VENTING | Coronavirus risks are mostly up in the air - Hazards magazine https://www.hazards.org/in fections/venting.htm

Hands. Face. Space Won't cut it! Covid is in the air: Ventilate Filter/clean air Worker PPE Source Control masks Multiple layer **Control measures** TUC webinar: http://www.hazardscamp aign.org.uk/blog/managi ng-ventilation-as-acovid-safety-measurewebinar-recording-andresources

as risks are mostly up in the air



Hands, face, space. We all know the mantra. But you can't stop breathing and if the workplace air is going nowhere and is chock-full of coronavirus you'll still be at risk. Hilda Palmer of the Hazards Campaign explains the critical importance of ventilation and why it is necessary to clear the air.



AND BREATHE Carbon dioxide (CO2) monitors can give a rough indication of how well your workplace ventilation - whether it's via an open door or a full-on mechanical system - is working

Coronavirus is in the air. It spreads like smoke in tiny aerosol particles exhaled by infected individuals with every breath. The prevention three amigos of 'hands, face, space' deals with contact and droplet risks - but does not address transmission of virus-laden airborne aerosols. A microscopic, invisible virus-carrying cloud - a 'far-field aerosol' - can get you at a distance. It is likely to be the most important mode of transmission. This isn't just theory - infectious disuse experts, aerosols scientists and demiologists have established the of aerosol transmission in Covid-19

tudies, sentinel cases, super vr events, cluster outbreaks and

v experiments. withs before the UK govern-Health England and the UK SAGE scientific advisory

spread further. Aerosols can fill a room and linger in HAZARDS PUBLICATIONS LTD | PO BOX 4042 SHEFFIELD 58 2DG

panel conceded the airborne transmis-

place safety regulator the Health and

Safety Executive (HSE) was late and

remains weak and unenforced.

And specific guidance from the work-

The consequence has been hundreds

of workplace clusters each week, some

sion) or gets into the mouth and nose

rate to become smaller aerosols, and

Droplets in spit or exhaled can evapo-

via touch (fomite transmission),

sion risk (Hazards 151)

and some die (page 4).

Every breath you take

the air for seconds to hours, often after the infected person has left. They fall out of the air, are deposited on surfaces and can be recirculated by air currents. Virus concentrations can build up in indoor areas that are poorly ventilated. where workers breathe shared air for hours at a time. Aerosols persist longer in colder, drier air, an added occupational risk in jobs

like food processing (page 8). Face masks can help, but good ventilation is critical to reducing the viral load in the air. Lower loads reduce the risk of infection and the severity of infection. Effective ventilation removes stale air and brings in cooler, drier air containing more oxygen, less carbon dioxide (CO2) and water vapour and fewer microbes. The concentration of carbon dioxide in indoor air is a useful indication of how well the ventilation is functioning. Carbon dioxide increases from 0.04 per cent to 4 per cent in exhaled breath. Outside air contains 300-400 parts per million (ppm) carbon dioxide near

ground level. Indoor air at 600 to 800 ppm carbon dioxide indicates a relatively well-ventilated room. Over 1,500 ppm means very poor ventilation and action is needed. A minimum of six air changes per hour is recommended.

There is no one silver bullet that is 100 per cent effective to prevent infection from coronavirus in near- and far-field aerosols. But a combination of good ventilation, 2 metre minimum distancing and PPE all contribute to overall protection

UK rules on ventilation

An infectious person may exhale 100,000 to 10 million virus particles an hour, so effective ventilation is essential to infection prevention. UK guidance was slow to recognise this. It was as recently as 26 November 2020 when the UK business department BEIS issued updated workplace guidance, with an 'objective' recommending seeing hundreds of workers test positive "ventilation to mitigate the transmission risk of Covid-19." The BEIS guide notes: "Good ventilation can be different for areas depending SARS Cov-2, the coronavirus responsible on how many people are in there, how for Covid-19, infects a person when it is inhaled (droplet and airborne transmis-

the space is being used, and the particular layout of the area. Therefore you will tion requirements in the area you are considering."

the coronavirus (Covid-19) pandemic', an HSE guide published in December 2020, notes: "Good ventilation, together with social distancing, keeping your workplace clean and frequent handwashing, can help reduce the risk of spreading coronavirus."

The Workplace (Health, Safety and Welfare) Regulations lays down the legal ventilation requirements at work. The regulations note: "Effective and suitable provision shall be made to ensure that every enclosed workplace is ventilated by a sufficient quantity of fresh or purified air.

normally fall below 5 to 8 litres per second, per occupant. When establishing a fresh-air supply rate, consider the following factors: the floor area per person; the processes and equipment involved; whether the work is strenuous." HSE references technical guidance from the building services professional body, CIBSE.

ommends a minimum of 10 litres per second per person of outside air in offices and avoiding recirculating air. That's your benchmark.

