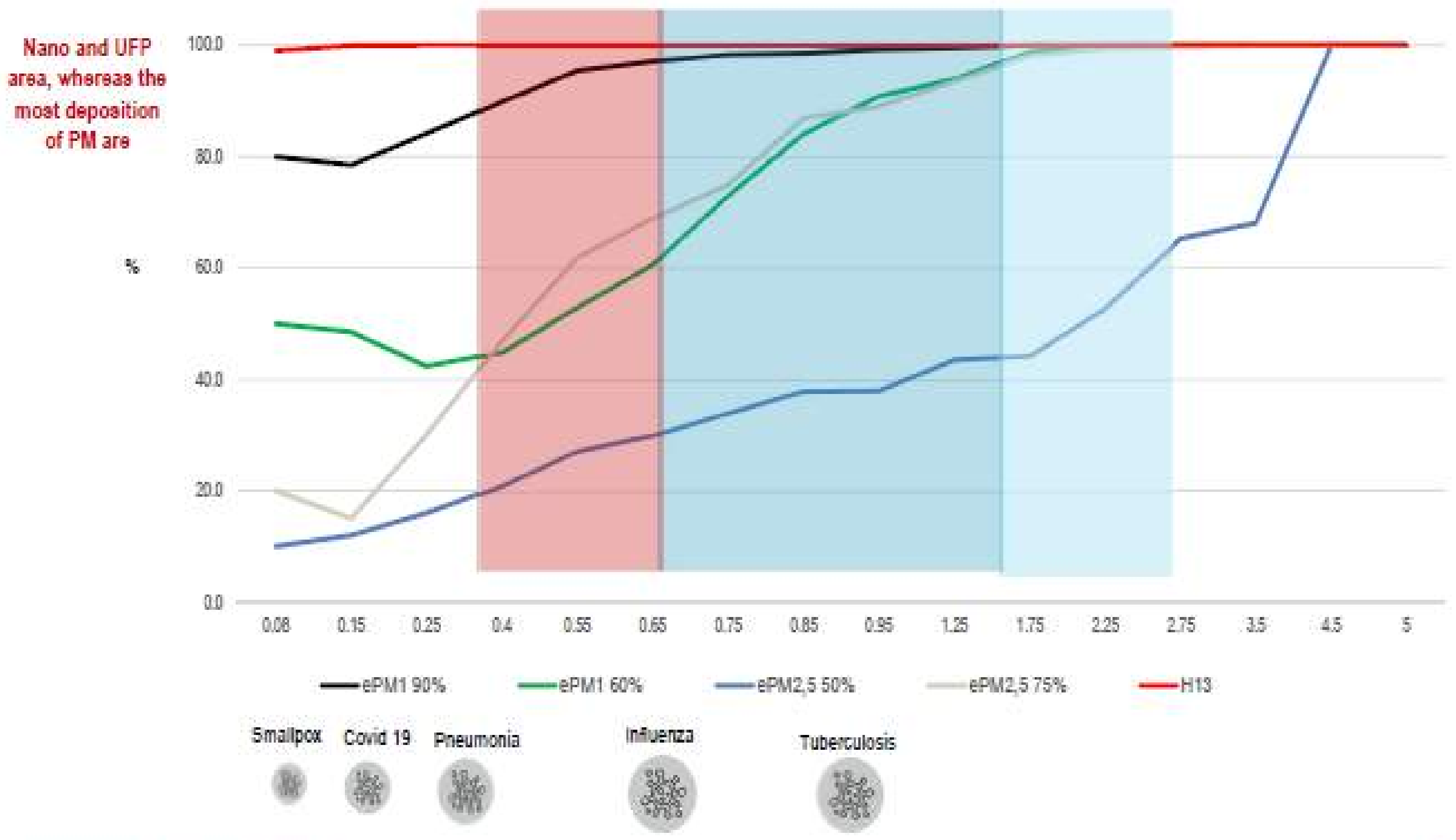
Table B.1. Air changes/hour (ACH) and time required for airborne-contaminant removal by efficiency *		
ACH § ¶	Time (mins.) required for removal 99% efficiency	Time (mins.) required for removal 99.9% efficiency
2	138	207
4	69	104
6+	46	69
8	35	52
10+	28	41
12+	23	35
15+	18	28
20	14	21
50	6	8

Table A3. **Retention capacity of different filter types used in HVAC systems**

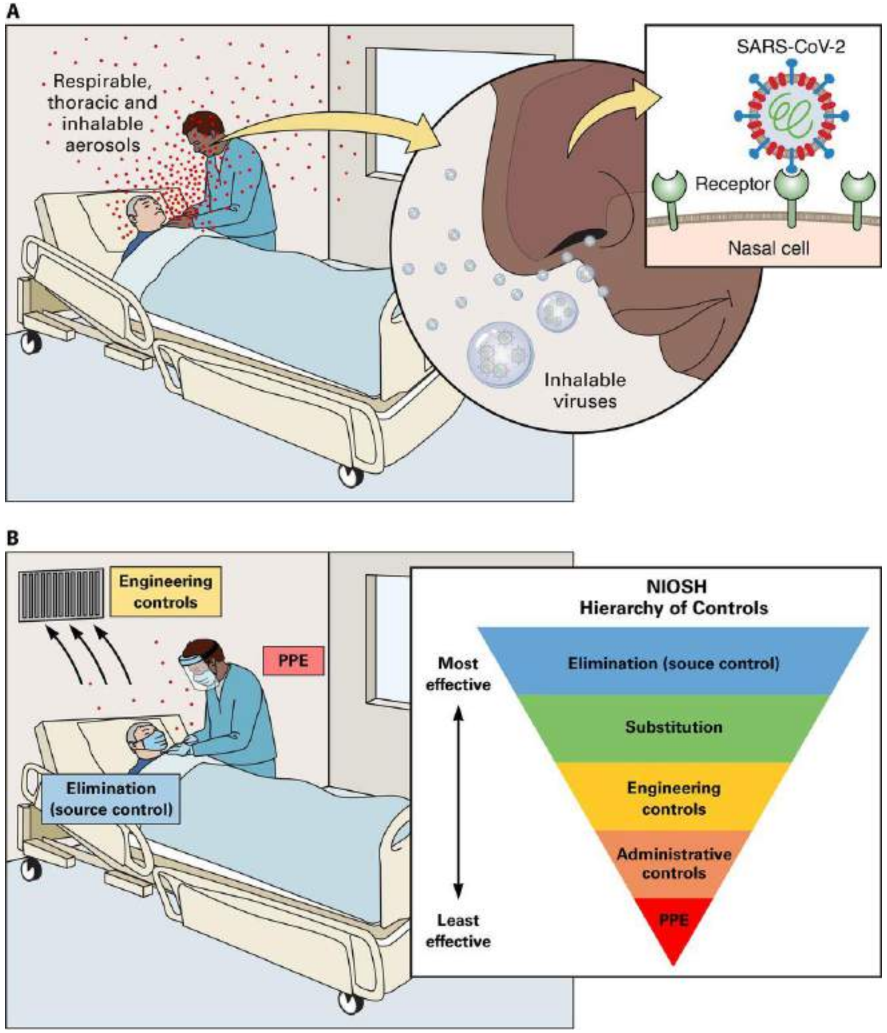
Ventilation system	Typical type of filter	Retention capacity			
		MERV rating[a]	Degree of separation[b]	SARS-CoV-2-containing droplets (≥ 5µm)	SARS-CoV-2-containing aerosol[c] (< 5µm)
Specialised HVAC systems (operating theatres, special laboratories)	H13 -14 [DIN EN]	16–20	99.99%	Yes	
HEPA filter	H13 [DIN EN]	16–20	99.95 %	Yes	
HVAC systems for office buildings, churches, cruise ships, etc.	ePM1 [EN ISO]	9–13	>80 %	Yes	No
Stand-alone air-conditioners (e.g. apartments, shops, restaurants)	- Fiberglass - Polyester/pleated air filters	1–4 8–13	<40% 45%	Yes	No
Pedestal fans	n/a	n/a		No	

a) Minimum Efficiency Reporting Value (MERV), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE);
b) Minimum separation efficiency for test particles, EN ISO 16890 (particle sizes 0.2 to 1.0 µm, depending on the type of filter);
c) Particles, droplet nuclei of different sizes.

SUMMARY FILTER CLASSES ACCORDING TO EN 1822 AND ISO 16890



A broader airborne model involving inhalable aerosols for SARS-CoV-2 transmission in low-risk health care settings.



X. Sophie Zhang, and Caroline Duchaine Clin. Microbiol. Rev. 2020; doi:10.1128/CMR.00184-20

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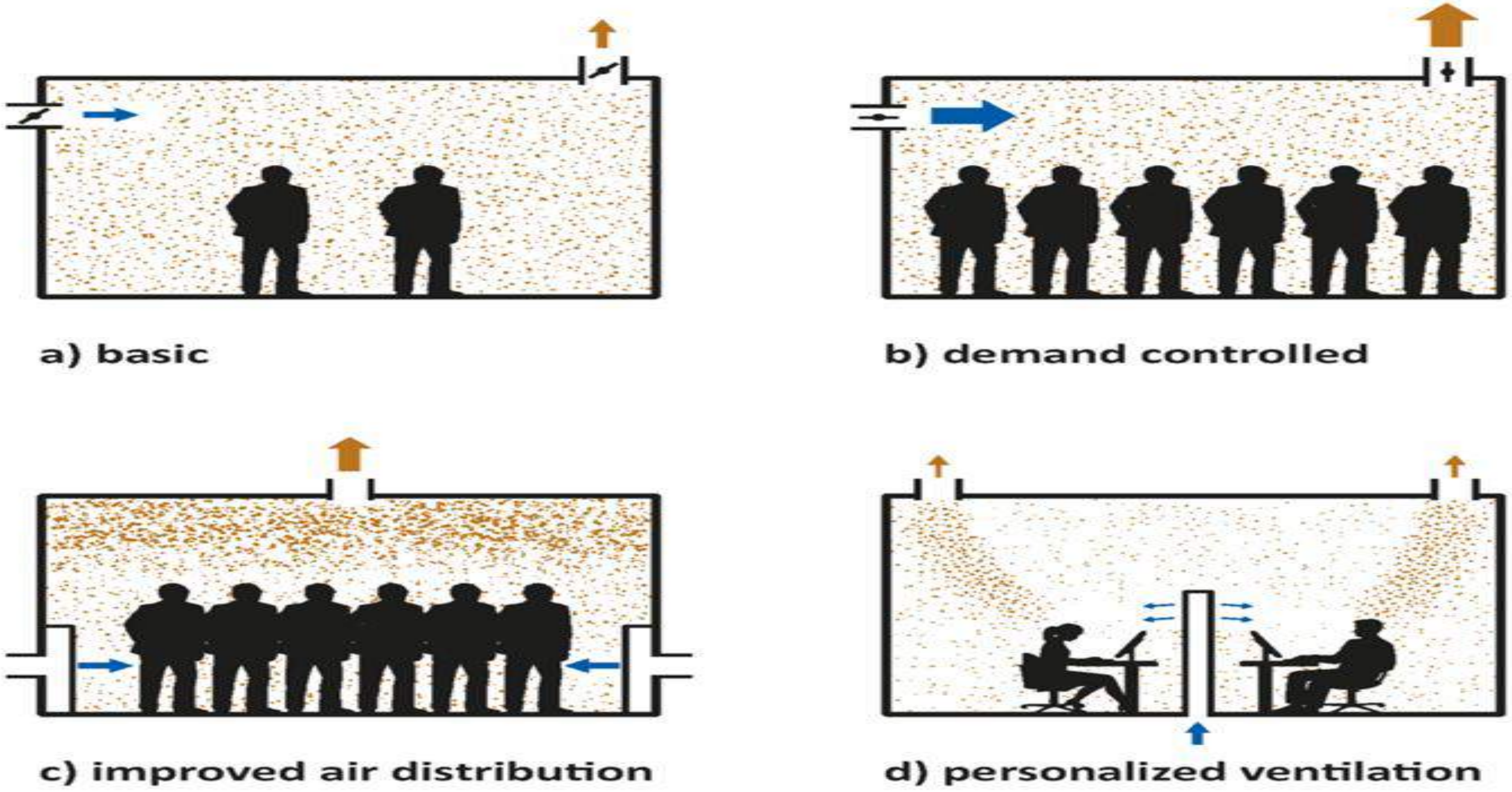
Advanced Room Air Distribution Strategies for Effective Airborne Infection Control.
http://ashrae-ireland.org/webinar-series/

- Personalised Exposure Effectiveness(PEE) goes up.
- Intake Fraction(iF) goes down.
- Exposure Reduction(ε)goes up.
- (Personalised Ventilation with local exhaust reduces risk and better energy efficiency).

