REDUCING TRANSMISSION OF COVID-19 THROUGH IMPROVEMENTS TO INDOOR AIR QUALITY: A CHECKLIST FOR COMMUNITY SPACES

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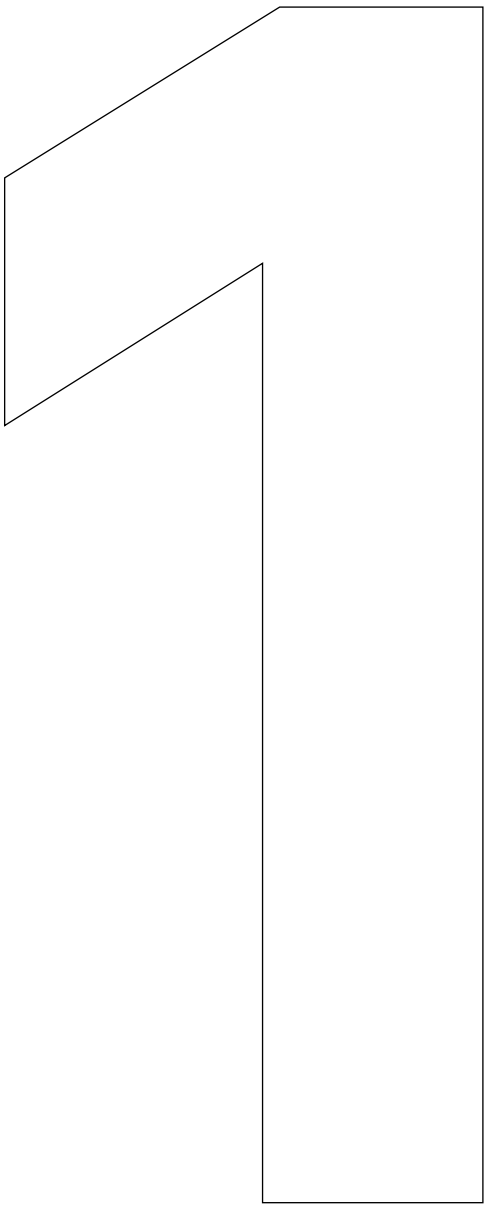
Introduction



About this checklist: This checklist is designed for community spaces and congregate settings such as drop-ins, community health centres and shelters. It is not designed for other types of workplaces, health care settings, individual homes or multi-unit apartment buildings.

This document was created based on local context and experience with community spaces in Toronto. Please carefully consider local context when using this checklist.

The information contained in this checklist and the resources listed at the end are current as of October, 2022. We hope you use this checklist to:

- Learn best practices for maintaining indoor air quality in your building.
- Record the current state of your building.
- Coordinate both short-term and long-term follow-up actions.

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What this checklist includes (and what it doesn't): This checklist only includes information about indoor air quality and does not contain advice about other important measures to help reduce transmission of COVID-19.

Indoor air quality and COVID-19: Many studies demonstrate that COVID-19 spreads through the air. And there is a lot of evidence that transmission of COVID-19 (and other respiratory diseases like the flu and tuberculosis) can be reduced using basic indoor air quality measures like ventilation and filtration.

About "safe spaces": In a respiratory pandemic, no common space will be perfectly safe. We are hoping that you will come away with some ideas about how you can use indoor air quality measures to make your space as safe as it can be.

This document does not replace or remove the need for on-site advice from licensed professionals. Always get expert advice specific to your building and the type of services offered there. In all cases it's important to use professional, licensed contractors to select, install and maintain equipment such as Heating Ventilation and Air Conditioning (HVAC) systems, exhaust fans and ultraviolet disinfection units.

Disclaimer: This checklist is provided for informational purposes only and does not create any contractual or professional relationship between the authors and users nor does it constitute professional advice.

The user is responsible for how they interpret and use this document. The user is responsible for evaluating the application of all guidance in this document in the context of the specific conditions and activities that apply to their facilities.

The user is advised to consult the appropriate licensed professionals before installing or making adjustments to exhaust fans or HVAC systems, or installing or making adjustments to ultra-violet disinfection systems. The user is advised to follow instructions from product manufacturers and licensed professionals.