Ventilation systems can be as simple as opening windows and doors to complex centralised Heating Air Conditioning Ventilation systems (HACV).

REDUCING THE RISKS

Follow the hierarchy of prevention

In order of priority, utilise:

Elimination

Substitution

Engineering

Controls

Controls

Find out the type of ventilation system in your workplace, how well it is performing in removing stale shared air and bringing in fresh air.

The employer should provide safety reps with information about the workplace ventilation system - is it providing the recommended air flow, is it

maintained properly, are the correct filters in use and replaced and maintained frequently? Ask for monitoring and maintenance data, including CO₂ levels. Workplace risk assessment must con-

sider all the factors affecting the risk of inhaling near- and far-field aerosols. Key factors to consider are: · Location: Outdoors less risk, indoor

workplaces higher risk, increasing with factors below.

Remove the hazard.

Working from home, furlough

workers, protect wages.

Replace the hazard. Atter the job, do it outside.

isolate the hazard.

Ventilation, filtration, disinfect

Change work practices. Distancing, screens, hand washing

A last resort, where other control do not sufficiently reduce the risks.

Occupancy: Halving occupancy is equivalent to doubling the ventilation rate, Remember, though, that aerosols can linger for minutes or hours so previous occupancy levels may create lingering risk. Infection levels: Research suggests

that around half of coronavirus trans mission could be from people with no symptoms (asymptomatic). · Proximity: 2 metres physical distancing is a rough minimum distance to avoid inhaling high concentrations of near-field aerosols or being sprayed with droplets.

Duration: The long higher the risk. · Activity: Aerosols are ex breathing and talking, m talking loudly, singing or aerobic activity.

www.

· Environment: Cooler, darker spread and persistence; higher perature and humidity shorter survival time of the virus.

. Air flow: The lower the air flow t higher the risk. Doubling ventilation rate per person can halve the risk · Masks: Face masks use can reduce

the amount of virus in the air. Hazards Campaign

» www.hazardscampaign.org.uk

www.hse.gov.uk/coronavirus

to risk assessments consider Is the ventilation system effective

Is the air flow at least 10 litres per second per person with a minimum of six air changes per hour? Is the ventilation system set for 100 per cent outdoor air to prevent

If there is no ventilation system, does natural ventilation create an unsatisfactory work environment noise, pollution) o pase a risk of spreading in Are areas with inadequate ventilation taken out of use or are we methods to redu used (eg reducing occupation

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need to consider the particular ventila-'Ventilation and air conditioning during

"The fresh-air supply rate should not

An October 2020 CIBSE update rec-



Assessing the risks

Ventilation requirements

- **People breathing in indoor space** take Oxygen out of air reducing it's level from 20% in inhaled to 16% in exhaled breath+ increase Carbon dioxide from 0.04% in inhaled air to 4% in their exhaled breath; and exhaled air contains viruses, bacteria, fungi, droplets from the lungs and airways, and is saturated with water and warm.
- Ventilation natural by windows/doors, trickle vents or HACV system is air flow in and out, it removes stale air (environmental contaminants, dust, plastic fibres/particles, VOCs, traffic pollution etc) and brings fresher, cooler, drier air containing more oxygen, less CO2 and less water vapour + microbes including Covid.
- Can use CO2 level as rough proxy for ventilation: 0.04% = 300-400 ppm CO2 outside near ground level. 600 to 800ppm, parts per million of air = well ventilated room; over 1000ppm = concern over 1,500 = take action urgently! Note other factors may affect
- Fresh/outdoor air: Optimum = 10 litres per second per person Fewer people=more fresh air p/person – half number = 2x as much ventilation per person
- **Recommended Air Changes per Hour** (ACH) per room: 6 per hour or higher 9x 10x ?
- Air Cleaners/Filtration- HEPA filters + UVC disinfection at source HVAC system or in room
- HSE advice is poor https://www.hse.gov.uk/coronavirus/equipment-and-machinery/air-conditioning-and-ventilation.htm— European REHVA, CIBSE and US ASHRAE recommendations are better https://www.ashrae.org/technical-resources/resources_ UK Govt SAGE C/te

Transmission Routes

Aerosol transmission is proven via observation, case studies, sentinel cases, cluster outbreaks +experimental studies. WHO reluctantly forced to accept it. UK Govt SAGE accepts, Guidance from HSE late + weak. It is unequivocally major method of spread.

> Traditionally defined as >5 μm and happening at close-range only (<2 m)



The origin of the 5- μ m cutoff is not clear. This cutoff is not supported by modern aerosol science. This distinction has hampered our understanding of transmission.