One significant article on IAQ policy was published in the Journal Science (* on May 13th written by 40 scientists from 14 counties, of which the five undersigned are from Nordic countries. The group was led by Prof. Lidia Morawska from Queensland Technical University. The main message of the article is that focus on building regulations, and guidelines should be changed from comfort to health of occupants, as the subtitle of the article states, “Building ventilation systems must get much better.”

Most importantly they should deliver clean air to breathing zone and remove the polluted air immediately before it is mixed completely within a space volume. Some solutions following this principles have been developed but they are seldom applied in the practical applications.



There must be a fundamental change in the ventilation technology to limit respiratory infection transmissions in energy efficient way. Outdoor air ventilation rates must be controlled by the number of occupants in the space and their activity a) and b). Exposure can be further reduced by better air distribution c) or by personalized ventilation d) without increasing the ventilation rate and energy use.

- **World Health Organization (WHO)**
- *Roadmap to improve and ensure good indoor ventilation in the context of COVID-19. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO.*
- Corrigenda, 13 April 2021: Roadmap to improve and ensure good indoor ventilation in the context of COVID-19
- https://apps.who.int/iris/handle/10665/339857

- ECDC. Heating, ventilation and air-conditioning systems in the context of COVID-19: first update 2020 [updated 10 Nov 2020; cited 2020 12 Nov]. Available from:
- https://www.ecdc.europa.eu/sites/default/files/documents/Heating-ventilation-air-conditioning-systems-in-the-context-of-COVID-19-first-update.pdf

ECDC Infection prevention and control and preparedness for COVID-19 in healthcare settings
Sixth update – 9 February 2021

- Ventilation plays a key role for the prevention of respiratory infections in healthcare settings.
- The minimum number of air exchanges per hour, in accordance with the applicable hospital regulations, **should be ensured at all times**. Increasing the number of air exchanges per hour will reduce the risk of transmission in closed spaces. This may be achieved by means of natural or mechanical ventilation, depending on the setting. Air recirculation without filtration should be avoided as much as possible.

ECDC Heating, ventilation and air-conditioning systems in the context of COVID-19: first update
10 November 2020

- **Engineering controls in mechanically ventilated (by HVAC systems) and naturally ventilated closed spaces**

- **Building administrators** should review, maintain (including the upgrade of filters where appropriate), and monitor HVAC systems according to the manufacturer's current instructions, particularly in relation to the cleaning and changing of filters. There is no benefit or need for additional maintenance cycles in connection with COVID-19.

- The minimum number of air exchanges per hour, in accordance with the applicable building regulations, **should be ensured at all times. Increasing the number of air exchanges per hour will reduce the risk of transmission in closed spaces. This may be achieved by natural or mechanical ventilation, depending on the setting**.

- Specific recommendations for natural ventilation through opening windows and doors should be developed on an individual basis, taking into account the characteristics of the room (volume, size and function of openings, occupancy rates), the activities taking place in the room, the climatic and weather conditions, as well as energy conservation and the comfort of the users.

WHO Roadmap to improve and ensure good indoor ventilation in the context of COVID-19 March 2021

- The virus can spread from an infected person’s mouth or nose in small liquid particles when the person coughs, sneezes , sings, breathes heavily or talks. These liquid particles are different sizes, ranging from larger “respiratory droplets” to smaller “aerosols”. Close range contact (typically within 1 m) can result in inhalation of, or inoculation with, the virus through the mouth, nose or eyes.

WHO Roadmap to improve and ensure good indoor ventilation in the context of COVID-19 March 2021

- Aerosol transmission can occur in specific situations in which procedures that generate aerosols are performed. The scientific community has been actively researching whether the SARSCoV-2 virus might also spread through aerosol transmission in the absence of aerosol-generating procedures.

WHO Roadmap to improve and ensure good indoor ventilation in the context of COVID-19 March 2021

- Some studies that performed air sampling in clinical settings where AGP were not performed found virus RNA, but others did not . *The presence of viral RNA* is not the same as replication and infection competent(viable) virus that could be transmissible and capable of initiating invasive infection.

- A limited number of studies have isolated viable SARSCoV-2 from air samples in the vicinity of COVID-19 patients.

WHO Roadmap to improve and ensure good indoor ventilation in the context of COVID-19 March 2021

- Outside of medical facilities, in addition to droplet and fomite transmission, 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 Roadmap to improve and ensure good indoor ventilation in the context of COVID-19 March 2021

- A well-designed, maintained and operated system can reduce the risk of COVID-19 spread in indoor spaces by diluting the concentration of potentially infectious aerosols through ventilation with outside air and filtration and disinfection of re-circulated air.

- Proper use of natural ventilation can provide the same benefits. The decision whether to use mechanical or natural ventilation should be based on needs, resource availability and the cost of systems to provide the best control to counteract the risks.

WHO Roadmap to improve and ensure good indoor ventilation in the context of COVID-19 March 2021

- SARS-CoV-2 transmission is particularly effective in crowded, confined indoor spaces where there is poor or no ventilation . *Therefore, ensuring* adequate ventilation may reduce the risk of COVID-19 infection.

WHO Roadmap March 2021:Healthcare

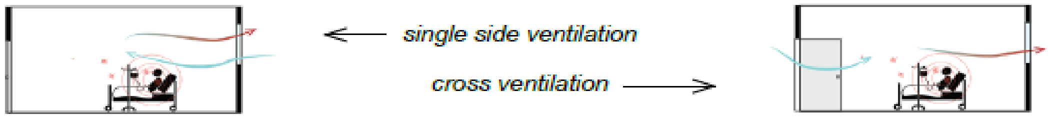
natural ventilation

Minimum requirements	Steps – key questions	Strategies
Ventilation rate minimum requirements *(32)*: • 160 L/s/patient or 12 ACH where AGP are performed • 60 L/s/patient or 6 ACH other	Does the ventilation rate meet WHO minimum requirements? To estimate the ventilation rate consult point 2.	

NO

+ Assess the opening locations and opening surfaces considering potential new openings (add/modify window or door dimensions).

+ Consider enabling cross ventilation rather than single-sided ventilation.
Note: Cross ventilation should not be implemented in these specific cases:
• within a room or ward for COVID-19 suspected cases where AGP may take place and when the exhaust air is not properly managed;
• when the airflow is moving from a less clean to a clean area.



If the system does not allow increasing ventilation to the recommended minimum per person requirement, consider reducing the maximum room occupancy to meet the L/s/patient standard.

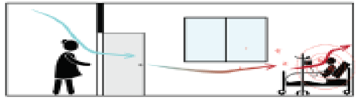
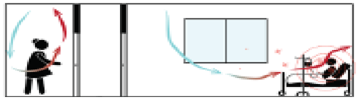
+ If no other (short-term) strategy can be adopted, consider using a stand-alone air cleaner with HEPA filters. Pay attention to the airflow direction (from clean to less clean areas) when positioning. The air cleaner should be positioned in the areas used by people and close to people, to provide the maximum possible treatment of the source(s) of infection. Stand-alone air cleaners should be operated continuously and air cleaner capacity should at least cover the gap between the minimum requirement and the measured ventilation rate – compare the device clean air delivery rate (CADR) (m^3/hr) with the room ventilation rate.
Note: Consider that stand-alone air cleaners do not replace ventilation in any circumstance.

YES

+ Consider modifying the functional distribution regarding airflow directions to minimize exposure of HCWs, i.e. changing patient and staff areas in order to have natural negative pressure (i.e. due to stack effect) close to patient rooms, if a clear airflow direction is identified.