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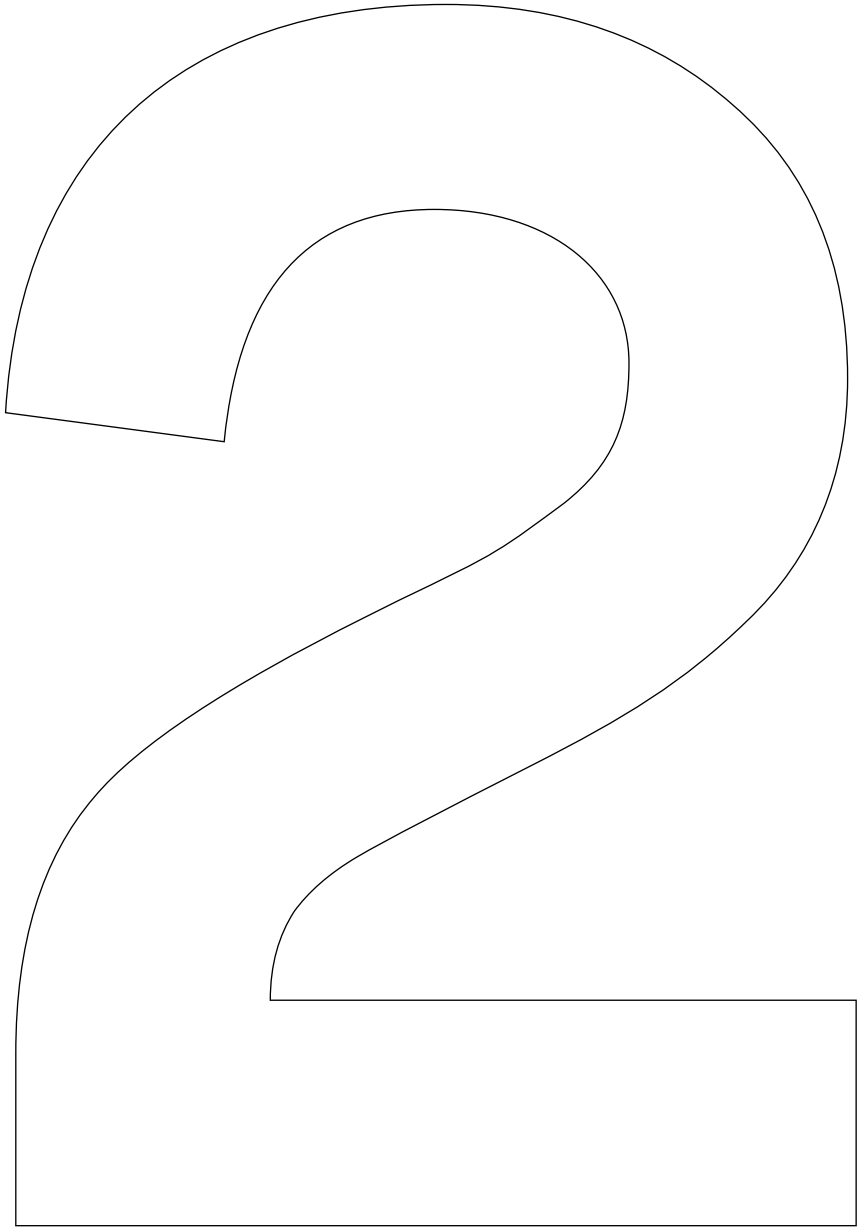
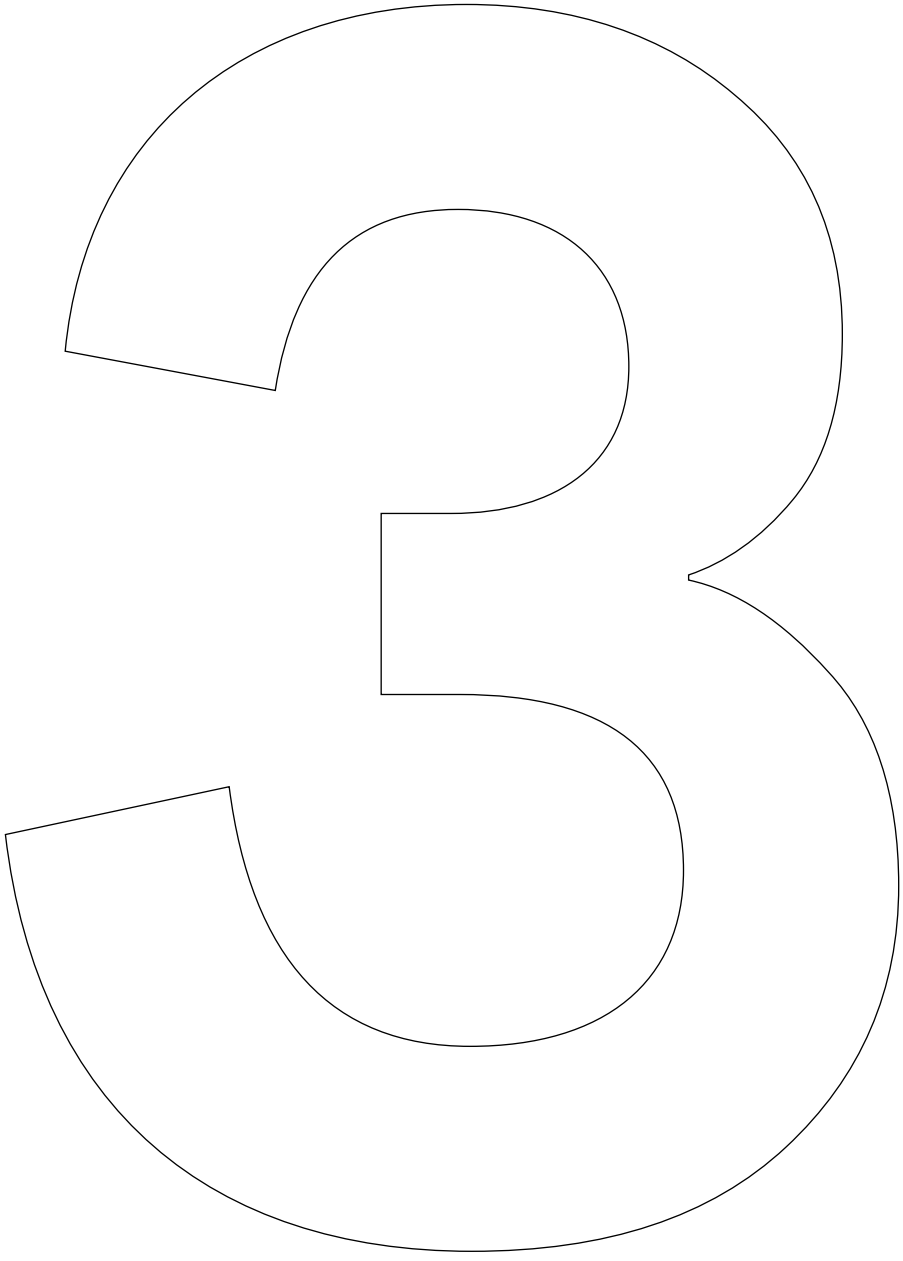
Best Practices Checklist



Here's a quick list illustrating what a building looks like when best indoor air quality practices are in place. We share details about each of these points in the following sections. **Check with an HVAC professional before changing any aspect of your HVAC system—for example, before upgrading your filters. If you can't achieve each point right away, don't worry**. Using different measures in combination can help you meet your goal of providing good indoor air quality and a safer environment for everyone in the building. You will find definitions of the terms used below in the next section.