Adapted from http://www.phas.come.co.co/onip.poloni/onpf/v2.come.php

Kate Cole Occupational Hygienist Australia https://twitter.com/Y ouAreLobbyLud/statu s/1351455732680466 442

https://english.elpais. com/society/2020-10-28/a-room-a-barand-a-class-how-thecoronavirus-isspread-through-theair.html

Traditionally defined as <5 μm and happening mainly at long-distance (>2 m)





https://www.gov.uk/government/publications/emg-application-of-physical-distancing-and-fabric-face-coverings-in-mitigating-the-

b117-variant-sars-cov-2-virus-in-public-workplace-and-community



Size Matters:

Inhalable particles/aerosols = 100 microns (µm) & less

Over 10 microns filtered out by nose/throat

Thoracic particles = 10microns & below, gets to lungs

Respirable dust = 5 microns and below, gets deep into lungs

WHO say: **2.5 microns & less** absorbed into blood crosses blood brain barrier – **NO SAFE LEVEL**

I micron, μ m = 1 thousandth of millimetre, 1 millionth of metre.

PM10 = particle matter with diameter of 10 microns.

Nanometre = 1 billionth of a metre smaller than a virus, size of DNA strand .

Smaller particles/ aerosols can be inhaled more deeply into lungs and cause most severe infections. The more particles inhaled- viral load- the more severe the illness.

So any reduction in smaller particles in air, reduces viral load and can reduce chance of infection and the severity of illness

Figure 1: Representative behaviour of different sizes of respiratory particles and the influence of face coverings (reproduced with permission from (Milton, 2020)

Safety Reps Ventilation Checklist

- 1. Do risk assessments consider ventilation requirements?
- 2. Have safety reps been consulted on the Covid risk assessment?
- 3. Is the ventilation system effective and maintained?
- 4. Is the air flow at least 10 litres per person per sec with minimum of 6 Air Changes an Hour ?
- 5. Is the ventilation system set for 100% outdoor air to prevent recirculation, turned on 2 hours before occupation and automatic CO₂ sensor switched off or set to 400ppm?
- 6. Is there is no ventilation system, does natural ventilation create an unhealthy or uncomfortable work environment (temperature, noise, pollution) or pose risk of spreading infection?
- 7. Are areas with inadequate ventilation taken out of use or alternative methods to reduce risk used (e.g. reducing occupancy, use of upper air UVC disinfection, portable HEPA filtration units)?
- 8. Are rooms subject to no occupancy to allow contaminants to dissipate?
- 9. Are rooms cleaned regularly to reduce recirculation of any virus deposited on surfaces, adsorbed on dust?
- 10.Is the relative humidity too low and the air dry optimum is 40-70%

Summary of practical measures for building services operation

REHVA: Federation of European Heating, Ventilation and Air Conditioning Associations <u>https://www.rehva.eu/activities/covid-19-guidance</u>

1. Secure ventilation of spaces with outdoor air

2. Switch ventilation to nominal speed at least 2 hours before the building usage time and switch to lower speed 2 hours after the building usage time

3. At nights and weekends, do not switch ventilation off, but keep systems running at lower speed

4. Ensure regular airing with windows (even in mechanically ventilated buildings)

5. Keep toilet ventilation 24/7 in operation

6. Avoid open windows in toilets to assure the right direction of ventilation

7. Instruct building occupants to flush toilets with closed lid

8. Switch air handling units with recirculation to 100% outdoor air

9. Inspect heat recovery equipment to be sure that leakages are under control

10. Switch fan coils either off or operate so that fans are continuously on

11. Do not change heating, cooling and possible humidification setpoints

12. Do not plan duct cleaning for this period

13. Replace central outdoor air and extract air filters as usually, according to maintenance schedule

14. Regular filter replacement and maintenance works shall be performed with common protective measures including respiratory protection

Role of ventilation – to remove stale exhaled air and replace with fresher/outdoor air – Beware air pollution - to keep Oxygen O2 level up, remove Carbon dioxide, microbes and moisture. Ventilation can achieve dilution, dispersal, removal of virus Can add disinfection of air at ventilation system intake – use of UVC light and other methods; Filtration of air with HEPA -High Energy Particle Air - filters at intake or via portable air cleaning units in room, or attached to intake/extraction fans, at suitable for size + number of people; Air Conditioning cools air and recirculates so should be switched off but maybe OK if filtering/disinfecting ait; Desk, floor fans recirculate air so don't use.



Figure 2. 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 amount 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.



Fig. 1. Single-zone mass-balance model of virus transport via exhaled aerosols. Image used under a creative commons license¹.

Location Outdoors less risk, indoor workplaces higher risk, increasing with factors below.

Occupancy Halving occupancy is equivalent to doubling the ventilation rate. Remember, though, that aerosols can linger for minutes or hours, so previous occupancy levels may create lingering risk.