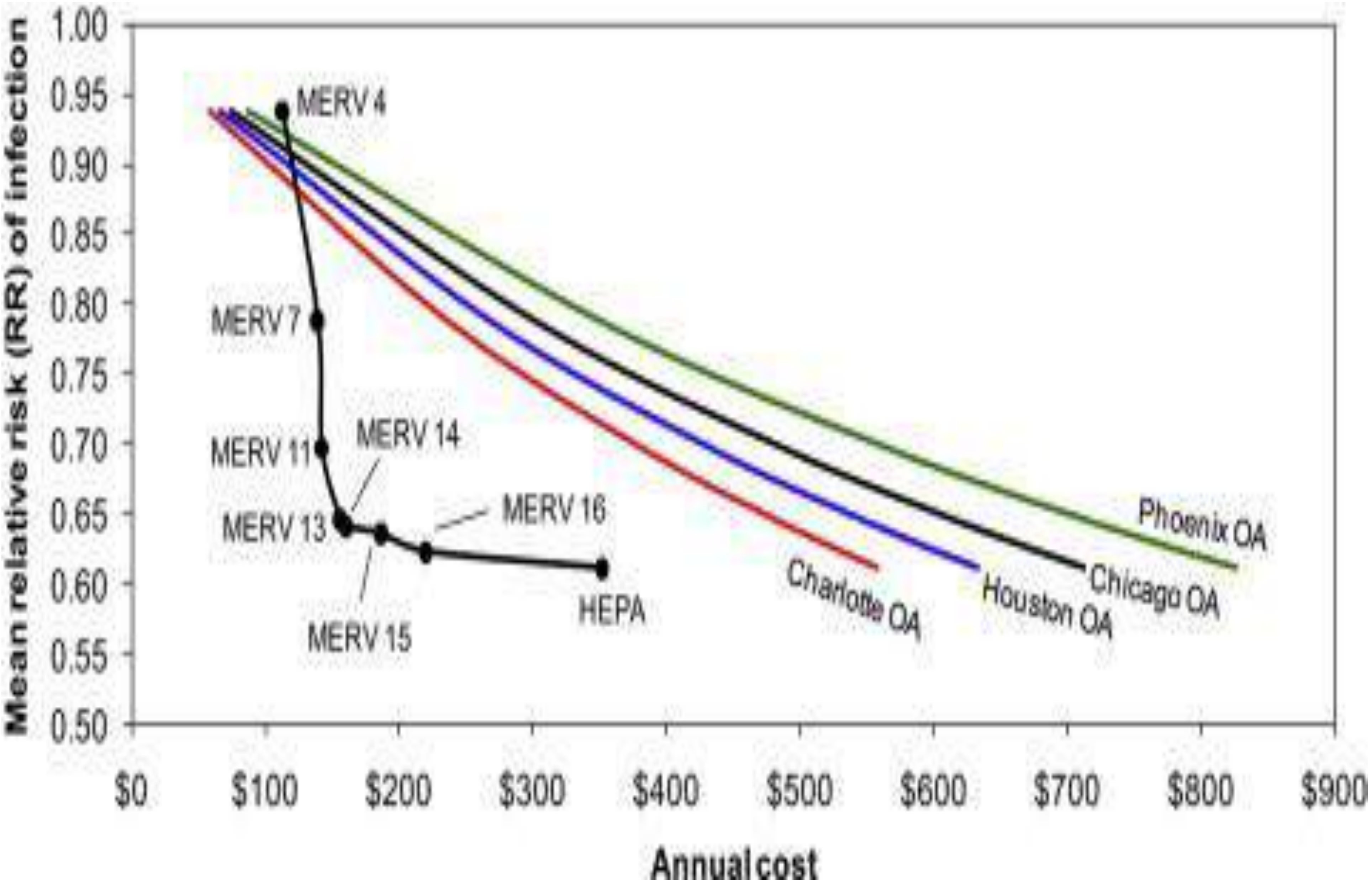
WHO Roadmap March 2021 Healthcare

mechanical ventilation

Minimum requirements	Steps – key questions		Strategies
Ventilation rate minimum requirements *(32)*: • 160 L/s/patient or 12 ACH where AGP are performed • 60 L/s/patient or 6 ACH other	Does the ventilation rate meet WHO minimum requirements? To assess the ventilation rate consult point 1.	NO	In consultation with a HVAC professional assess the opportunity to increase the ventilation rate according to system capabilities. Disable demand-control ventilation controls that reduce air supply based on temperature or occupancy (CO_2 concentration). If the ventilation rate cannot be increased mechanically, consider maximizing ventilation by using natural ventilation through opening windows *(37)* (see natural ventilation section for more strategies). If the system does not allow increasing the ventilation to the recommended minimum per person requirement, consider reducing the maximum room occupancy to meet the L/s/patient standard. If no other (short-term) strategy can be adopted, consider using a stand-alone air cleaner with HEPA filter. Pay attention to the airflow direction (from clean to less clean areas) when positioning. The air cleaner should be positioned in the areas used by people and close to people, to provide the maximum possible treatment of the source(s) of infection. Stand-alone air cleaners should be operated continuously. Air cleaner capacity should at least cover the gap between the minimum requirement and the measured ventilation rate – compare the device clean air delivery rate (CADR) (m^3/hr) with the room ventilation rate. Note: Consider that filtered recirculated air does not replace ventilation in any circumstance.
	YES		
The airflow direction should be from clean to less clean area *(32)*	Does the airflow move from clean to less clean area? To evaluate the airflow consult point 3. 	NO	Consider modifying the functional distribution regarding airflow directions to minimize exposure of HCWs, i.e. swapping patient and health care staff areas, if a clear airflow direction is identified. In consultation with a HVAC professional, assess the opportunity to modify airflow direction, i.e. modifying the location of supply and exhaust (return) air devices. + In rooms where AGP are performed: add ante-rooms in order to have more strict control of airflow direction. Doors in ante-rooms should not be open at the same time in order to clearly separate the air between the patient room and the corridor (cleaner area). A cost-effective solution is the use of a plastic door zipper as a partition to create an ante-room. 

HVAC filtration for controlling infectious airborne disease transmission in indoor environments: Predicting risk reductions and operational costs

Parham Azimi and Brent Stephens



WHO Roadmap to improve and ensure good indoor ventilation in the context of COVID-19 March 2021

- Indoor ventilation is part of a comprehensive package of prevention and control measures that can limit the spread of certain respiratory viral diseases, including COVID-19.
- However, ventilation alone, even when correctly implemented, is insufficient to provide an adequate level of protection.
- Correct use of masks, hand hygiene, physical distancing, respiratory etiquette , testing, contact tracing, quarantine, isolation and other IPC measures are critical to prevent transmission of SARS-CoV-2.

Summary

- Follow Public Health Advice
- Remember Social Distancing Cleaning & Disinfection, PPE to be worn and Testing/Tracing.
- Avoid confined spaces with large crowds and poor ventilation.
- Be aware of activity levels/dose.
- Remember Time X Exposure
- Risk assessment hence can the risk be avoided
- Provide Good Air Dilution, Ventilation, Treatment, Filtration, LEV as per guidance docs set out above **(see latest Public Health advice with reference to WHO, ECDC,CIBSE,REHVA,HIQA HVAC Guidance).**
- Embrace new technology i.e. air treatment units provided their is evidence based data and risk assessment by competent person and ensure they cause no harm.
- Look at life cycle costs and life cycle performance and future proofing.
- Is it evidence based, independent and IPC approved.
- **Integrated/Coordinated Approach required in collaboration with Public Health/IPC advice.**

- **In Conclusion:**

- Although the vaccine programme will greatly reduce the infection rates once fully rolled out we need to future proof our Healthcare facilities with regard to the this pandemic and future pandemic's or other airborne diseases.

- With regard to poor outdoor air environment during winter months in urban locations and greater recognition of IS EN 16798-1:2019 is required.

- **World Health Organization (WHO)**
- *Roadmap to improve and ensure good indoor ventilation in the context of COVID-19. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO.*
- Corrigenda, 13 April 2021: Roadmap to improve and ensure good indoor ventilation in the context of COVID-19
- https://apps.who.int/iris/handle/10665/339857

- <u>Other Engineering Design Guides such as HBN's/HTMs/CIBSE/ISEN's/ISO standards will define the Engineering requirements.</u>

- Designers will need to integrate infection control requirement into Computerised Fluid Dynamic(CFD) modelling design tools are available to determine the most appropriate solution taking account of energy, sustainability and maintenance issues.

Thank-you for listening to this presentation.

THE CAMFIL GROUP

Benefits of HEPA filters, Local exhaust systems & Air Cleaners

July 6th, 2021

IHEEM

CLEAN AIR SOLUTIONS

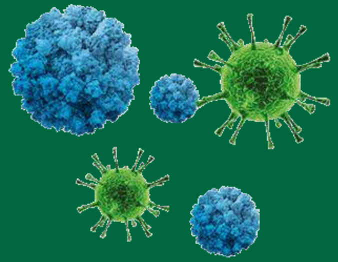
camfil

CONTENTS

- ***Benefits of HEPA filter local exhaust systems.***
- ***Air Cleaners.***
- ***Use of HEPA Filtration during COVID19.***

PAUL FLANAGAN

- Managing Director - Camfil Ireland
- 26 years experience in clean air Industry
- Working with key healthcare clients across Ireland, Europe & Globally

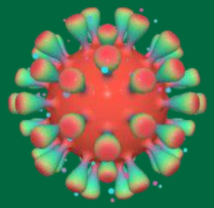


QUESTION. 1 : CAN RESPIRATORY VIRUS(COVID-19) SPREAD BY AIRBORNE TRANSMISSION?

Answer, Yes! Studies have shown that a person infected by respiratory viral infection such as Influenza or COVID can create droplets containing the virus by sneezing and coughing etc. These droplets can be both visible and invisible to the human eye. The droplets that are invisible can range from 0.5 to 15 micrometers. Studies on other common viruses suggest that a droplet of 1 micrometer can carry enough virus to cause an infection.

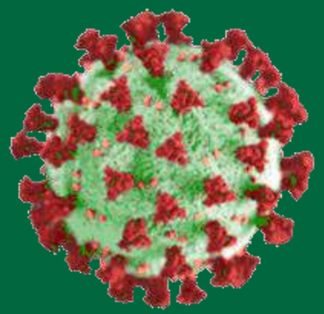
QUESTION 2: ARE AIR FILTERS EFFECTIVE IN CAPTURING AIRBORNE VIRUS?

Answer, Yes! The effectiveness depends on the efficiency of the air filter. But as infectious droplets generally are larger than 1 micrometer the reduction of virus is significantly greater than the efficiency stated on an ePM1 or an EPA/HEPA air filter. The stated air filter efficiency on these filters is the minimum virus protection/reduction that you will get.



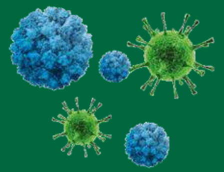
QUESTION 3.: CAN VIRUSES CAPTURED IN THE AIR FILTER BE RELEASED BACK INTO THE AIR-STREAM?

Answer, No! Virus captured in the filter are strongly bound to the fibers in the filter media. Once the virus is captured it will stay in the air filter and eventually dry out and die (refers to as inactive). Studies on COVID-19 virus indicates that the virus does not survive longer than 3 days on open surfaces.



QUESTION 4: IS THERE SOMETHING ELSE I CAN DO TO FURTHER IMPROVE THE AIR QUALITY?

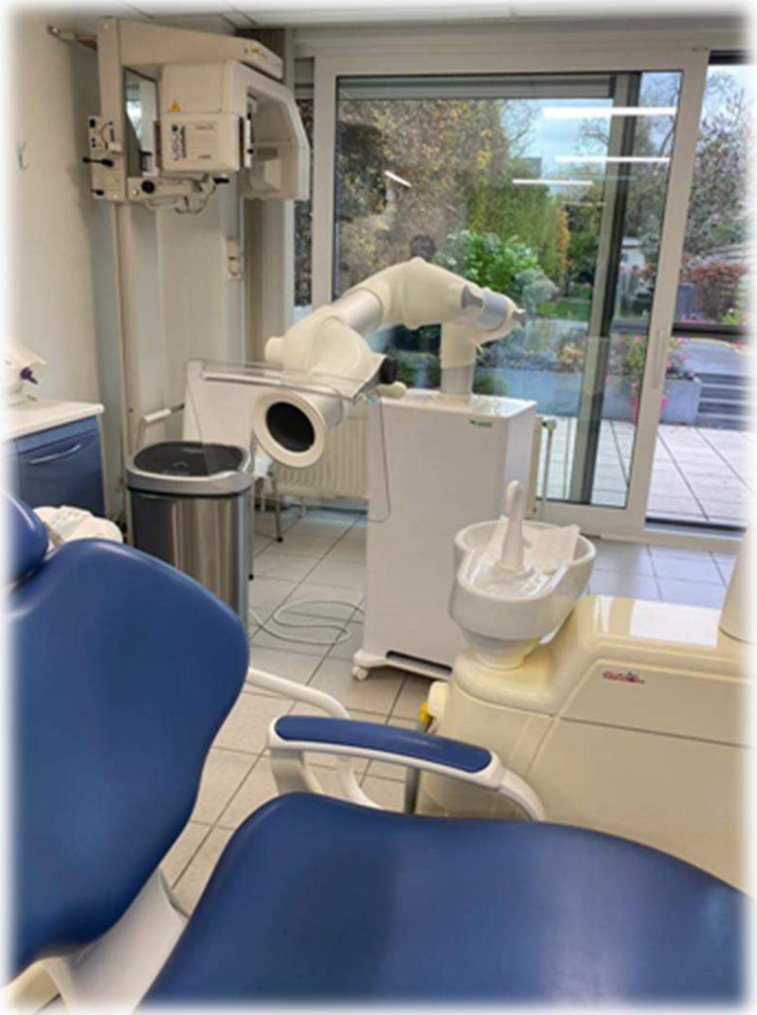
ANSWER: YES, APPLY USE OF AIR CLEANERS. If you have already turned off the re-circulation, increased the air flow and upgraded the filters to the maximum allowable filtration efficiency, then there is a possibility to use high quality re-circulation air cleaners. They are very effective in improving overall air quality. The advantage of Air Cleaners and Air Purifiers is that a significantly higher filtration efficiency can be applied to rooms where it would otherwise be impossible. Through high air turnovers and high filtration efficiency it is possible to reduce the contamination in a room by 90% or more. It is a good idea to use room air cleaners in high risk areas and places where many people need to stay close together (such as waiting rooms, etc.)