- ☐ HVAC system is regularly maintained by an **HVAC professional.**
- ☐ HVAC system uses filters that have a **Minimum Efficiency Reporting Value or "MERV" of 13** or higher (check with HVAC professional before upgrading filters).
- ☐ HVAC filters are surrounded by a **good seal,** so that no air by-passes them.
- ☐ Each room has a minimum of **six total air changes per hour.**
- ☐ Where you are not confident that your HVAC system provides six total air changes per hour, or where there is no HVAC system, each room has **appropriately-sized portable air filters.**
- ☐ HVAC system brings in some outdoor air and, at a minimum, meets **ventilation standards.**
- ☐ HVAC system provides ventilation and filtration **at all times** while building is in use.
- ☐ In higher-risk spaces, such as communal eating or sleeping areas, **additional measures** are used to achieve more than six total air changes an hour. For example, additional measures may include:
    - If possible, HVAC system brings in **100 per cent outdoor air.**
    - Where room conditions such as ceiling height allow, a professional has installed **upper-room ultraviolet disinfection.**
- ☐ Bathrooms are equipped with appropriate-sized fans that **exhaust to the outside.**
- ☐ Room air is changed over **at least three times** between appointments or groups.

Definitions and Context



This section contains some definitions and basic principles related to indoor air quality. It answers frequently asked questions and will give you context for the detailed checklist that comes next.

How COVID-19 spreads through the air. Small particles (sometimes referred to as **aerosols**) can float in the air, in some cases for hours. When a person has COVID-19, they release small particles that contain the virus when they breathe, talk, sing, cough or sneeze. These are often referred to as **respiratory particles.** Most of these small particles initially hover around an infected person's face—that's why keeping a distance can help reduce infections. But small particles can also move, like cigarette smoke. When someone develops COVID-19 by breathing in small particles that contain the virus, this is often referred to as **airborne transmission** or **aerosol transmission.** If a person who has COVID-19 is wearing a good, well-fitted **respirator**-type mask, such as an N95, this is called **source control,** because it helps prevent small particles that contain the virus from entering the room.

Ventilation. In this document, we are using **ventilation** to refer to the process of bringing fresh air from outside into a building or a room while removing stale air from the same space. If a room feels stuffy or there are a lot of odours, this may be an indication that it is not well ventilated.

Natural ventilation happens without the help of fans, for example, when you open a window. **Mechanical ventilation** uses your building's mechanical systems, including the centralized heating, ventilation and air-conditioning system (the **HVAC system**), to bring fresh air in and exhaust stale air out. This air exchange process helps to remove virus-containing particles from a room.

Ventilation is not just moving indoor air around in the building or room. For example, ceiling fans and portable air conditioners only circulate air in the same building or room, but do not exchange indoor and outdoor air. In addition, some forced-air HVAC systems only provide heating and cooling and do not bring in outdoor air at all. In other words, these HVAC systems simply recirculate the same air throughout the building.

Filtration refers to the process of passing air through a filter. It is different from ventilation, as there is not necessarily outdoor air involved. Most centralized, forced-air HVAC systems use filters to protect equipment from debris like hair or larger dust particles. Many HVAC systems, however, don't use filters that are high-efficiency enough to filter out the smaller particles that carry viruses. In some buildings, there may be opportunities to upgrade HVAC filters to improve the filtration performance of the HVAC system. In addition to centralized HVAC systems, portable air filters also help to filter smaller particles out of the air.

Heating, ventilation and air-conditioning system (HVAC). A centralized forced-air **HVAC system** regulates temperature and circulates air through a building. Depending on the system design and setting, it may or may not provide both ventilation and filtration. It may be one integrated system, or there may be separate components. Buildings without centralized forced-air HVAC systems often use **conditioning devices** such as hot water radiators; electric baseboard heaters; and portable air conditioning units to regulate temperature. These non-centralized conditioning devices often do not provide ventilation or filtration.

HEPA vs. MERV filters. HVAC systems generally use filters that are classified according to **Minimum Efficiency Reporting Value** or **MERV.** The higher the MERV, the higher the efficiency of the filter. Many portable air filters use **high efficiency particulate air** or **HEPA** filters. Most HVAC systems can't handle HEPA filters. Some companies, such as 3M, may use their own rating system for their HVAC filters. 3M shares the MERV equivalent on their website.

Air changes per hour, equivalent air changes per hour and total air changes per hour. Air changes per hour refers to ventilation: the number of times each hour a room is filled with outdoor air. This can be achieved by the HVAC system, by open windows, or both. **Equivalent air changes per hour refers to filtration or ultraviolet disinfection:** the number of times each hour a room is filled with air that has been passed through filters or treated using ultraviolet disinfection.

In this document, we use **total air changes per hour** to refer to **the results you can achieve using any combination of ventilation, filtration and ultraviolet disinfection**. In other words, in this document, total air changes per hour refers to the number of times each hour a room is filled with air that is relatively free of potentially infectious respiratory particles. This can be achieved through a given combination of indoor air quality measures. For example, if:

- Your HVAC system supplies a particular room **with two air changes** of outdoor air per hour through ventilation (i.e. bringing in fresh air) AND
- Your HVAC system supplies that same room with **two equivalent air changes** per hour by passing air through a high-efficiency filter AND
- Your portable air filter supplies that same room with **two equivalent air changes** per hour through filtration THEN

The **total air changes per hour for that room is six.**

Air pressure management is used to regulate the direction of airflow in a building. It makes sure air flows into some spaces and can't escape from other spaces.

