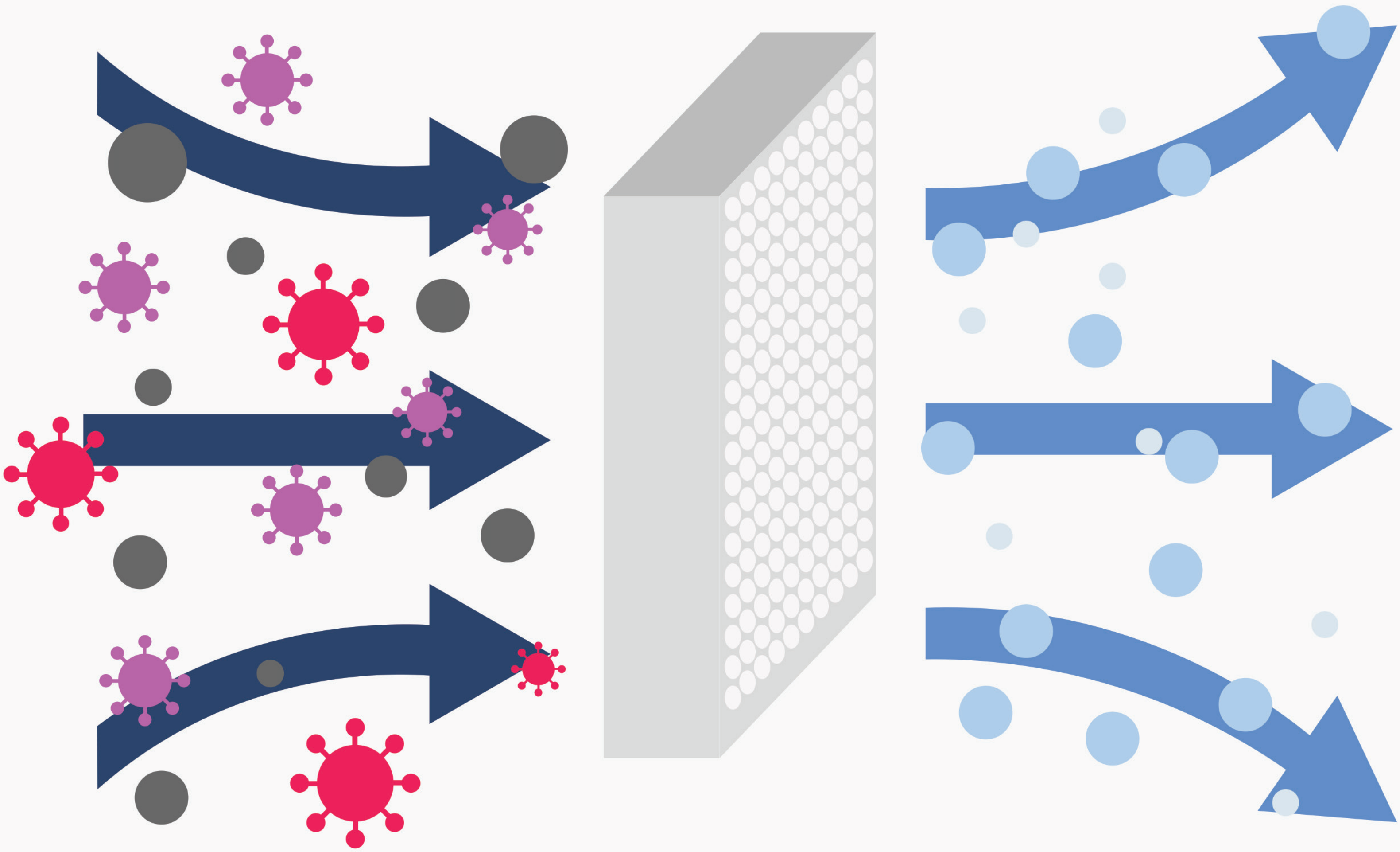
SAFER INDOOR AIR



Core Recommendations for Safer Indoor Air

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EXECUTIVE SUMMARY

In spring 2022, the Ontario Society of Professional Engineers (OSPE) formed the **Indoor Air Quality (IAQ) Advisory Group**, responding to the need for evidence-based guidance around indoor air quality and airborne transmission of COVID-19. COVID-19 is primarily transmitted when airborne particles (aerosols) that contain the virus are emitted by an infected person and are inhaled by another person. Removing these airborne particles from the air can prevent exposure and infection. This underscores the vital importance of including engineers and other building science and air quality experts in the continued response to COVID-19.