LOCAL EXHAUST SYSTEMS WITH HEPA FILTERS

AREAS OF USE

DENTIST



HOSPITAL

TECHNICAL INFORMATION

15 AIR FLOW DETAILS

Easy to clean thanks to the flatness of the main body and the suction hood made from cleaning resistant plastic (PETG)

Height (mm)	1290
Width (mm)	454
Depth (mm)	454
Weight (kg)	25.0 (including new filters)
Filter weight (kg)	2.0 kg (2 filters are needed)

8 FAN SPECIFICATIONS

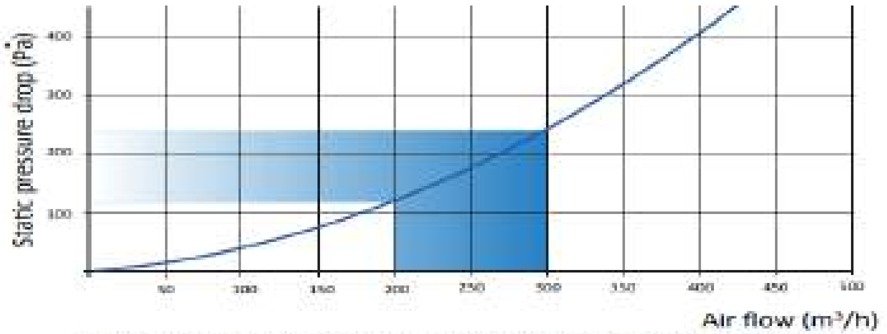
Phase		1~
Nominal voltage	VAC	230
Nominal voltage range	VAC	200 .. 240
Frequency	Hz	50/60
Type of data definition		ml
Speed	min^{-1}	3230
Power input	W	170
Current draw	A	1.4
Min. ambient temperature	°C	-25
Max. ambient temperature	°C	+60

ml=max.load; subject to alterations

9 AIR FLOW

With filter H14 (incl. 2pcs , plastic frame)

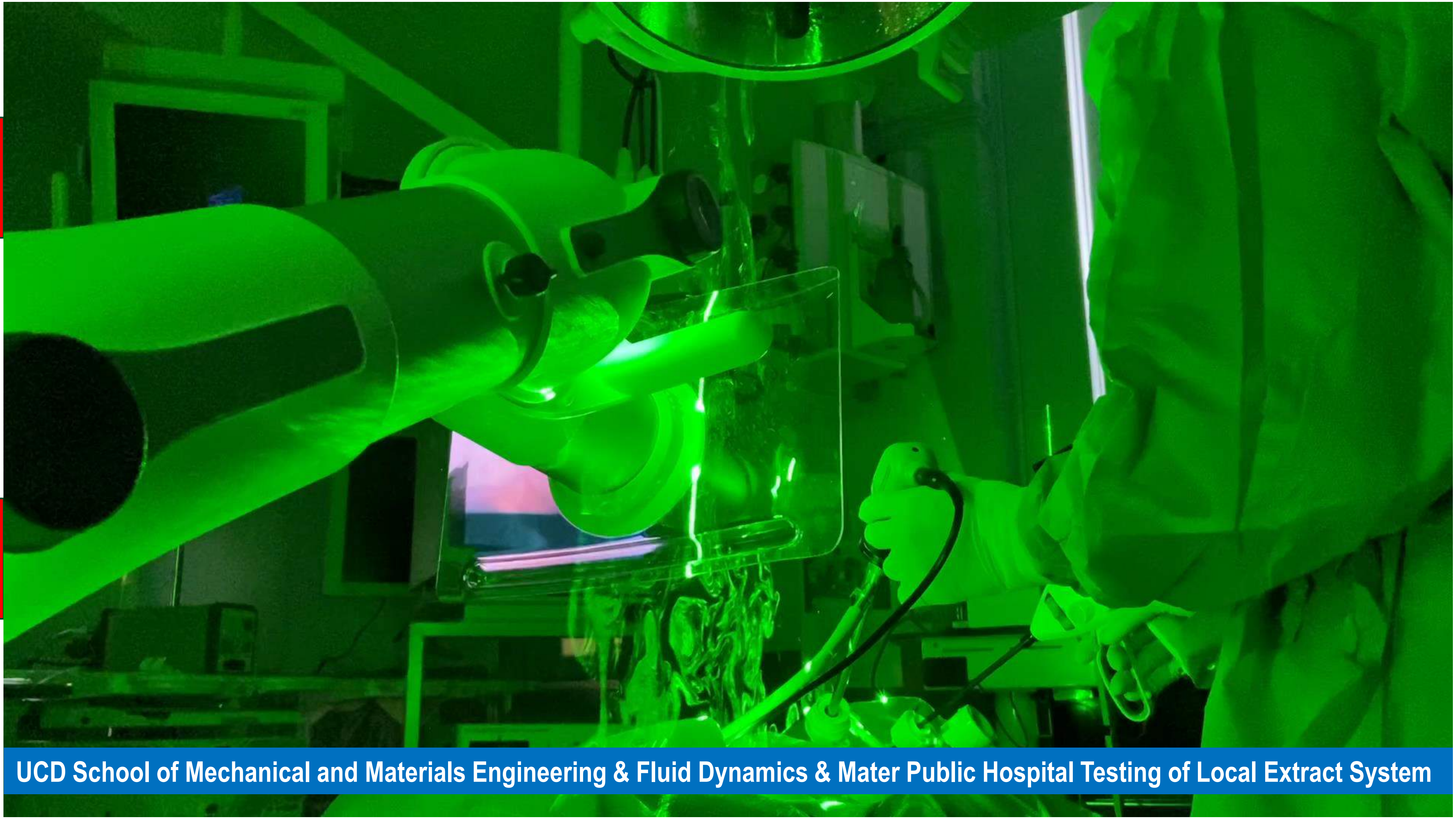
	City H Dental Care			
Step	Qv [m³/h]	N [rpm]	Pe [W]	LpA [dBA]
1	70	780	5	25
2	150	1320	15	46
3	200	1680	23	52
4	240	1945	35	57
5	270	2114	45	60
6 Max.	300	2398	61	64



Static pressure drop is measured in accordance with ISO standard 5167-1.

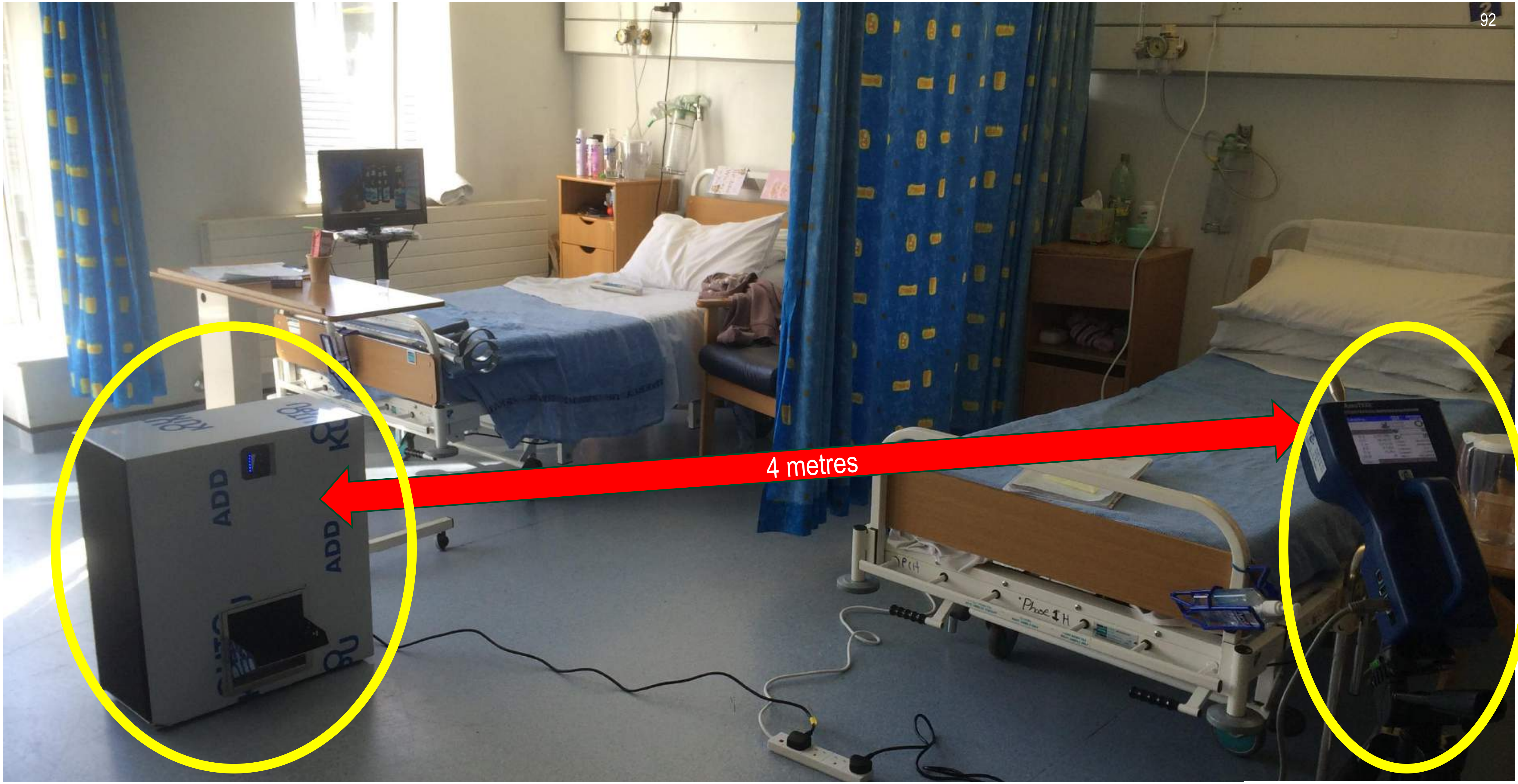
Unit now switched on!

Unit now switched off again!



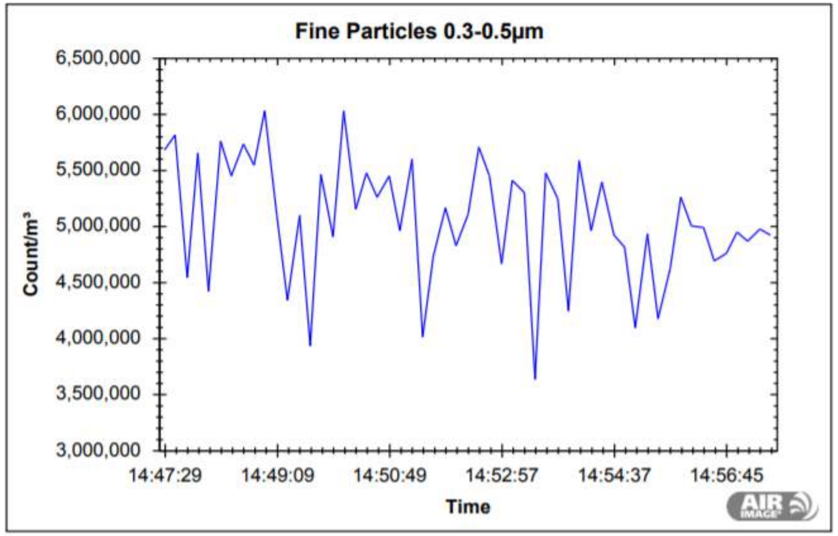
UCD School of Mechanical and Materials Engineering & Fluid Dynamics & Mater Public Hospital Testing of Local Extract System

