REHVA
Federation of European Heating, Ventilation and Air Conditioning Associations

REHVA COVID-19 guidance document, March 17, 2020 (updates will follow as necessary)

How to operate and use building services in order to prevent the spread of the coronavirus disease (COVID-19) virus (SARS-CoV-2) in workplaces

Introduction

In this document REHVA summarizes advice on the operation and use of building services in areas with a coronavirus disease (COVID-19) outbreak, in order to prevent the spread of COVID-19 depending on HVAC or plumbing systems related factors. Please read the advice below as *interim* guidance; the document may be complemented with new evidence and information when it becomes available.

The suggestions below are meant as an addition to the general guidance for employers and building owners that is presented in the WHO document 'Getting workplaces ready for COVID-19'. The text below is intended primarily for HVAC professionals and facility managers, but may be useful for e.g. occupational and public health specialists.

In the following the building related precautions are covered and some common overreactions are explained. The scope is limited to commercial and public buildings (e.g. offices, schools, shopping areas, sport premisies etc) where only occasional occupancy of infected persons is expected; hospital and healthcare facilities (usually with a larger concentration of infected people) are excluded.

Disclaimer:
This REHVA document is based on best available evidence and knowledge, but in many aspects' corona virus (SARS-CoV-2) information is so limited or not existing that previous SARS-CoV-1 evidence[1] has been utilized for best practice recommendations. REHVA excludes any liability for any direct, indirect, incidental damages or any other damages that would result from, or be connected with the use of the information presented in this document.

[1] In the last two decades we are confronted with three coronavirus disease outbreaks: (i) SARS in 2003-2004 (SARS-CoV-1), (ii) MERS in 2012 (MERS-CoV) and Covid-19 in 2019-2020 (SARS-CoV-2). In the present document our focus is on the last aspect of SARS-CoV-2 transmission. When it is referred to the SARS outbreak in 2003-2004 we will use the name of SARS-CoV-1 virus at that time.

Transmission routes

Important for every epidemic are the transmission routes of the infectious agent. In relation to COVID-19 the standard assumption is that the following two transmission routes are dominant: via large droplets (droplets/particles emitted when sneezing or coughing or talking) and via surface (fomite) contact (hand-hand, hand-surface etc.). A third transmission route that is gaining more attention from the scientific community is the faecal-oral route.

The faecal-oral transmission route for SARS-CoV-2 infections is implicitly recognized by WHO, see their latest technical briefing of March 2, 2020. In this document they propose as precautionary measure to flush toilets with closed lid. Additionally, they suggest avoiding dried-out drains in floors and other sanitary devices by regularly adding water (every 3 weeks depending on climate) so that the water seal works properly. This is in line with an observation during the SARS 2003-2004 outbreak: open connections with sewage systems appeared to be a transmission route in an apartment building in Hong Kong (Amoy Garden). It is known that flushing toilets are creating plumes containing droplets and droplet residue when toilets are flushed with open lids. And we know that SARS-CoV-2 viruses have been detected in stool samples (reported in recent scientific papers and by the Chinese authorities). In addition, a comparable incident was recently reported in an apartment complex (Mei House). Therefore, the conclusion is that the faecal-oral transmission routes can't be excluded as transmission route.

Via air there are two exposure mechanisms:

1. Close contact transmission through large droplets (> 10 microns), which are released and fall to surfaces not further than about 1-2 m from the infected person. Droplets are formed from coughing and sneezing (sneezing forms many more particles typically). Most of these large droplets fall on nearby surfaces and objects – such as desks and tables. People could catch the infection by touching those contaminated surfaces or objects; and then touching their eyes, nose or mouth. If people are standing within 1-2 meter of an infected person, they can catch it directly by breathing in droplets sneezed or coughed out or exhaled by them.
2. Airborne transmission through small particles (< 5 microns), which may stay airborne for hours and can be transported long distances. These are also generated by coughing and sneezing and talking. Small particles (droplet nuclei or residue) form from droplets which evaporate (usually within milliseconds) and desiccate. The size of a coronavirus particle is 80-160 nanometre[2] and it remains active at common indoor conditions up to 3 hours in indoor air and 2-3 days on room surfaces (unless there is specific cleaning). Such small virus particles stay airborne and can travel long distances carried by airflows in the rooms or in the extract air ducts of ventilation systems. Airborne transmission has caused infections of SARS-CoV-1 in the past; currently there is no reported evidence yet specifically for Corona disease (COVID-19) infection via this route. There is also no reported data or studies to rule out the possibility of the airborne-particle route. One indication for this: Corona virus SARS-CoV-2 has been isolated from swabs taken from exhaust vents in rooms occupied by infected patients. This mechanism implies that keeping 1-2 m distance from infected persons might not be enough and increasing the ventilation is useful because of removal of more particles.