As a first step, OSPE'S IAQ Advisory Group is releasing six recommendations that all businesses and organizations can implement to provide safer indoor air in their facilities. These recommendations set clear and achievable targets for clean air in all buildings, and if implemented, will create safer indoor environments and make a significant contribution to protecting all Canadians from the spread of COVID-19.

Additional details and guidance are shared following the six high level recommendations.

- **Mitigation of Airborne Disease Transmission:** Target a minimum of six air changes per hour in occupied indoor spaces using any combination of ventilation, filtration, and ultraviolet germicidal irradiation systems.

- **Ventilation:** Bring buildings into compliance with current ventilation standards established by ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers) [1] and the Canadian Standards Association (CSA) [2] confirmed through CO2 monitoring.

- **Filtration:** Upgrade filters in air handling units to MERV-13 or higher where possible, or use a portable HEPA filter or DIY CR box in each occupied space when air pollution is a concern.

- **Ultraviolet Germicidal Irradiation (UVGI):** Use upper room UVGI systems installed by qualified professionals in health care settings and congregate living settings. Consider its use in high-risk settings and places with high occupant density.

- **Avoiding Additive Air Cleaning and Alternative Methods:** Do not use additive air cleaning methods or similar products, such as ionization, until there is a standardized way to ensure their safety and effectiveness.

- **Transparency and Public Education:** Share information about your facility's air quality with occupants including sharing the strategies you are using to ensure safe indoor air and install CO2 monitors with readable displays.

TECHNICAL GUIDANCE AND SUPPORTING DOCUMENTS

1. Mitigation of Airborne Disease Transmission

- Buildings should achieve a minimum of six air changes per hour (ACH) in occupied spaces.
    - This is consistent with commonly used values for air quality in ASHRAE 170-2021, general health care settings in CSA Z317.2-2019, and CDC recommendations for existing healthcare facilities. [1, 2, 3]
    - This can be achieved through a combination of ventilation, filtration or UVGI.
    - For rooms with higher ceilings:
        - Building managers can limit ceiling height to 2.7 m or 9' above floor level(s) when calculating the volume of the room and the required amount of clean air to be supplied each hour, even in rooms with a greater ceiling height.
        - Consider ceiling fans to mix the air in the space.

- Demand control ventilation and flushing recommendations for airborne disease mitigation:
    - Running equipment during unoccupied hours is not required if there are at least six hours between occupancies, as virus concentrations naturally reduce over time.
    - Reducing ventilation under partial occupancy (demand control ventilation) should be discontinued.
    - During generally occupied hours within a building, ventilation should remain on to allow spaces to be flushed between occupied periods (known as "occupied standby mode"). This may include, for example, classrooms in between class lectures, or movie theatres in between showings. When using occupied standby mode, provide three air changes post-occupancy before stopping ventilation. A default duration can be set to two hours, but calculating the rate of clean air provided can lead to shorter flushing times, saving energy.

2. Ventilation

- Buildings ventilation rates should be brought in line with current applicable ventilation standards:
    - ASHRAE 62.1-2022 applies to non-residential buildings and non-healthcare facilities. [4]
    - ASHRAE 62.2-2022 applies to residential buildings. [5]
    - CSA Z317.2-2019 applies to healthcare facilities, including hospitals, doctors' offices and long-term care facilities. [2]

- Compliance with ventilation requirements can be verified through monitoring CO2. See OSPE calculator for expected CO2 concentrations in various settings. [6]