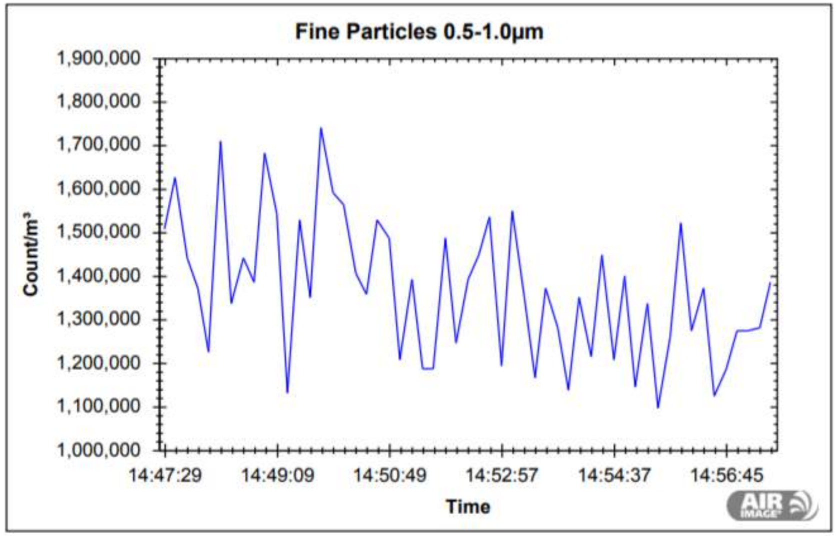
STATIC OR MOBILE / PLUG & PLAY AIR CLEANERS


4 metres

Measurement: Phae 1H (Ward B) Pre Camcleaner
Company: St. James Hospital
Building: Phase 1H (Ward B)
Date: 2014-03-20
Time: 14:46:36

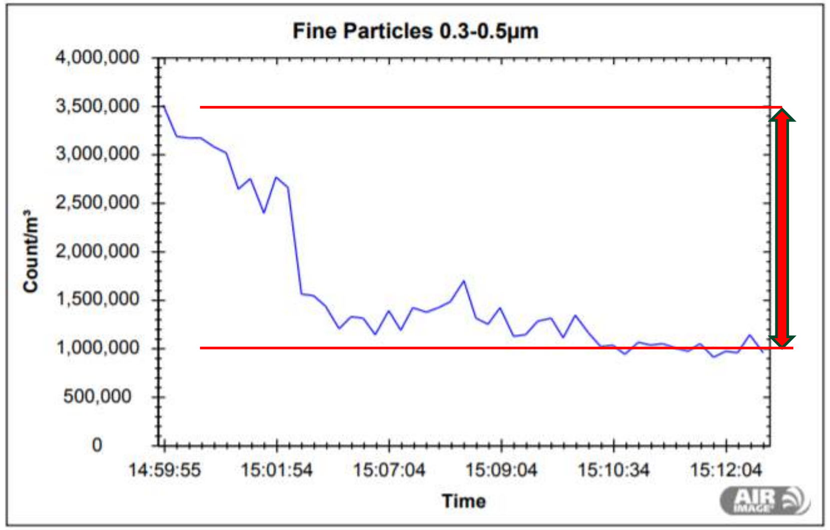
Unit *not* switched on

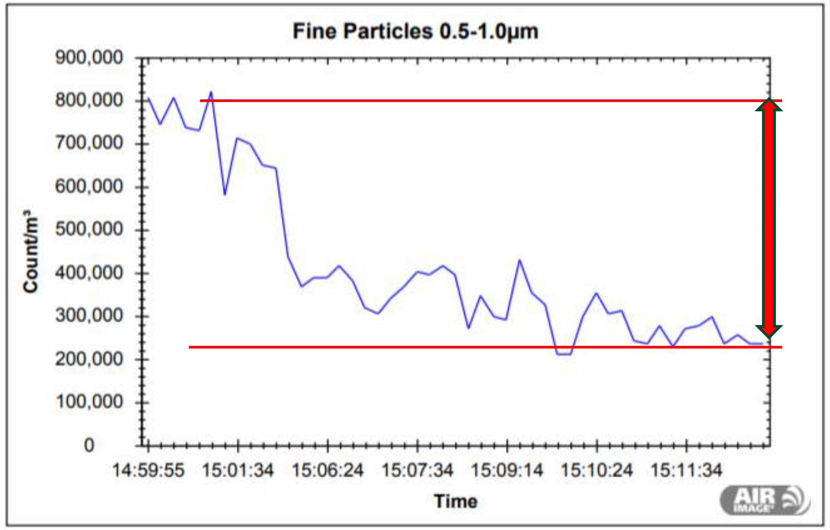




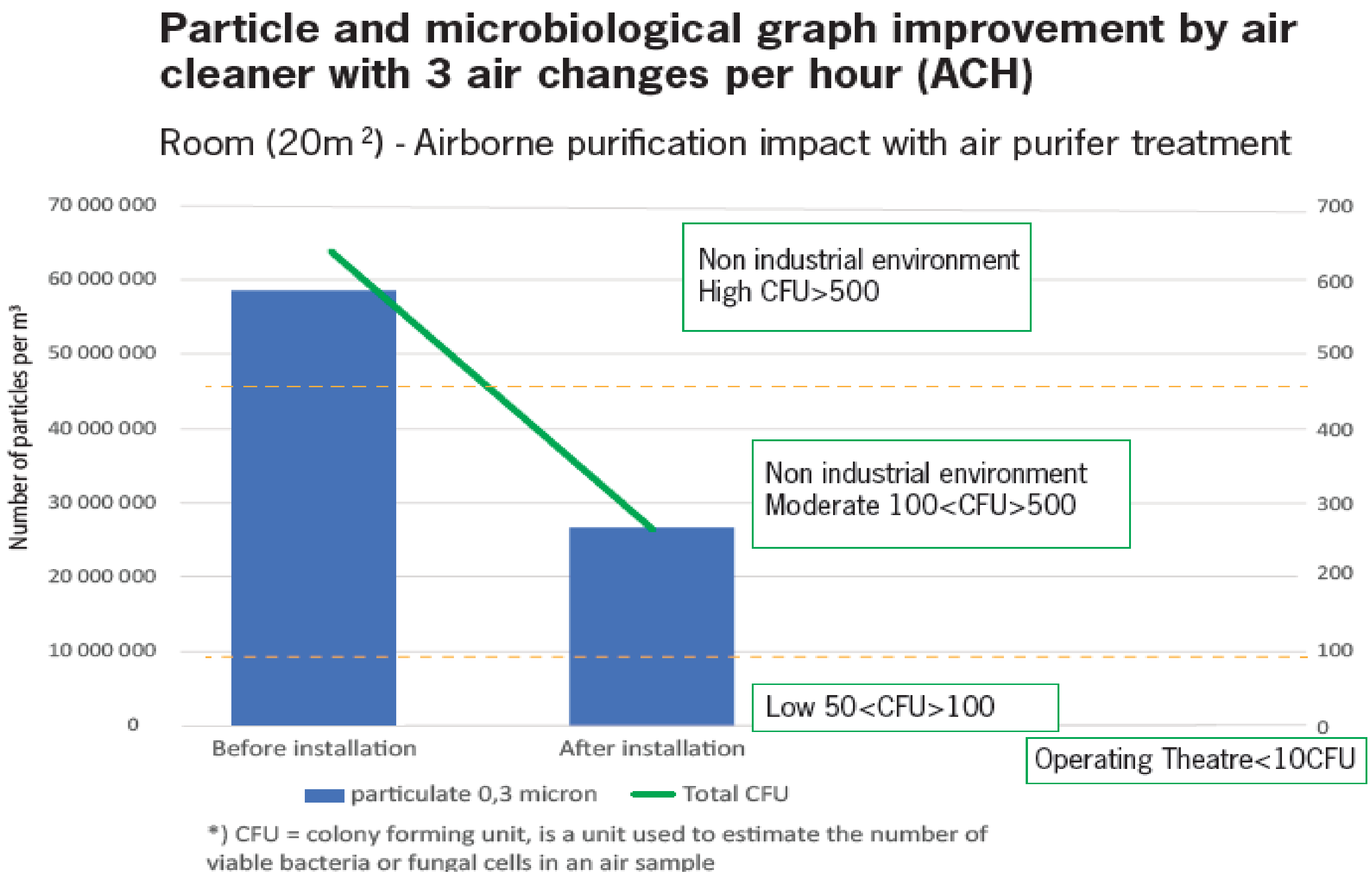
Measurement: Phase 1H (Ward B) With Camcleaner
Company: St. James Hospital
Building: Phase 1H (Ward B)
Date: 2014-03-20
Time: 14:59:27

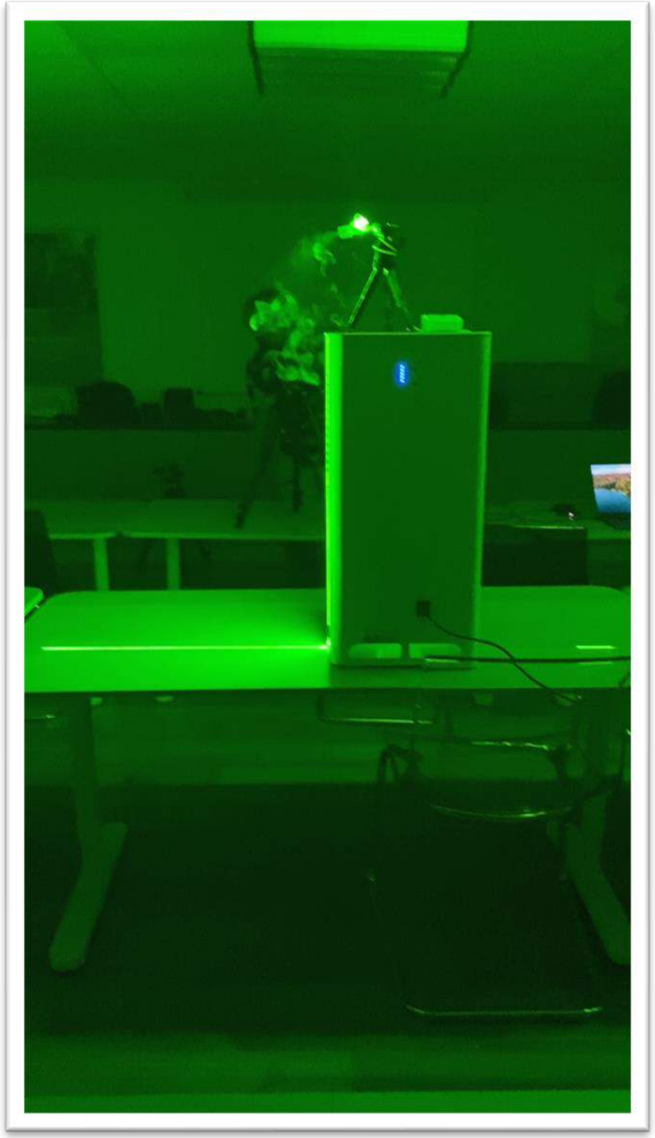
Unit switched on





- Specific air cleaners can be used to mitigate the risk of airborne viruses in waiting rooms or office spaces. These are especailly effective during colder months where it might be difficult open windows.
- Installed with certified H14 filters, they can enusre you will have a high capture rate of particles.