[2] 1 nanometer = 0.001 micron

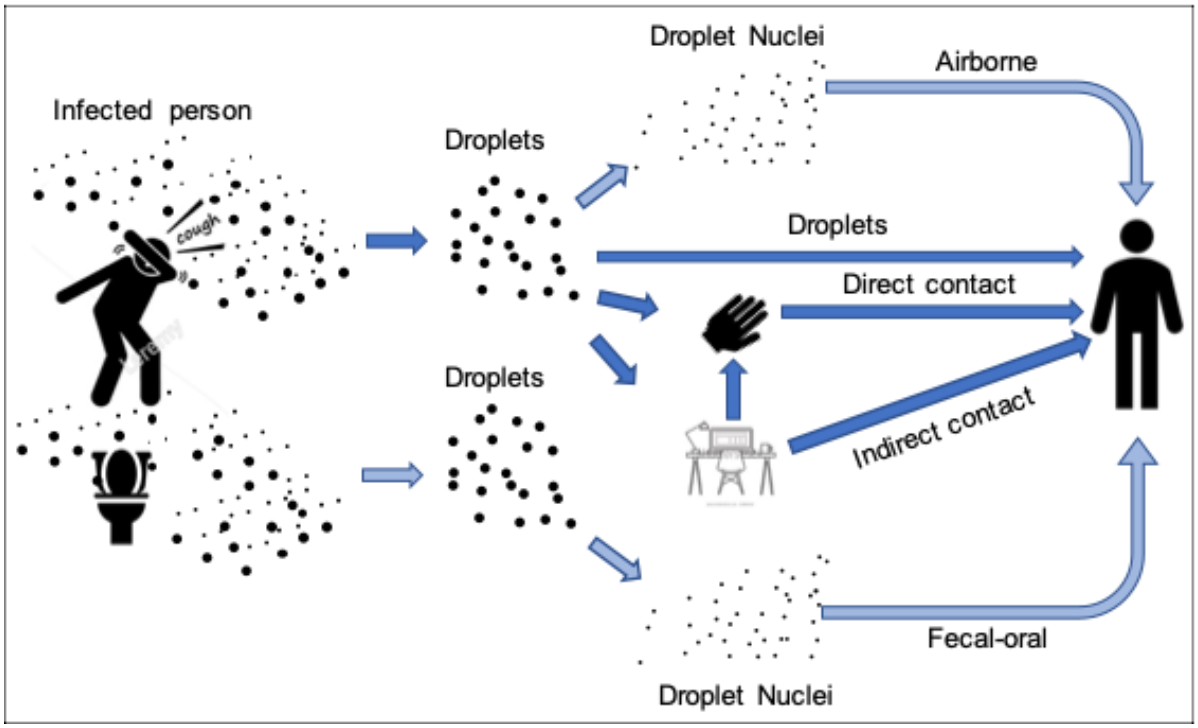

Figure 1. WHO reported exposure mechanisms of COVID-19 SARS-CoV-2 droplets (dark blue colour). Light blue colour: airborne mechanism that is known from SARS-CoV-1 and other flu, currently there is no reported evidence specifically for SARS-CoV-2 (figure: courtesy Francesco Franchimon).

With SARS-CoV-2 the airborne route – infection through exposure to droplet nuclei particles – has not been demonstrated but may exist when certain conditions are met (i.e. opportunistic airborne) according to Chine national Health Commission (unpublished result).