- Ventilation can be improved using the following measures:
    - Ensuring fans on thermostats are set to "on" and not "auto" while occupied
    - Increasing outdoor air percentage for systems with recirculated air
    - Increasing air flow to the room within design limits of variable air volume systems
    - Using windows and doors for natural ventilation when weather permits (and training occupants to ensure this is done)
    - Installing a fan exhausting air out the window to increase the airflow rate (when doing this, ensure there is an opening - e.g., a separate open window - in the same space to allow the outdoor air to replace the exhausted air)

- When replacing HVAC units that have recirculated air and are not sufficient for ASHRAE standard 62.1-2022, replace with a unit that has energy recovery and can bring in more outdoor air with minimal impact on energy consumption
- Installing or upgrading mechanical ventilation in buildings or spaces that are under-ventilated

- Attempts to increase ventilation should not:
  - Override thermal comfort requirements in ASHRAE 55-2020 [7]
  - Compromise the safety of the HVAC equipment (e.g. freeze heating coils)
  - Exceed the design limitations of the system (e.g., supply air at too high a speed through the duct)

- Most spaces do not have directional airflow. When directional airflow is not required, promote the mixing of air in the space. This can be done using the following measures:
  - Use of standalone portable HEPA filters or DIY Corsi-Rosenthal Boxes [8, 9]
  - Use of fans, including ceiling fans (fans that discharge air vertically are preferable to fans that discharge air horizontally)
  - Avoid creating airflow patterns between occupants

- School bus ventilation can be improved with the following measures: [10]
  - Open hatches with the exhaust fan on
  - Use the defroster on fresh setting as high as possible
  - Open windows as much as possible weather permitting (even several windows opened 5 cm can have a significant impact)
  - Educate drivers on implementing these strategies
  - Bus companies and schools should have policies to ensure these methods are implemented.

3. Filtration

- Filtration is particularly important in places where particulate matter is a known issue, such as:
  - Areas with poor outdoor air quality (e.g., wildfire smoke, adjacent to major highway, factory, construction site) [11]
  - Areas with fine particulate matter pollution (smog)
  - Areas where occupants report allergic symptoms
  - Areas where the air handling unit intake is adjacent to a location with high particulate matter concentration (e.g., parking lot)

- Filtration can be used to remove infectious aerosols from the air by:
  - Upgrading the filters in air handling units to filters that are rated at least MERV-13;
  - Using stand-alone portable HEPA filters, or; [8]
  - Using DIY Corsi-Rosenthal boxes [9]

- When changing the filter type on an air handling unit:
  - If the filter has a higher pressure drop than ones previously used, ensure it does not restrict the airflow rate.
  - Filters should be monitored for dust loading to ensure airflow rate is not restricted.
  - Filters should be well-fitted to the filter holder to ensure there is no air bypassing the filters.

- Stand-alone portable HEPA filters should be selected to provide the required clean air delivery rate at a noise level that is appropriate for the occupants.

4. Ultraviolet Light Germicidal Irradiation

- Ultraviolet Light Germicidal Irradiation (UVGI) uses ultraviolet light to inactivate microorganisms such as bacteria, viruses, and fungal spores. [12, 13]

- Upper room UV systems use fixtures to expose upper rooms to UV radiation while limiting the dose to a safe level for occupants in the lower room. These systems can be especially effective at mitigating airborne disease transmission, and should be considered in the following places:
    - Areas with high occupant density or high risk of spread. (These may include lecture halls, multiuse assemblies, cafeterias, gyms, transportation waiting areas, places of religious worship, casinos, spectator areas, bars, cocktail lounges, and food processing plants.)
    - Areas with at-risk populations, including all healthcare facilities and congregate living settings. (These may include long term care facilities, retirement homes, homeless shelters, prisons, hospitals, doctors' offices, and all other healthcare settings.)
    - Upper room UV systems can be used in other locations like schools, offices, and restaurants.

- Upper room UV devices should comply with local health and safety standards and regulations. Systems should be designed, installed, and tested by a qualified HVAC professional or a reputable UV-system manufacturer.