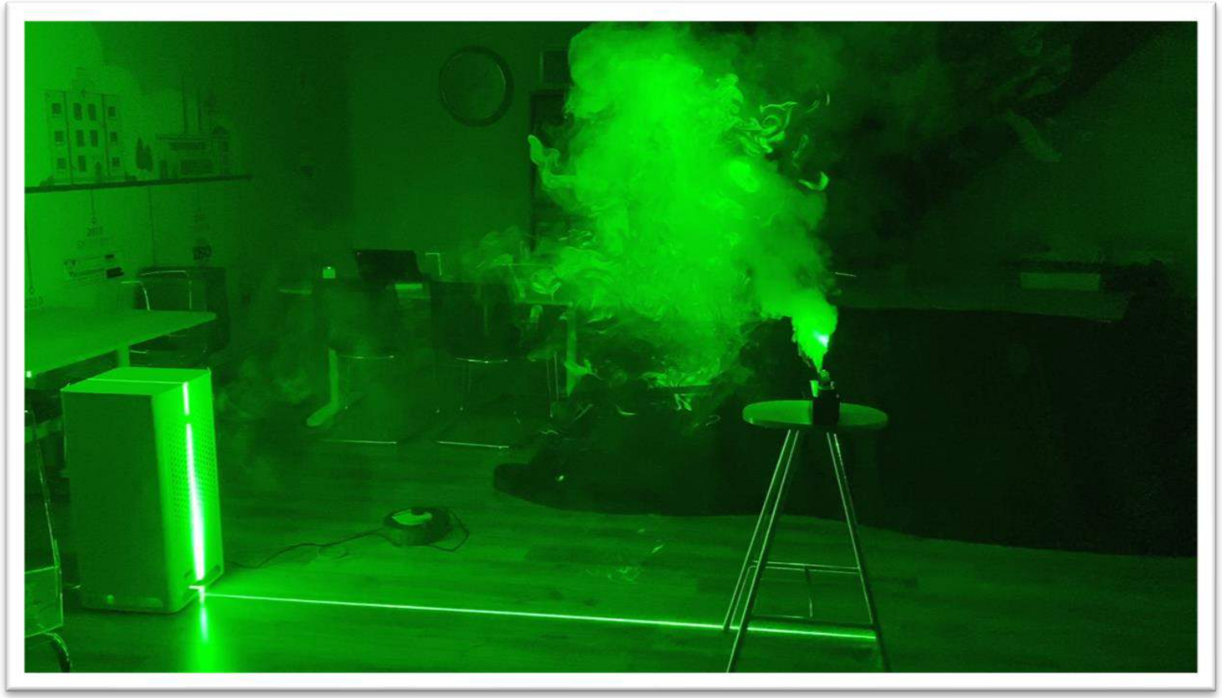


Tests carried out, April 28th, 2021

UCD School of Mechanical and Materials Engineering & Fluid Dynamics & Mater Public Hospital & HSE Witness

Ronan Cahill: Professor of Surgery at Mater Misericordiae University Hospital and University College Dublin

Kevin Nolan: Professor, School of Mechanical and Materials Engineering



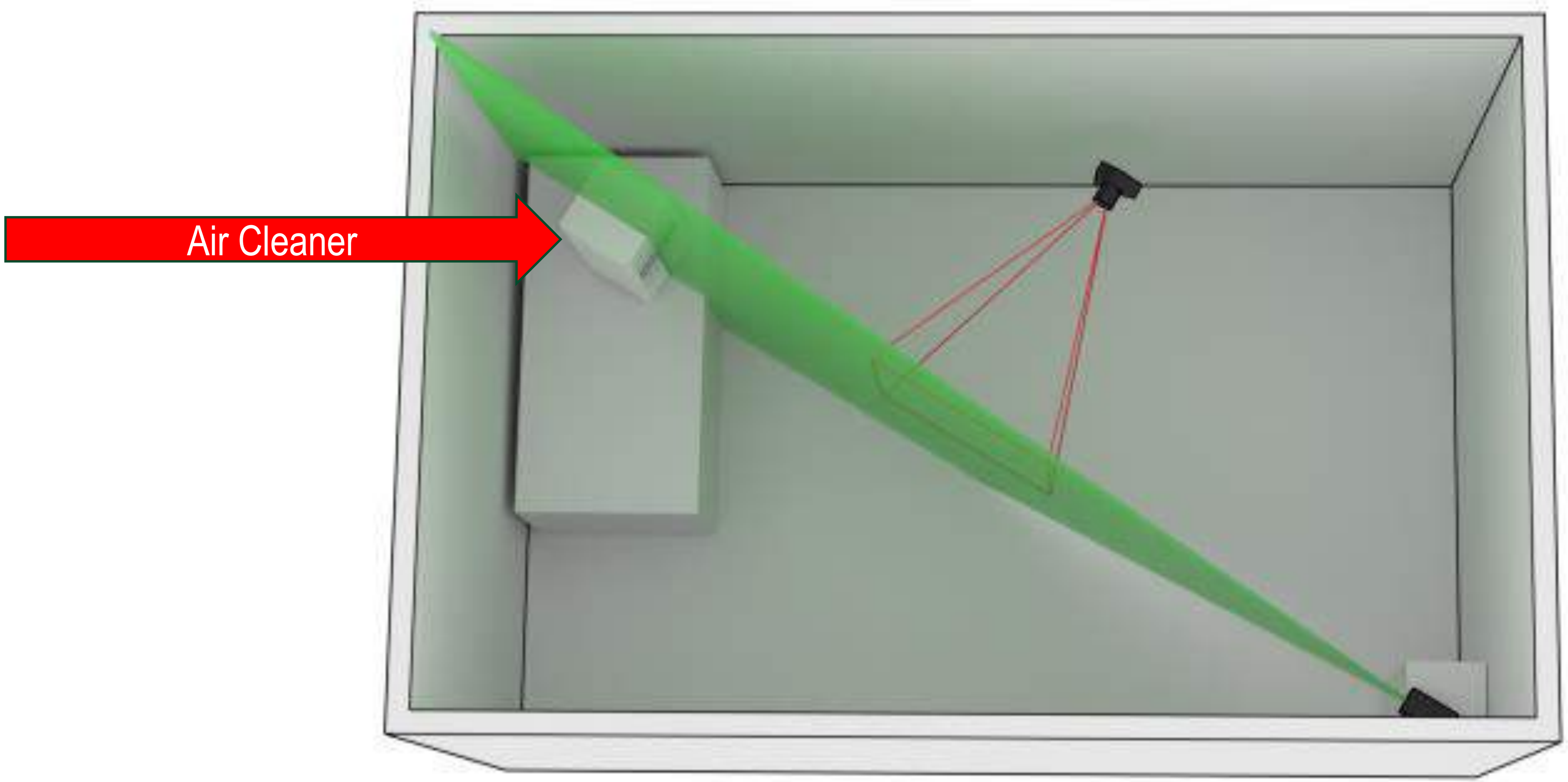
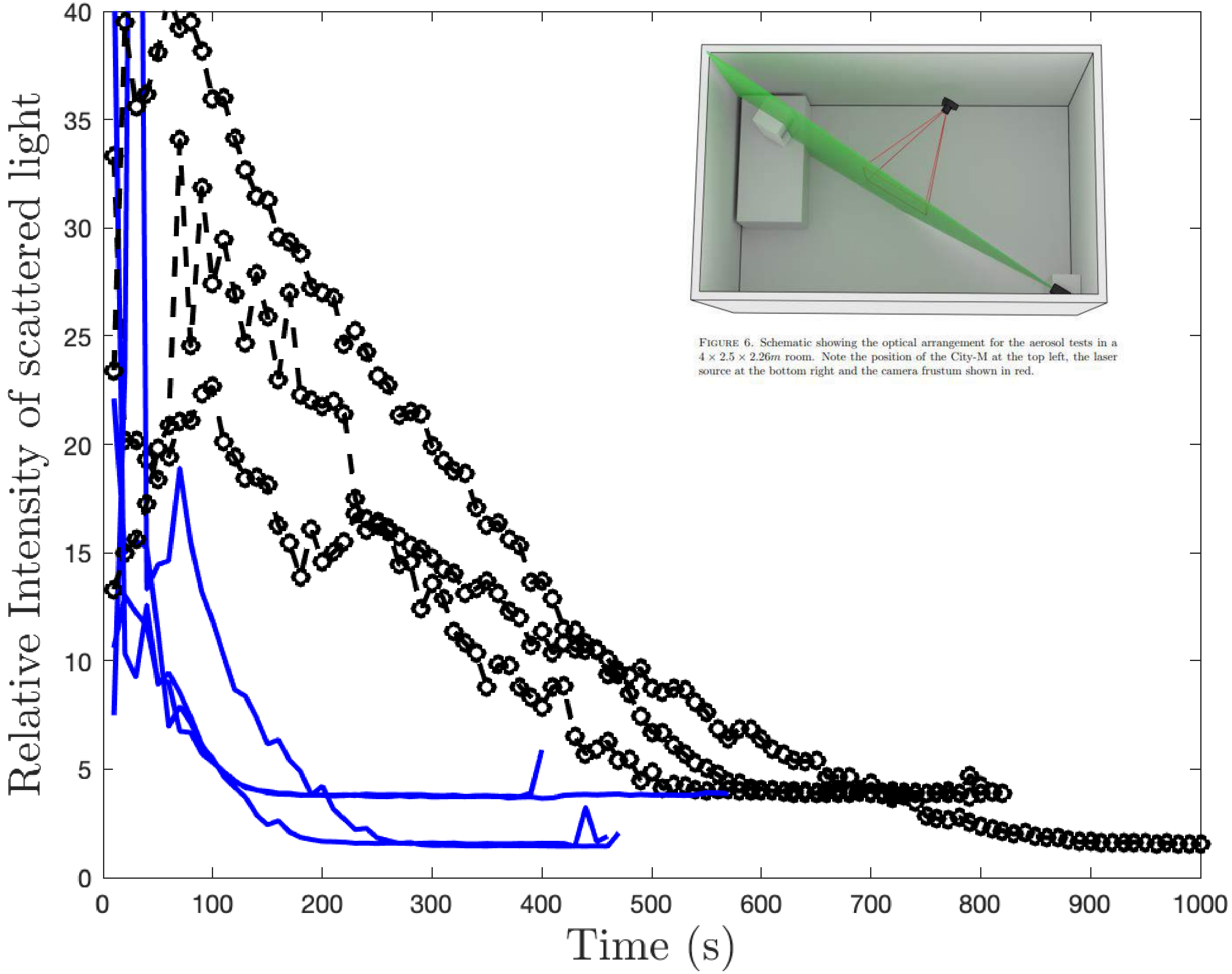


FIGURE 6. Schematic showing the optical arrangement for the aerosol tests in a $4 \times 2.5 \times 2.26m$ room. Note the position of the City-M at the top left, the laser source at the bottom right and the camera frustum shown in red.

UCD School of Mechanical and Materials Engineering & Fluid Dynamics & Mater Public Hospital Testing of City M Units



The black data lines show the reduction in light scattering for a series of tests where the air purifier was switched off. The blue curves are when the system is switched on. As you can see the Air Cleaner system significantly improves the situation.

Untreated the aerosol slowly dissipates over a period of 500 to 800 seconds.

When the unit is switched on we see that there is a rapid reduction in the aerosol observed resulting in the space being effectively cleaned in <150 seconds.

The key point is that the unit achieves aerosol removal in an unventilated space 4 times quicker than without.