For example, in some apartment buildings, the HVAC system supplies a large volume of air to the stairwells and hallways to keep them **positively pressurized**. Because the air pressure is higher in the hallway, air flows into the apartments from the hallway. That's why, in some buildings, you won't smell many cooking smells in the hallways—the air can't escape the apartments.

As another example, kitchen range-hoods and bathroom exhaust fans remove air from rooms, causing them to be **negatively pressurized** relative to the surrounding spaces. The negative pressure, again, helps to prevent air from escaping the kitchen or bathroom.

Many things can influence pressurization—strong winds, outdoor temperatures or even opening a window.

Pressure management is always important. It can also play a particular role in helping to reduce the transmission of airborne diseases, because it can control airflow and limit the amount of contaminated air from moving from one room to an adjacent space.

Heat Recovery Ventilators (HRVs) and Energy Recovery Ventilators (ERVs) are mechanical systems that use the air expelled from the building to condition the air entering the building. For example, in winter, the hot air exhausted from the building is used to help heat the cold air coming in. HRVs exchange heat only, while ERVs exchange both heat and moisture. For example, when it's very dry in the winter, ERVs will recover some of the moisture expelled from the building to help maintain a comfortable humidity level indoors. HRVs and ERVs play a particular function in air-tight, energy efficient, modern buildings. As these buildings have few leaks and cracks, they need mechanical help to make sure air and moisture get in and get out. Professionally installed and maintained HRVs and ERVs can help ensure appropriate ventilation, while cutting down on the energy used to maintain comfortable indoor temperatures.

Respirators. There are different kinds of masks including cloth masks, medical masks and respirators. **Respirators** include N95s, KN95s, KF94s or FFP2s. A well-fitted respirator is the best protection against COVID-19. A fit-tested N95 mask is ideal. But even without fit-testing, a well-fitted respirator will work better than a medical or cloth mask.

Detailed Checklist

The goal of this checklist is to make sure that the air in each room is relatively free of respiratory particles and other contaminants. **Every small thing will help make the space a bit safer**.

4.1 CENTRALIZED FORCED-AIR HVAC SYSTEMS

Here are some best practices to apply to centralized **forced-air HVAC systems** to minimize the transmission of infectious respiratory diseases like COVID-19. These best practices should be applied in consultation with an HVAC professional, especially if you upgrade filters or modify equipment.

If your building does not have an operating, centralized, forced-air HVAC system, consult with an HVAC professional about the possibility of installing one. In the meantime, you can implement strategies 4.2, 4.3, 4.4 and 4.5 to improve indoor air quality.

☐ **Your HVAC system is changing over the air in each room at least six times per hour.** This means that, six times each hour, your building's HVAC system is replacing stale air with fresh outdoor air and/or well-filtered air. Air changes do not include simply recirculating stale or poorly-filtered air through the HVAC system. You can use a variety of strategies in addition to the HVAC system to increase total air changes per hour, including portable air filters (see 4.2) and ultraviolet disinfection (see 4.4). To calculate the total air changes per hour achieved in each room by your HVAC system—or your HVAC system in combination with other measures—you will likely need to talk to an HVAC professional.

☐ **Your HVAC system is bringing in a high ratio of outdoor air.** Most HVAC systems in non-residential buildings use a combination of fresh air brought in from the outside and air that is recirculated from the rooms on the same system. You want to bring in as much outdoor air as possible, and use as little recirculated air as possible, while maintaining a comfortable temperature. We can't give you an exact ratio as it will depend on your specific set-up, but ask an HVAC professional if it's possible to increase the amount of outdoor air running through your HVAC system.

Bringing in more outdoor air through your HVAC system may use more energy (particularly in extreme weather). So investigate options like Heat Recovery Ventilators or Energy Recovery Ventilators—they allow you to bring in lots of fresh air without using as much energy. For higher-risk areas such as communal eating and sleeping areas, consider bringing in 100 per cent outdoor air if possible.

☐ **Your HVAC fan is running all the time while the building is occupied, even when the desired temperature has been met.** Some HVAC systems are set to shut down when the correct temperature is reached. Some HVAC systems—for example, in commercial buildings—are set to shut down after normal operating hours. But when HVAC systems stop running, they stop bringing in fresh air and filtering re-circulated air. So talk to an HVAC professional about the best way to set up your system to **maximize ventilation and filtration** while there are people in the building.

With the system running continuously or for longer periods each day, you will need to change your HVAC filter more frequently than the manufacturer's recommendation because there will be more air passing through the filter. See recommendations around filter changes below. You will also use more electricity if you are running the fan all the time. It may be possible to replace your current fan motor with one that is more efficient.

☐ **You are using a filter with the highest MERV that is compatible with your HVAC system.** If the HVAC system uses a filter (or filters, some HVAC systems use more than one), find out the Minimum Efficiency Reporting Value or "MERV" of the filter. Ideally, filters should be MERV-13 or higher, as these filters can remove the small particles that contain viruses out of the air. But not all HVAC systems will be able to handle filters with higher MERVs. In some HVAC systems, filters with higher MERVs may restrict airflow, a phenomenon often called increased "pressure drop." Work with an HVAC professional to ensure your building is using the filter with the highest MERV compatible with your HVAC system. You can always use portable air filters (see 4.2) to further improve filtration, especially if your HVAC system can't handle high-efficiency filters.

☐ **Your HVAC filters are well-sealed.** When HVAC filters are not well-sealed to the filter holder, air can leak out around the edges and escape without passing through the filter. An HVAC professional can help make sure your filter is sealed.

☐ **Your HVAC filters are changed safely.** Contaminants can build up on filters. Wear a well-fitted N95 respirator, goggles and gloves when changing HVAC filters, and make sure they are handled carefully and disposed of in sealed bags.