Infection levels Research suggests that around half of coronavirus transmission could be from people with no symptoms (asymptomatic).

Proximity 2 metres physical distancing is a rough minimum distance to avoid inhaling high concentrations of near-field aerosols or being sprayed with droplets.Duration The longer spent in a space with poor ventilation, the higher the risk.

Activity Aerosols are exhaled when breathing and talking. Loud talking, singing, aerobic activity result in more potentially virus-loaded aerosols being exhaled.

Environment Cooler, darker and drier conditions assist aerosol spread and persistence; higher temperature and humidity shorten the survival time of the virus.

Air flow The lower the air flow the higher the risk. Doubling the ventilation rate per person can halve the infection risk.

Masks Face masks use can reduce the amount of virus in the air and is particularly effective if they are used 'properly' and by all occupants of the room

Type and level of group activity	Low occupancy			High occupancy		
	Outdoors and well ventilated	Indoors and well ventilated	Poorly ventilated	Outdoors and well ventilated	Indoors and well ventilated	Poorly ventilated
Wearing face cove	erings, contact for sh	ort time				
Silent						
Speaking						
Shouting, singing						
Wearing face cove	erings, contact for pr	olonged time				
Silent						
Speaking		*		*		
Shouting, singing						
No face coverings	s, contact for short ti	me				
Silent						
Speaking						
Shouting, singing						
No face coverings	s, contact for prolong	ged time				
Silent						
Speaking						
Shouting, singing						

Risk matrix – work in progress From: https://www.bmj.com/content/370/bmj.m3223

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Risk Control Hierarchy



Non PPE Face Masks do work- in addition to other measures + especially for airborne aerosol transmission but they vary in efficiency and do leak



(c)

(a)

(b)

Medical mask

N95/FFP2 mask without valve

Face shield/visor





and the second s



Beautiful visualization by Philo Bluyssen's team showing imp. is to control leakage <u>https://youtube.com/watch?v=</u> <u>mJ81IBTMvcU&feature=youtu.b</u> <u>e...</u> Surgical-type mask terrible. Good-fitting cloth mask at the end has the least leakage.

Experts tell HSE to step up and do its job

The HSE should be 'restored the wherewithal' to fulfil its mandate and should get on and do its job, occupational medicine experts have said. In correspondence published in the Lancet on 23 January, the academics from De Montfort, Manchester and Nottingham university note: "The HSE needs to step up in this pandemic, independently of political influence, and to firmly enforce occupational hygiene measures for source control, including regular staff testing, segregation, and ventilation." In an implied criticism of the regulator's relaxed approach to airborne risks posed by the virus, they add "the HSE should apply precautionary principles with regards to the proliferating evidence for aerosol transmission of severe acute respiratory syndrome coronavirus." The article also questions whether the regular based some of its strategy on political expediency rather than good practice, leaving workers at avoidable risk. The authors note: "The HSE should recognise research, such as its own showing the marked superiority of filtering facepiece respirators (eg, FFP3) over surgical masks, and should re-assert its own guidance to use such respirators as personal protective equipment (PPE) for workers. Early in the pandemic, the HSE adopted a risk-adapted management strategy and tolerated less stringent PPE requirements, perhaps because of the inadequate, depleted, and neglected state of the national stockpile of PPE." They conclude: "Several months have since elapsed, and billions of pounds of taxpayers' money has been spent amassing huge stocks of PPE. It is not clear why the HSE is still not recommending respirators as PPE for public transport workers and other public-facing occupations, as well as in health and social care in situations where control at source, barriers, and ventilation are not adequate." Unions have called for extended use of the more protective FFP3 respirators (Risks 980). Raymond M Agius, Denise Kendrick, Herb F Sewell, Marcia Stewart, John FR Robertson. Reaffirming health and safety precautionary principles for COVID-19 in the UK, The Lancet, volume 397, issue 10271, page 274, 23 January 2021. doi: https://doi.org/10.1016/S0140-6736(21)00088-X

HSE in the pandemic: astoundingly invisible or making a difference? | Construction News

https://www.constructionnews.co.uk/health-and-safety/the-hse-in-the-pandemic-astoundingly-invisible-or-making-adifference-26-01-2021/



Useful modelling tools that show how changing different factors affect ventilation allows visual comparison of the risks factors and the effects of control measures and mitigations: <u>https://www.zeit.de/wissen/gesundheit/2020-11/coronavirus-aerosols-infection-risk-hotspot-interiors?utm_referrer=https%3A%2F%2Ft.co%2F;</u> Airborne.cam - evaluate COVID-19 risk of infection from airborne transmission <u>https://airborne.cam/</u> <u>https://indoor-covid-safety.herokuapp.com/apps/advanced</u>