Camfil Air Image Sensor

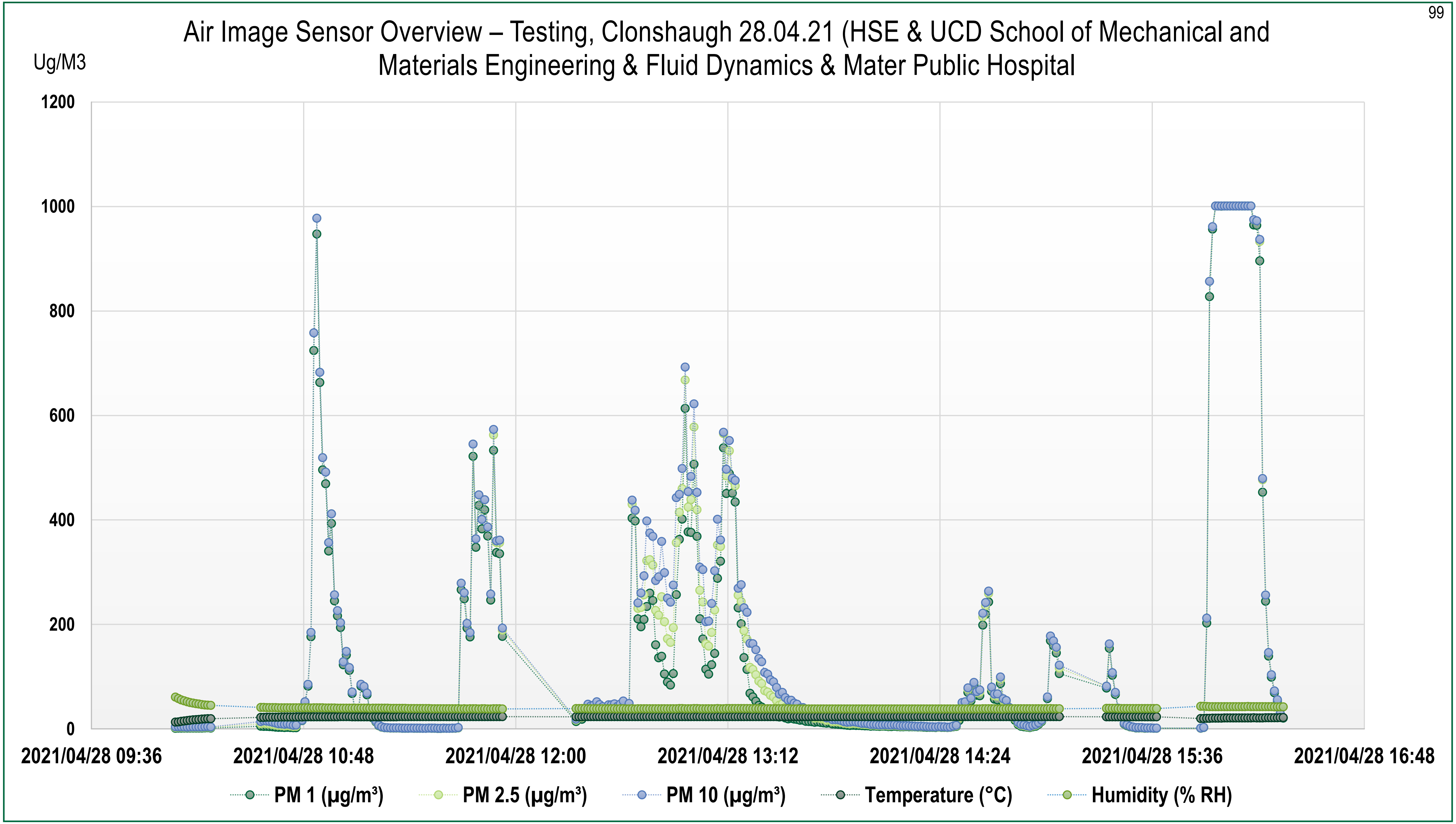
This is the Air Image Sensor user interface designed for the dedicated user in a company or organisation assigned to manage and control their indoor air quality - usually the maintenance personnel.

It allows them to view several sensors within the premises as well as buildings located elsewhere as seen on the map.

- It allows the user to view historical data for up to one year
- Alarms if measured data is not sent
- Allows export to excel if an analysis needs to be done for a specific time period
- User can obtain time reports
- Allows setting of desired IAQ values to achieve
- Automatically regulates connected Camfil air purifiers

These various visual displays are ways a restaurant, gym, or any facilities or processes can choose to give an image or visualisation of their indoor air quality:

- Shows instant measured indoor air quality excellence
- Instant measurement against WHO recommended values
- Shows real-time outdoor air quality value
- Easy to understand visuals
- Customisable with own logo branding
- Unique television screen display interface
- Display is easily accessible for monitoring on other devices such as mobile phones and computers



Air Image Sensor Overview – Testing, Clonshaugh 28.04.21 (HSE & UCD School of Mechanical and Materials Engineering & Fluid Dynamics & Mater Public Hospital
Ug/M3
1200
1000
800
600
400
200
0
2021/04/28 09:36
2021/04/28 10:48
2021/04/28 12:00
2021/04/28 13:12
2021/04/28 14:24
2021/04/28 15:36
2021/04/28 16:48
PM 1 (µg/m³)
PM 2.5 (µg/m³)
PM 10 (µg/m³)
Temperature (°C)
Humidity (% RH)

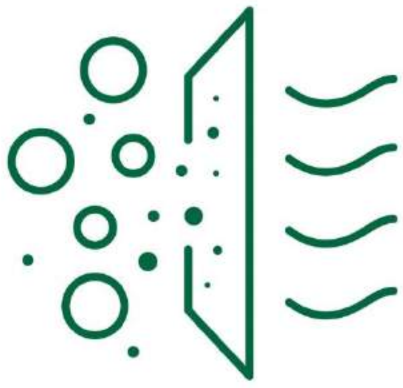
HEPA FILTERS – CERTIFICATION AND APPLICATION

WHICH INDUSTRIES ARE HEPA FILTERS USED

WHERE ARE HEPA FILTERS USED IN A TYPICAL FACILITY


Gift Shop

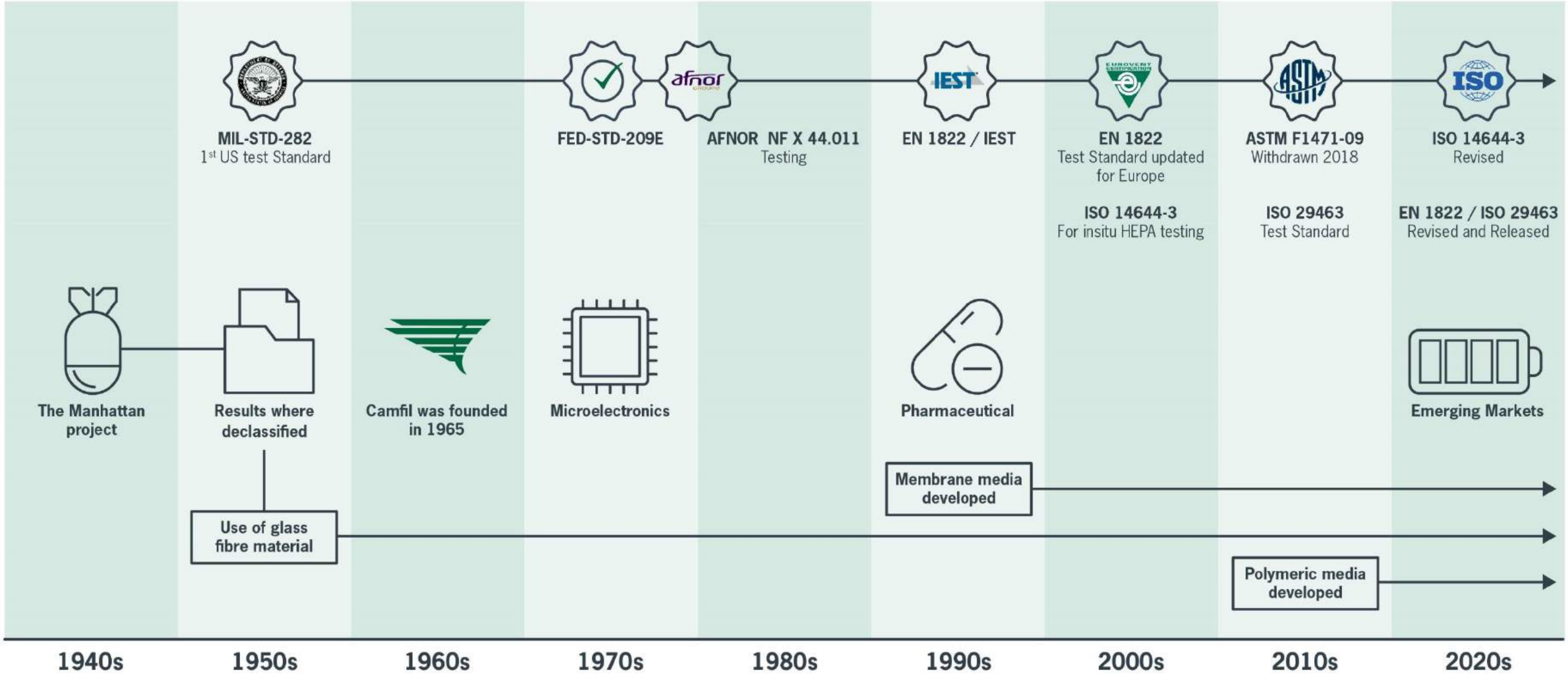
CHALLENGES FOR HEPA FILTRATION



Maintaining air cleanliness levels

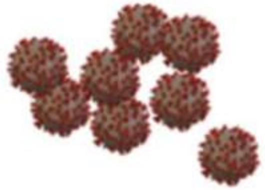
Ensuring compliance to Industry Standards