- Ultraviolet light can also be used against COVID-19 in the following ways:
    - In air handling units to limit microbial growth on the coils. (These systems are not designed to be effective at disinfecting the air from airborne pathogens.)
    - In air handling units in the supply duct. (These systems should be designed and sized in accordance with ASHRAE standard 185.1.) [14]
    - Portable stand-alone UV air cleaning devices. (These should be purchased from a reputable company.)

- Far-UV systems use a specific wavelength of UV light that can be directly exposed to people in an occupied room. Far-UV is still a relatively new technology that has shown signs of being safe and effective in laboratory settings but should undergo further study, including in non-laboratory settings before widespread implementation. [15, 16] When more extensive evidence of safety and effectiveness is available, far-UV systems may be effective alternatives to upper room UV systems.

- The following uses of ultraviolet light are not recommended to mitigate transmission of COVID-19:
    - In systems to clean surfaces. (This is not an effective method to improve air quality and limit the airborne transmission of COVID-19.)
    - With a titanium dioxide surface as a catalyst. (This is a form of additive air cleaning known as photocatalytic oxidation; see guidance below on additive air cleaning.)

5. Avoiding Additive Air Cleaning and Alternative Methods

- This category of technologies includes a wide range of products and methods in which particles or chemically reactive species are supplied to the air in a space. The goal is to either inactivate viruses, increase the deposition rate onto surfaces or allow fine particulate matter to be removed through a lower quality filter.

- These methods include ionization, bi-polar ionization, gaseous hydrogen peroxide, UV photocatalytic oxidation (UV with a catalyst like titanium dioxide), nano-confined catalytic oxidation, ozone emitters, hydroxyl emitters, plasma wave and other active technologies. [17]

- Currently these systems are not standardized, are not sufficiently regulated and can produce unwanted and potentially harmful by-products. The purchase or use of electronic air cleaning equipment should be avoided until such time as credible certifications of effectiveness and safety are available.

- Existing additive air cleaning and other alternative method systems should be disabled.

- Claims about electronic air cleaning technology should not be used when determining if airborne disease mitigation targets have been reached until the technology has been standardized.

- Portable air cleaners with an electronic air cleaning component should only be used if this component is disabled.

6. Transparency and Public Education

- Facilities should make information about their air quality measures available to the occupants, including information about what strategies have been used to ensure safe indoor air. This can include sharing information about regular maintenance strategies, the use of filtration or UVGI in the space, or basic information about the ventilation strategies and the targeted level of ACH.

- Whenever occupant participation is required to ensure systems are working properly, training and signage should be provided. These situations include:
    - Ensuring thermostats are set to “on” and not “auto” during occupied periods [18]
    - Using portable HEPA filters or DIY Corsi-Rosenthal boxes [8, 9, 18, 21]
    - Understanding CO2 readings [19, 20]
    - Using windows and doors
    - Verifying ventilation is operating [21]
    - Using manually operated ceiling fans
    - Using push buttons and switches that control ventilation equipment

- Nondispersive infrared CO2 monitors with readable displays should be used in each space with a printout detailing the CO2 level target. This can alert occupants to increase ventilation in the space either manually or mechanically, or take other protective measures (such as ensuring they are wearing a high-quality respirator-like mask, or temporarily exiting the space). The monitors should be used in places that represent the average conditions in the room. In addition, CO2 sensors should be used to:
    - Verify ventilation requirements are being met
    - Identify maintenance issues
    - Identify areas that require increased airborne mitigation measures

- Recommended CO2 levels in compliance with current standards can be found using the OSPE calculator. [6] Recommendations for some spaces include:
    - Daycare – 850 ppm

- Elementary School Classrooms – 900 ppm
- Highschool Classrooms – 1150 ppm
- Offices – 1050 ppm
- Retail Stores – 1300 ppm
- Doctor’s Offices – 1000 ppm
- Dental Procedure Room – 800 ppm

- Government and public health agencies should also consider public education campaigns empowering Canadians with knowledge about the importance of air quality in the context of COVID-19 and other respiratory diseases. Public education campaigns can help Canadians to understand the science behind indoor air quality and empower them to advocate for cleaner air in their indoor spaces.