☐ **Your HVAC filters are changed regularly.** When HVAC systems are running on and off throughout the day to maintain comfortable temperatures, HVAC filters should be changed according to the manufacturer's recommendations. To optimize indoor air quality, however, you want to run HVAC systems continuously while the building is in use (see above for details). If you are running your HVAC system continuously, you will likely have to change your HVAC filters more often than the manufacturer recommends.

You can also check your filters visually to determine if they need to be changed more often. If the filter is caked in dust, this is a good indication that it needs to be changed. Ask an HVAC professional to help you determine how often to change your filters.

☐ **Your HVAC system is regularly inspected and maintained by an HVAC professional.** A building's schedule for HVAC evaluation and maintenance depends on many variables. Most commercial HVAC systems should be inspected at least once a year. Consult an HVAC professional about how often you should receive regular system maintenance. If there is a major change in your building or HVAC system, or you have concerns about your HVAC system's performance, it's a good time to work with an HVAC professional to conduct a system evaluation over and above your regular maintenance schedule.

☐ **Your HVAC system is upgraded if/when/as possible.** This doesn't always mean a complete overhaul or a replacement of the existing system. Upgrading HVAC fans or integrating the existing system with heat or energy recovery systems can improve air quality and conserve energy.

☐ **You have considered in-duct ultraviolet disinfection if you can't achieve sufficient air changes, in particular in higher-risk spaces.** (See 4.4 and 4.6)

☐ **You have avoided unproven air cleaning technologies in HVAC systems** like ionization, plasma, photocatalytic oxidation, hydroxyl radical and other similar approaches. Many of these technologies are not effective and some can release harmful by-products (see resources).

4.2 PORTABLE AIR FILTERS WITH HIGH EFFICIENCY FILTERS

Even when HVAC systems are optimized, it is a good practice for community spaces to put portable air filters in most rooms, with the exception of bathroom and shower areas. Portable air filters are a particularly important strategy for buildings that have sub-optimal HVAC systems, or that do not have centralized forced-air HVAC systems at all. You can purchase a portable air filter, or make a portable air filter yourself using four MERV-13 filters and a box fan (see more information in the resources section).

Remember, using a portable air filter will improve indoor air quality no matter where it exhausts from or where it is placed.

Ensure that:

☐ **Your portable air filters are chosen based on the room size and the clean air delivery rate**. Clean air delivery rate (CADR) tells you the volume of air cleaned per minute or per hour by a portable air filter. The higher the CADR, the better the air-cleaning performance. Large rooms may require multiple portable air filters. Many manufacturers only report the CADR of portable air filters at the maximum level—switching the portable air filter to a lower level will reduce its CADR.

Most portable air filters list the room size they can serve based on an assumed ceiling height of eight feet. If your room has a higher ceiling, the actual room size the portable air filter can serve will be smaller. CADR and equivalent air changes per hour (ACHe) are not exactly the same thing. But you can calculate the ACHe achieved by a portable air filter using the following equations:

- If the manufacturer expresses the CADR in cubic feet per minute (cfm):
  ↳ ACHe = CADR*60/Room volume, where the room volume is in cubic feet.

- Or if the CADR is expressed in cubic meters per hour (m^3/hr):
  ↳ ACHe = CADR/Room volume, where the room volume is in cubic meters.

There are also online calculators available to help you calculate equivalent air changes per hour or determine the CADR you need for a particular room (see resources).

☐ **You consider noise when choosing portable air filters.** Portable air filters can be noisy on their highest settings. If you buy a portable air filter that is oversized—bigger than you need for your room size—you may be able to run it on a quieter setting, and still achieve your air-cleaning goals. Another option is to run multiple portable air filters on lower settings at the same time.

☐ **You change filters as per the manufacturer's instructions, and take safety precautions when doing so.** As with HVAC filters, particles that contain contaminants can build up on portable air filters. Wear a well-fitted N95 respirator, goggles and gloves, handle filters carefully, and dispose of them in a well-sealed bag. If it is dry outside, consider changing filters outside (you will still need all safety measures listed here).

☐ **If possible, your portable air filters exhaust from the top and pull air from the sides.** This configuration can minimize the disturbance of particles that contain viruses that may have landed on the floor, and will avoid direct airflow between people. Always make sure there is enough room for airflow around the portable air filter.

- If your portable air filter exhausts from the bottom (as opposed to the top), elevate it so it does not disturb particles that may have been deposited on the floor, and so clean air reaches people while they sleep.

- If your portable air filter exhausts from the sides, do not put it too close to a wall.

☐ **You position portable air filters to ensure there is no direct airflow between people.** (See resources section for more information).

☐ **You avoid tripping hazards.** Make sure someone who knows the space well is involved in placing portable air filters. Avoid creating tripping hazards, and monitor the situation over time.

☐ **You turn portable air filters up to maximum levels for higher-risk settings.** See section 4.6 for information about identifying higher-risk settings.

☐ **If people are sleeping in a shared space, you place portable air filters between beds.** Some portable air filters can be noisy at the maximum level. Communicate with the people in the space and explain the importance of keeping the portable air filters running. As mentioned earlier, you may want to choose an oversized portable air filter you can run on a lower setting while still meeting your air-cleaning goals. You can also run multiple portable air filters at once on lower settings to achieve the same effect. In addition, be aware of potential tripping hazards when placing portable air filters between beds.

☐ **You are not using portable air filters in bathrooms or shower areas.** Bathrooms are full of smooth surfaces like toilets and tile. Particles don't stick well to these surfaces. As a result, there is a greater chance that portable air filters will disturb particles and send them back into the air.

☐ **You have avoided unproven air cleaning technologies.** These include many devices that use ionization, plasma, photocatalytic oxidation, hydroxyl radical and other similar approaches. Many of these air cleaners are not effective and some can release harmful by-products (see resources).