Conclusion in relation to the airborne transmission route:
At this date we need all efforts to manage this pandemic from all fronts. Therefore REHVA proposes, especially in 'hot spot' areas to use the ALARA principle (As Low As Reasonably Achievable) and to take a set of measures that help to also control the airborne route in buildings (apart from standard hygiene measures as recommended by WHO, see the 'Getting workplaces ready for COVID-19' document).

Practical recommendations for building services operation

Increase air supply and exhaust ventilation
In buildings with mechanical ventilation systems extended operation times are recommended. Change the clock times of system timers to start ventilation a couple of hours earlier and switch off later than usual. Better solution is even to keep the ventilation on 24/7, possibly with lowered (but not switched off) ventilation rates when people are absent. Considering a springtime with small heating and cooling needs, the recommendations above have limited energy penalties, while they help to remove virus particles out of the building and to remove released virus particles from surfaces.
The general advice is to supply as much outside air as reasonably possible. The key aspect is the amount of fresh air supplied per person. If, due to smart working utilization, the number of employees is reduced, do not concentrate the remaining employees in smaller areas but maintain or enlarge the spacing among them in order to foster the ventilation cleaning effect.
Exhaust ventilation systems of toilets should always be kept on 24/7, and make sure that under-pressure is created, especially to avoid the faecal-oral transmission.

Use more window airing

General recommendation is to stay away from crowded and poorly ventilated spaces. In buildings without mechanical ventilation systems it is recommended to actively use operable windows (much more than normally, even when this causes some thermal discomfort). Window airing then is the only way to boost air exchange rates. One could open windows for 15 min or so when entering the room (especially when the room was occupied by others beforehand). Also, in buildings with mechanical ventilation, window airing can be used to further boost ventilation.

Open windows in toilets with passive stack or mechanical exhaust systems may cause a contaminated airflow from the toilet to other rooms, implying that ventilation begins to work in reverse direction. Open toilet windows then should be avoided. If there is no adequate exhaust ventilation from toilets and window airing in toilets cannot be avoided, it is important to keep windows open also in other spaces in order to achieve cross flows throughout the building.

Humidification and air-conditioning have no practical effect

Transmission of some viruses in buildings can be limited by changing air temperatures and humidity levels. In the case of COVID-19 this is unfortunately not an option as the SARS-CoV-2 virus is quite resistant to environmental changes and is susceptible only for a very high relative humidity above 80% and a temperature above 30 ˚C, which are not attainable and acceptable in buildings for other reasons (e.g. thermal comfort).

Small droplets under interest (0.5 – 10 micron) will evaporate fast under any relative humidity (RH) level. Nasal systems and mucous membranes are more sensitive to infections at very low RH of 10-20 %, and this is the reason for which some humidification in winter is sometimes suggested (up to a level of about 30%). This indirect need for humidification in the COVID-19 case is not relevant however given the incoming climatic conditions (from March onwards we expect indoor RH higher than 30% in all European climates without humidification).

Thus, there is no need to change humidification systems' setpoints. Considering the springtime that is about to start, these systems should not be in operation anyhow.

Heating and cooling systems can be operated normally as there are no direct implications on COVID-19 spread. Usually, any adjustment of setpoints for heating or cooling systems is not needed.

Safe use of heat recovery sections

Under certain conditions virus particles in extract air can re-enter the building. Heat recovery devices may carry over virus attached to particles from the exhaust air side to the supply air side via leaks. In rotary heat exchangers (including enthalpy wheels) particles deposit on the return air side of the heat exchanger surface after which they might be resuspended when heat exchanger turns to the supply air side. Therefore, it is recommended to (temporarily) turn off rotary heat exchangers during SARS-CoV-2 episodes.

If leaks are suspected in the heat recovery sections, pressure adjustment or bypassing can be an option in order to avoid a situation where higher pressure on extract side will cause air leakages to supply side.

Virus particle transmission via heat recovery devices is not an issue when a HVAC system is equipped with a twin coil unit or another heat recovery device that guarantees 100% air separation between return and supply side.

No use of recirculation

Virus particles in return ducts can also re-enter a building when centralized air handling units are equipped with recirculation sectors. It is recommended to avoid central recirculation during SARS-CoV-2 episodes: close the recirculation dampers (via the Building Management System or manually). In case this leads to problems with cooling or heating capacity, this has to be accepted because it is more important to prevent contamination and protect public health than to guarantee thermal comfort.

