

Organisers and administrators responsible for gatherings and critical infrastructure settings in confined spaces should ensure that all relevant measures and controls are in place or followed, and also provide guidance material to participants regarding the application of the preventive measures

1. Control of COVID-19 sources in closed spaces

To avoid the direct transmission of SARS-CoV-2 and subsequent potential airborne transmission in closed spaces in which people are present for significant durations, it is essential that the guidance is followed, which are outlined in documents such as ECDC's guidance for discharge and ending of isolation of people with COVID-19 [43]. These include that COVID-19-positive people, people with COVID-19-related symptoms and people in quarantine must not stay in closed spaces together with other people.

In the enclosed spaces of vehicles, it is also essential to adhere to the guidance as outlined in guidance documents from ECDC in collaboration with other relevant EU agencies:

- COVID-19 Rail Protocol: Recommendations for safe resumption of railway services in Europe, 21 July 2020 [44];
- COVID-19 Aviation Health Safety Protocol: Guidance for the management of airline passengers in relation to the COVID-19 pandemic, issue 2, 1 July 2020 [45];
- EU guidance for cruise ship operations, 27 July 2020 [46].

2. 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 [2]. 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 [1,6,32,33,34].

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. Advice on these topics can be found in the documents referenced in this guidance [2,33,38].

When it is not possible to measure the ventilation rate, measuring carbon dioxide air levels can be considered, especially in naturally ventilated rooms, as a surrogate of the sufficiency of ventilation. Technical guidelines recommend that the carbon dioxide concentration is kept below 800 to 1 000 ppm to ensure sufficient ventilation [2].

Energy-saving settings, such as demand-controlled ventilation in central HVAC systems controlled by a timer or CO₂ detectors, should be assessed for their possible impact on risks of transmission. Consideration should also be given to extending the operating times of HVAC systems before and after the regular period [1,2,39].

Direct air flow should be diverted away from groups of individuals to avoid the dispersion of SARS-CoV-2 from infected persons and transmission to other persons. For example, in supermarkets, cashiers and customers have different levels of mobility and durations of occupancy. As a general principle, mechanical ventilation should be arranged so that it minimises the direction of sustained air flow towards stationary persons.

Building administrators should, with the assistance of their technical/maintenance teams, explore options to avoid the use of air recirculation as much as possible [1,2,39]. They should consider reviewing their procedures for the use of recirculation in HVAC systems based on information provided by the manufacturer or, if unavailable, seeking advice from the manufacturer.

It is not recommended to change heating set points, cooling set points and possible humidification set points of HVAC systems as a measure to reduce potential SARS-CoV-2 transmission [2,33].

The use of stand-alone air cleaning devices equipped with an HEPA filter or a filter with comparable efficiency level can be considered, especially in spaces in which optimal ventilation is impossible. Such 'room air cleaners', however, usually only cover small areas and need to be placed close to the people occupying the room [2]. UVGI devices, either in the ducts of HVAC systems or placed sufficiently high in rooms, can also be considered, but they should be shielded from direct vision due to the risk of causing cataracts [47]. Stand-alone air cleaning devices and UVGI devices can have a role in settings where central HVAC systems are not capable of increasing the air exchange or reducing the re-circulation of air.

The technical specifications regarding the logistical arrangement of closed spaces, including the physical placement of HVAC systems, need to be informed by scientific evidence and technical expertise, so as to