4.3 BATHROOMS

Bathrooms are often small, so it's easier for a higher concentration of particles that contain viruses to build up in the air. In addition, it's possible flushing toilets can release particles that contain some viruses. Finally, activities such as brushing teeth can't be done while masked. There are many ways to help reduce transmission in bathrooms. Ensure that:

☐ **Your exhaust fans are in good shape and exhaust directly to the outside.** These fans can remove particles that contain viruses, increase ventilation, and ensure the air doesn't flow out of bathrooms into surrounding areas. If needed, work with an HVAC professional to install new fans or upgrade existing fans. If smells linger in the bathroom, or escape out into the hallway, this may be one indication that your bathroom exhaust fan is not working well.

☐ If possible, **only one person uses the bathroom at once,** even in multi-person bathrooms.

☐ **You leave the bathroom empty** and the fan running for as long as possible between uses.

☐ If possible, **you leave windows open.**

☐ **If your toilets have seat covers, you leave them down while flushing.** This may help reduce the dispersion of particles that contain viruses.

☐ **If you're doing a bathroom renovation, you work with a professional to consider vented toilets,** which provide localized exhaust.

As noted above, **portable air filters are not appropriate for bathrooms.**
As mentioned earlier, these recommendations are only related to airborne transmission and do not address or replace other infection control measures such as masks and handwashing.

4.4 UPPER-ROOM AND IN-DUCT ULTRAVIOLET (UV) DISINFECTION

Upper-room UV disinfection can be very useful in common areas such as dining rooms, waiting rooms and shared bedrooms, if room specifications allow. These units are installed near or on the ceiling, and help neutralize viruses and bacteria that circulate through the UV light. Like portable air filters, these units are particularly important where HVAC systems are not optimized, or where there is no central forced-air HVAC system at all. It's important to note, however, that upper-room and in-duct UV can be useful even when HVAC systems are optimized, in particular in higher-risk settings (see 4.6).

It is important that upper-room UV units are installed and maintained by professionals, as UV light can damage eyes and skin. In addition, upper-room UV units will only be safe and effective when there is appropriate air circulation, an adequate dose of UV light, and when UV light is contained to the part of the room near the ceiling.

In-duct UV disinfection can also be used to neutralize particles that contain viruses as air runs through forced-air HVAC systems. Please note, however, that most common in-duct UV systems do not remove respiratory viruses from the air. Instead, they are designed to prevent fungal growth on cooling coils. If you want an in-duct UV system to remove virus from the air, make sure to specify this to get the right device.

Because UV light can cause eye and skin damage, avoid any devices that direct UV light towards people, and always consult professionals before you introduce a new UV disinfection system into a space.

4.5 ADDITIONAL (AND IMPORTANT) INDOOR AIR QUALITY MEASURES

☐ **You run kitchen exhaust fans while cooking is occurring.**

☐ **Where weather and safety permit, you open windows and doors to the outside, especially when your HVAC system is not optimized or your building does not have a centralized HVAC system.** Open windows and doors can improve ventilation by introducing fresh air from the outside. Keep in mind, however, that the ventilation provided by windows and doors will vary from room to room and throughout the day, depending on weather conditions. Open windows and doors may not provide sufficient ventilation in some spaces. For maximum benefit, you can also consider running portable air filters and opening windows and doors at the same time.

☐ **You clear the air between appointments or groups.** For example, if a group of people is using a dining or meeting room, change all the air in the room over at least three times before the next group comes in. If you change the air over three times, at least 95 per cent of stale air will be replaced with outside and/or filtered air by the time the next group arrives.

Room air can be cleared using HVAC systems, portable air filters, open windows/doors or some combination of the three. Even if you have an optimized HVAC system, opening windows and running portable air filters on their highest settings can increase the room's total air changes per hour and reduce the wait time between groups.

Leaving windows open while running portable air filters may, however, reduce filter life if the outdoor air is polluted. If you are not sure that open windows will provide lots of ventilation in your space and if resources around filter purchases are constrained, you may want to consider closing windows and running portable air filters on their highest setting while clearing empty rooms between appointments or groups. This will avoid excessive loading of filters with dust and debris from outdoors that can occur in some contexts.

If you don't know the room's total air changes per hour, use all the tools you have to air the room out for as long as possible. If you do know the room's total air changes per hour, you can use the table below to find out the time required to clear the room.

Table 1. Calculating the time needed to clear 95 per cent of stale air out of a room

Total air changes per hour	Time in minutes required for 95% removal
2	90
4	45
6	30
8	23
10	18

☐ **You take precautions when removing contaminated personal protective equipment like gowns.** Gowns can shed particles that contain viruses, which is a particular concern in small, enclosed rooms. Respirators, portable air filters, open windows and clearing the air between appointments or groups can help to mitigate this.

4.6 IDENTIFYING HIGHER-RISK SPACES IN YOUR BUILDING

When considering where to focus your attention, it's important to identify the spaces and activities that are most likely to put people at risk of catching COVID-19 through the air. **These are the spaces that are most in need of excellent ventilation and filtration.** Some of these spaces may also be good candidates for **upper-room UV disinfection.**

To identify these rooms and activities, consider the factors that: a) help virus build up in the air; and b) make it more likely someone will breathe in enough virus to get sick. Pay special attention to spaces where:

- ☐ **People are not wearing masks.** If a person *who has COVID-19* is wearing a mask, this will reduce the degree to which particles that contain the virus enter the room, depending on mask fit and quality. This is called source control because it helps stop the virus at its source. If a person *who does not have COVID-19* is wearing a well-fitted respirator, this will make it less likely they will become infected (although it is still possible). Rooms where people are not wearing masks because they are eating—such as a **break rooms** and **dining rooms**—should be considered higher-risk spaces.