Sometimes air handling units and recirculation sections are equipped with return air filters. This should not be a reason to keep recirculation dampers open as these filters normally do not filter out particles with viruses effectively since they have standard efficiencies and not HEPA efficiencies.
When possible, decentralized systems such as fan coil units that use local recirculation, also should be turned off to avoid resuspension of virus particles at room level (esp. when rooms are used normally by more than one occupant). Fan coil units have coarse filters which practically do not filter out particles with viruses. If not possible to turn off, these units are to be included into cleaning campaigns, because they might collect particles as any other surface in the room.

Duct cleaning has no practical effect

There have been overreactive statements recommending to clean ventilation ducts in order to avoid SARS-CoV-2 transmission via ventilation systems. Duct cleaning is not effective against room-to-room infection because the ventilation system is not a contamination source if above guidance about heat recovery and recirculation is followed. Viruses attached to small particles will not deposit easily in ventilation ducts and normally will be carried out by the air flow anyhow. Therefore, no changes are needed to normal duct cleaning and maintenance procedures. Much more important is to increase fresh air supply, avoid recirculation of air according to the recommendations above.

Change of outdoor air filters is not necessary

In COVID-19 context, it has been asked should the filters to be replaced and what is the protection effect in very rare occasions of outdoor virus contamination, for instance if air exhausts are close to air intakes. Modern ventilation systems (air handling units) are equipped with fine outdoor air filters right after the outdoor air intake (filter class F7 or F8[3] or ISO ePM1) which filtrate well particulate matter from outdoor air. The size of a coronavirus particle of 80-160 nm (PM0.1) is smaller than the capture area of F8 filters (capture efficiency 65-90% for PM1), but many of such small particles will settle on fibres of the filter by diffusion mechanism. SARS-CoV-2 particles also aggregate with larger particles which are already within the capture area of filters. This implies that in rare cases of virus contaminated outdoor air, fine outdoor air filters provide a reasonable protection for a low concentration and occasionally spread viruses in outdoor air.
From the filter replacement perspective, normal maintenance procedures can be used. Clogged filters are not a contamination source in this context, but they reduce supply airflow which has a negative effect on indoor contaminations itself. Thus, filters must be replaced according to normal procedure when pressure or time limits are exceeded, or according to scheduled maintenance. In conclusion, we do not recommend changing existing outdoor air filters and replace them with other type of filters nor do we recommend changing them sooner than normal.

Room air cleaners can be useful in specific situations

Room air cleaners remove effectively particles from air which provides a similar effect compared to ventilation. To be effective, air cleaners need to have at least HEPA filter efficiency. Unfortunately, most of attractively priced room air cleaners are not effective enough. Devices that use electrostatic filtration principles (not the same as room ionizers!) often work quite well too. Because the airflow through air cleaners is limited, the floor area they can effectively serve is normally quite small, typically less than 10 m^2. If one decides to use an air cleaner (again: increasing regular ventilation often is much more efficient) it is recommended to locate the device close to the breathing zone. Special UV cleaning equipment to be installed for the supply air or room air treatment is also effective as killing bacteria and viruses but this is normally only a suitable solution for the equipment for health care facilities.

[3] An outdated filter classification of EN779:2012 which is replaced by EN ISO 16890-1:2016, Air filters for general ventilation - Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM).

Toilet lid use instructions

If toilet seats are equipped with lids it is recommended to flush the toilets with closed lids in order to minimize the release of droplets and droplet residues from plumes in the air. It is important that water seals work all time. Therefore, organise that building occupants are instructed to use the lids.

Feedback

If you are specialist in the issues addressed in this document and you have remarks or suggestions for improvements, feel free to contact us via info@rehva.eu. Please mention 'COVID-19 interim document' as subject when you email us.

Colophon

This document was prepared by a group of REHVA volunteers in the period March 6-15th 2020. Members of the expert group are:

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Literature

This document is partly based on a literature survey, the scientific papers and other documents that were used can be found in this document:
https://www.rehva.eu/fileadmin/user_upload/REHVA_COVID-19_guidance_document_Bibliography.pdf