The core recommendations made here are in alignment with the Final Report from the Lancet’s COVID-19 Commission. In particular, we agree with the Commission on the effectiveness of masking, on the positive roles that ventilation and filtration play and how existing building standards are insufficient in the context of airborne transmission of disease. [22]

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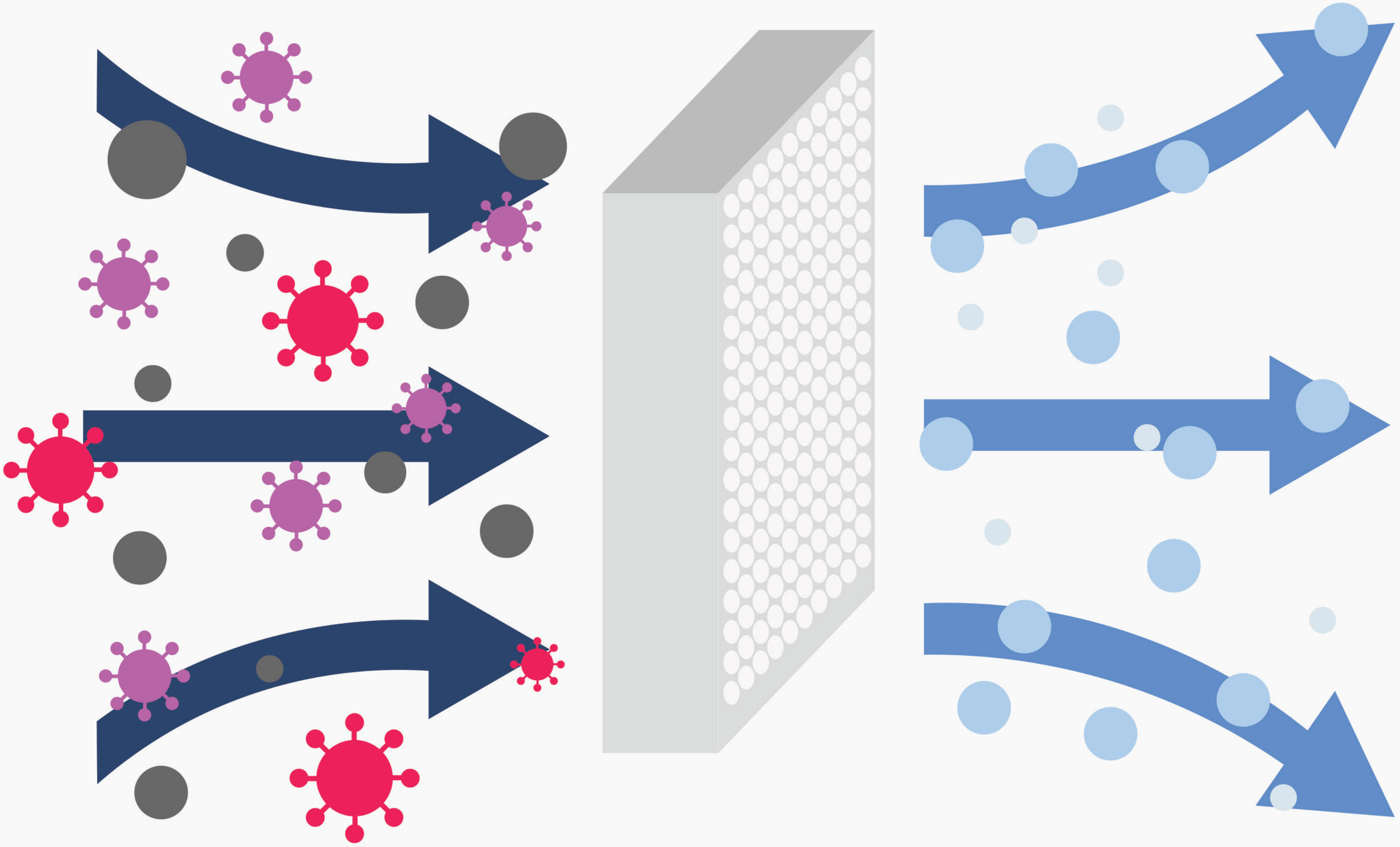

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