- ☐ **There are many people in the space.** The more people in the space, the higher the risk, which may occur in **common areas**. This risk increases if people are not able to maintain a lot of distance from each other.

- ☐ **People are spending a long time together.** The longer a person is exposed to virus in the air, the more likely it is they will get infected. That is why spaces like **sleeping areas**, **waiting rooms** and **shared work areas** require special attention.

- ☐ **The room is small.** In smaller rooms, the virus will build up faster in the air. Ceiling height makes a difference, too. That why, in some cases, **consultation rooms**, especially when people are spending a long time together inside, could be considered higher-risk spaces.

- ☐ **People are breathing hard, talking loudly, shouting or singing.** While people release particles that contain viruses just by breathing, when they are expelling more air, they will release more particles. That's why **areas where there is exercise or singing** need special attention.

☐ **There are particular conditions that make COVID-19 transmission more likely.** For example, **refrigerated work environments** carry particular risks for catching viruses because they are cold, confined spaces and typically have little ventilation. **Shower areas** can carry particular risks as people are close together, may be unmasked and ventilation may not be adequate. There may also be areas of your building that are particularly risky due to the design and operation of your HVAC system. An HVAC professional can help you identify these areas.

☐ As mentioned earlier in this document, **bathrooms** should always be considered higher-risk environments.

4.7 MASKS AND OTHER NON-INDOOR AIR QUALITY STRATEGIES

While this checklist is focused on indoor air quality measures, there are additional strategies that can help when dealing with viruses that spread through the air. These include:

- Maintaining very low occupancy in common spaces.
- Ensuring people have private bedrooms and bathrooms.
- Physical distancing.
- Reducing "bottlenecks" in buildings (e.g. entrances, exits or line-ups).
- Limiting time spent together indoors (e.g. wait times for appointments).
- Grouping people into "cohorts" that eat and spend leisure time together.
- Moving activities outdoors when possible.

One of the most important ways to protect yourself and others from an airborne virus is **wearing a mask that both filters small particles and fits well**. A fit-tested N95 respirator is ideal. But even without fit-testing, a well-fitted respirator such as an N95, KN95, KF94 or FFP2 will work better than a medical or cloth mask. For information about choosing masks, please see the resources section.

4.8 CAUTIONARY NOTES

☐ **Address issues that might come up when using HVAC systems to increase ventilation and filtration.**

- **Energy use.** When you are running the HVAC fan more often, this may increase energy costs. To help with this, you can talk to an HVAC professional about replacing your current fan motor with one that uses less energy. The same goes for bringing in more outdoor air through your HVAC system, especially when it's very hot or very cold outside. Imagine it's a very cold day, and your HVAC system is bringing in a lot of outdoor air. The system will need to heat all this air before it enters the room, and that takes energy. Heat Recovery Ventilators or Energy Recovery Ventilators can help with this, as they use warm air expelled from the building to heat incoming air in winter, and cool air expelled from the building to cool incoming air in summer.

- **Wear and tear on HVAC components.** When you are using the HVAC system more, there can be more wear and tear on the different components. Work regularly with an HVAC professional to keep the HVAC system in good shape.

- **Outdoor air pollution.** Bringing more outdoor air comes with particularly considerations. First, consider outdoor air quality in your immediate area. If outdoor air quality is poor, you may require additional filtration and/or you may need to change filter(s) more often.

- **Humidity and condensation.** Increased amounts of outdoor air may cause issues with humidity or condensation. If this becomes an issue, you can look into dehumidifiers. But remember that dehumidifiers collect a lot of water, and if they're not emptied regularly, this can lead to leaks or floods. Consider working with a plumber to attach dehumidifiers to a permanent drain in order to avoid this problem. Controlling moisture sources coming from the inside may also help. For example, using kitchen exhaust fans while cooking and boiling water, and bathroom exhaust fans while showering or taking baths.

☐ **Be aware of the potential to "over-implement" certain indoor air quality strategies.** In rare cases, over-implementing indoor air quality strategies could cause issues. For example, using a filter that is not compatible with your HVAC system could lead to reduced airflow or even cause damage to the system. Using kitchen exhaust fans that are too powerful may change the airflow direction in your building, resulting in a backdraft and/or allowing in contaminated air. Always consult an expert if you wish to upgrade existing mechanical systems (including exhaust fans), upgrade HVAC filters or install new devices in your building. See resources for more on the potential hazards of "over-implementation."

☐ **Avoid unproven air cleaning technologies.** These could include both portable devices and devices integrated with centralized forced-air HVAC systems. As mentioned earlier, many of these technologies are not effective and some can release harmful by-products (see resources).