THE EVOLUTION OF HEPA FILTRATION

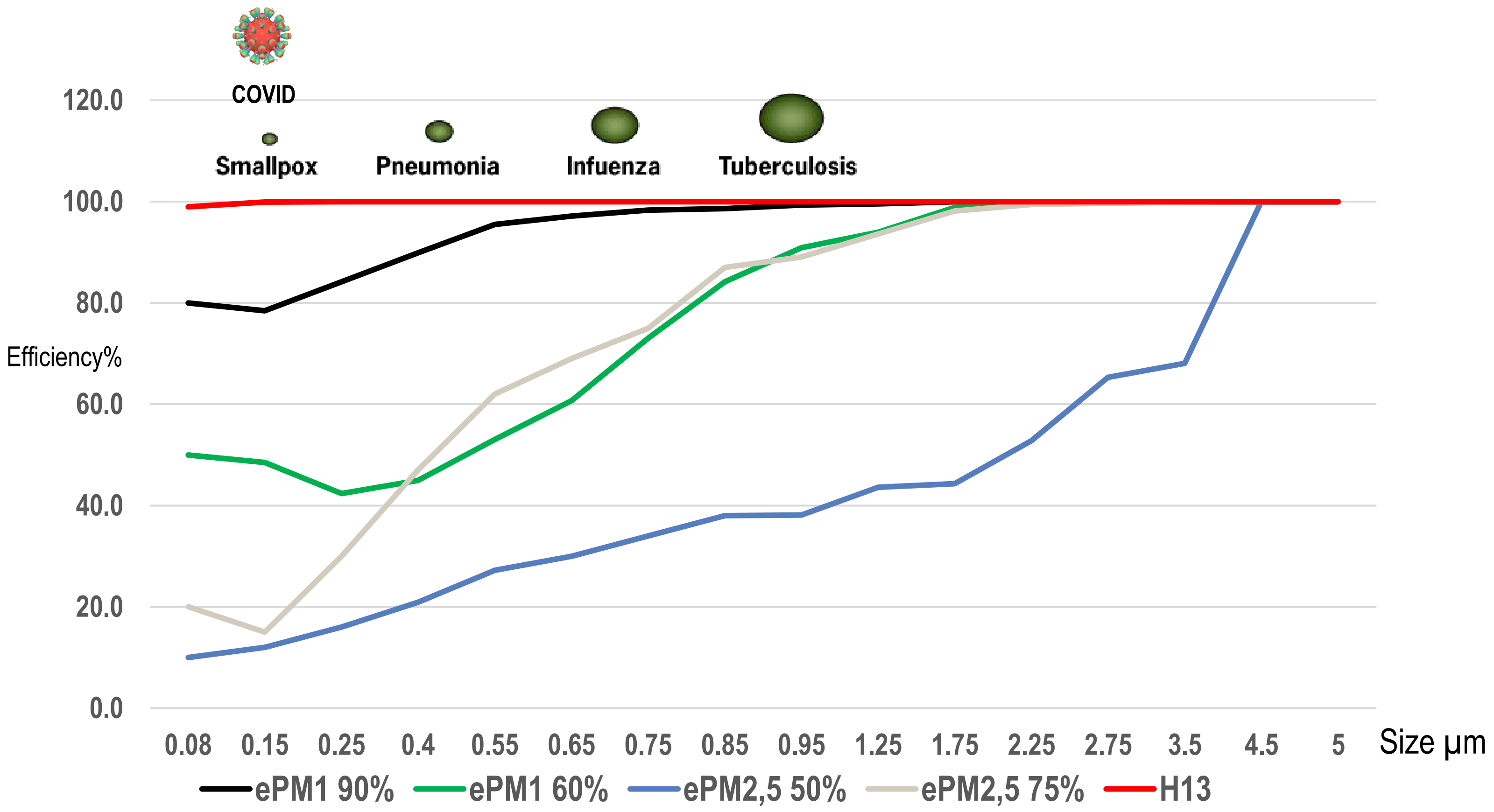


COMPARING STANDARDS & PERFORMANCE

COMPARING FILTER EFFICIENCIES

PARTICLE SIZE TEST RANGE	FRACTIONAL EFFICIENCY VALUES ACCORDING TO ISO16890-1:2016					
 Virus Particle Size Range in Micrometers (µm)	 ePM1 50% Standard Flo	 ePM1 60% Hi-Flo Bag	 ePM1 70% Opakfil	 ePM1 70% Hi-Flo Bag	 ePM1 80% Opakfil	 ePM1 85% Hi-Flo Bag
0.3 -0.4	39%	48%	62%	57%	79%	80%
0.4 -0.55	49%	57%	70%	67%	85%	87%
0.55 -0. 7	59%	67%	78%	77%	90%	93%
0.7 -1.0	72%	75%	86%	86%	95%	96%

SUMMARY FILTER CLASSES ACCORDING TO EN 1822 AND ISO 16890



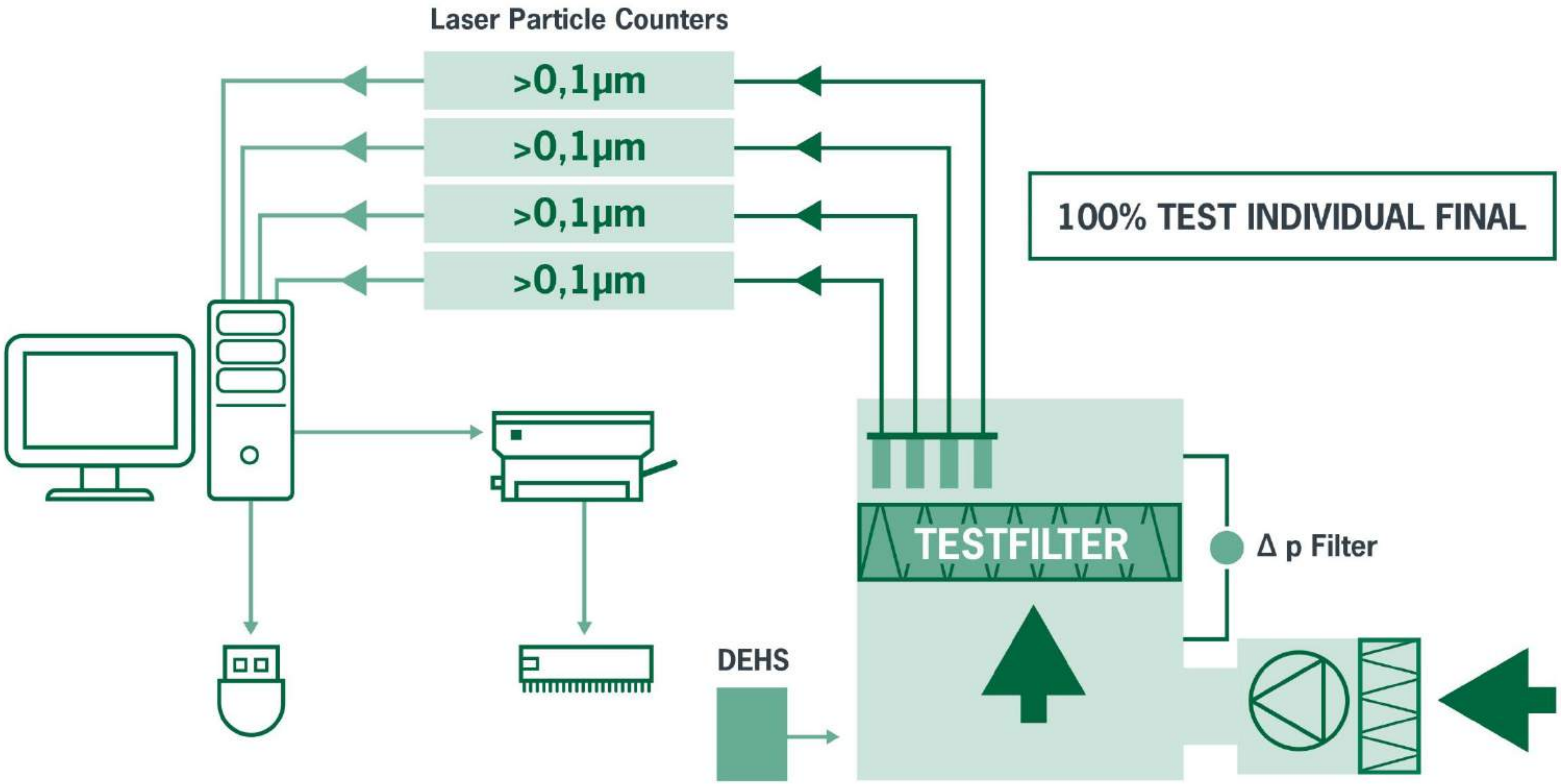


EN 1822 Classification

		Global Value	Local Value
Filter Class	Particle Size for Testing	Collection Efficiency in %	Multiple of Global Efficiency %
E10		≥ 85	
E11		≥ 95	
E12		≥ 99,5	
H13	MPPS	≥ 99,95	5
H14	MPPS	≥ 99,995	5
U15	MPPS	≥ 99,9995	5
U16	MPPS	≥ 99,99995	5
U17	MPPS	≥ 99,999995	20


The test will show you
the difference between
my Absolute HEPA-filters...

EN 1822 SCANNING RIG PRINCIPLE

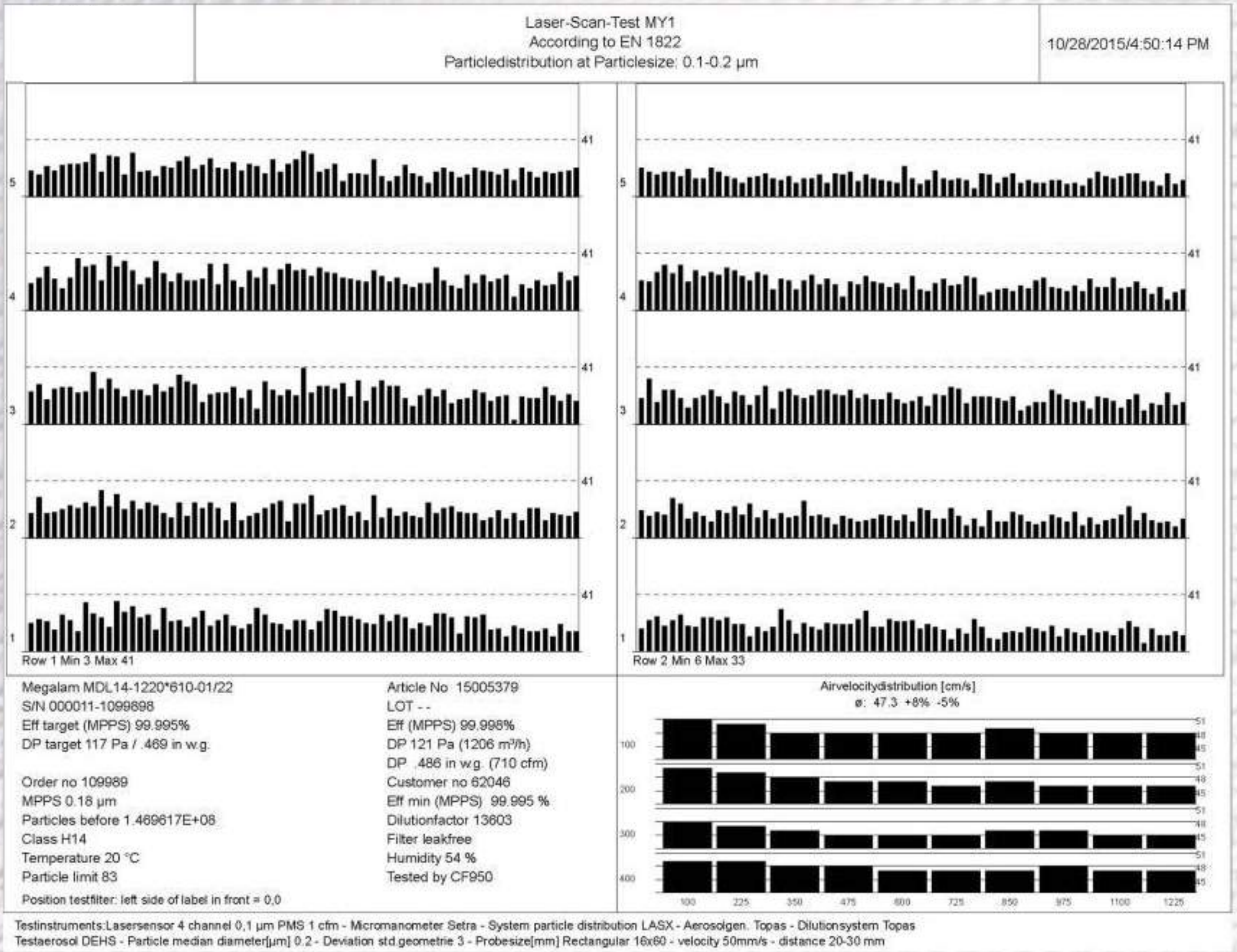


WHAT SHOULD YOU RECEIVE AS A MINIMUM ON A TEST CERTIFICATE

- Proof of conformity: Individual Scan Test certificate for your HEPA filter which includes
  - Date and Time of Test
  - Conformation of Test method
  - Details of test filter
  - Corresponding serial number with HEPA filter
  - Details of Test, conditions and equipment
  - Details on test results
  - Pressure drop
  - Minimum and maximum efficiency
  - Confirmation of leak-freeness
  - Filter class as specified by standard used

Stop accepting false efficiency test reports for HEPA filters!

Ask for indiviudal HEPA laser scan test report according to Eurovent - EN1822.



IHEEM

Institute of Healthcare Engineering and Estate Management

Republic of Ireland Branch

NEXT PRESENTATION
Thursday the 8th of July 2021
@12.00pm

IHEEM

Institute of Healthcare Engineering and Estate Management

Republic of Ireland Branch

THANK YOU

- *for your participation*

- To Our Speakers

    Mr. Brenadan Redington

    Mr. Paul Flanagan

- To the IHEEM Committee

    Stephen Walshe, James Reilly, Brendan Reddington, Damien Clarke and Pearse Douglas.

IHEEM

Institute of Healthcare Engineering and Estate Management

Republic of Ireland Branch