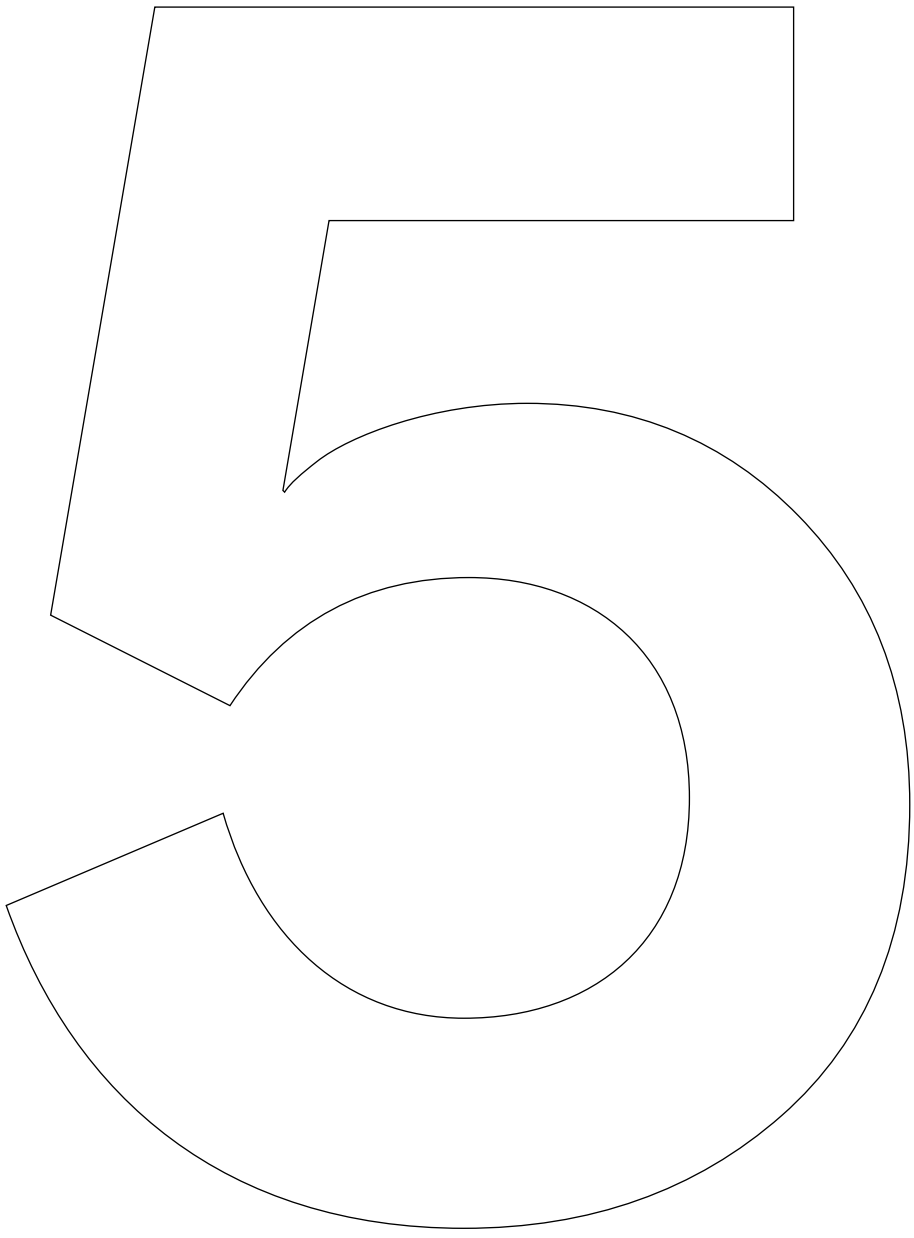
☐ **Exercise caution with partitions such as plastic barriers and curtains.** Partitions such as plastic barriers and curtains can be counter-productive. Unless partitions are ceiling-to-floor, without gaps, they do little to protect people, as particles that contain viruses will find their way through small gaps. In addition, these partitions may restrict airflow and disrupt ventilation patterns, trapping a greater amount of stale air on one side or the other.

Short plastic barriers used in customer service situations may offer a small degree of protection from very close contact transmission as they enforce some physical distance, and may protect people from some large particles such as those produced by a cough or sneeze. It's important to note, however, that these barriers will not protect workers or clients from smaller particles.

There is a risk that partitions can trap virus-containing particles on one side or the other. If partitions are in use, consider putting portable air filters on both sides of the partition to reduce risk.

☐ **Avoid creating direct airflow between people.** For example, take care with the placement and use of portable fans, air-conditioning units and ceiling fans and avoid creating strong airflow from person to person. This is a particular concern in poorly ventilated environments.

Measuring Ventilation Through CO_2 Monitoring



When we breathe, we release carbon dioxide (CO_2). There are other sources of CO_2 too, see below for details. If a room is not well-ventilated, CO_2 will build up. That's why CO_2 monitors can help you approximate ventilation levels in a particular room and track improvements in ventilation. Please note, if you have limited resources, it is likely more effective to invest in portable air filters or HVAC upgrades before you get to CO_2 monitoring. If you are interested in CO_2 monitoring, here are some things to consider:

☐ **Select the right device.** "Parts per million" (ppm) is a way of measuring one substance within a larger mixture. It's sometimes used to measure how much of a particular substance is present in the air. PPM applies to measuring gases in the air. PPM does not apply to solid or liquid particles. Solid or liquid particles, even tiny ones like respiratory particles, are measured differently.

CO_2 monitors measure how much CO_2 is in the air and express this measurement in ppm. Most CO_2 monitors available on the market are only accurate within around 50 to 100 ppm. That means that a reading of 800 ppm is no different than a reading of 750 or 850 ppm. Some factors to consider when choosing a CO_2 monitor (all of this information should be listed by the manufacturer):

- How it performs in different humidity conditions.
- How frequently the sensor measures CO_2 in the air.
- How long the battery lasts before it needs to be replaced.
- How much data the device can store before it is full.
- The download method—how you get the information off the device in a format that is usable for you.

☐ **Select the right location for monitoring.** Install or use the sensor somewhere that represents the average conditions in the room. In other words, don't use it right by an open window, or right next to a source of CO_2. Sources of CO_2 include people and sources of combustion. Sources of combustion include anything that is burning (like a fireplace) and gas appliances.

☐ **Understand the factors that influence the amount of CO_2 in the air.**
The amount of CO_2 that is in the air will change over time. That's why it's important to monitor CO_2 levels in a room continuously to see how different factors impact ventilation levels.

Increases in CO_2 can come from:

- More people in the space.
- Increased level of physical activity (if people are breathing hard, this will produce more CO_2).
- Use of gas appliances like gas stoves and gas fireplaces.
- Anything that is burning, like a wood-burning fireplace.
- Outdoor sources of CO_2 like traffic or idling vehicles.

Decreases in CO_2 can come from:

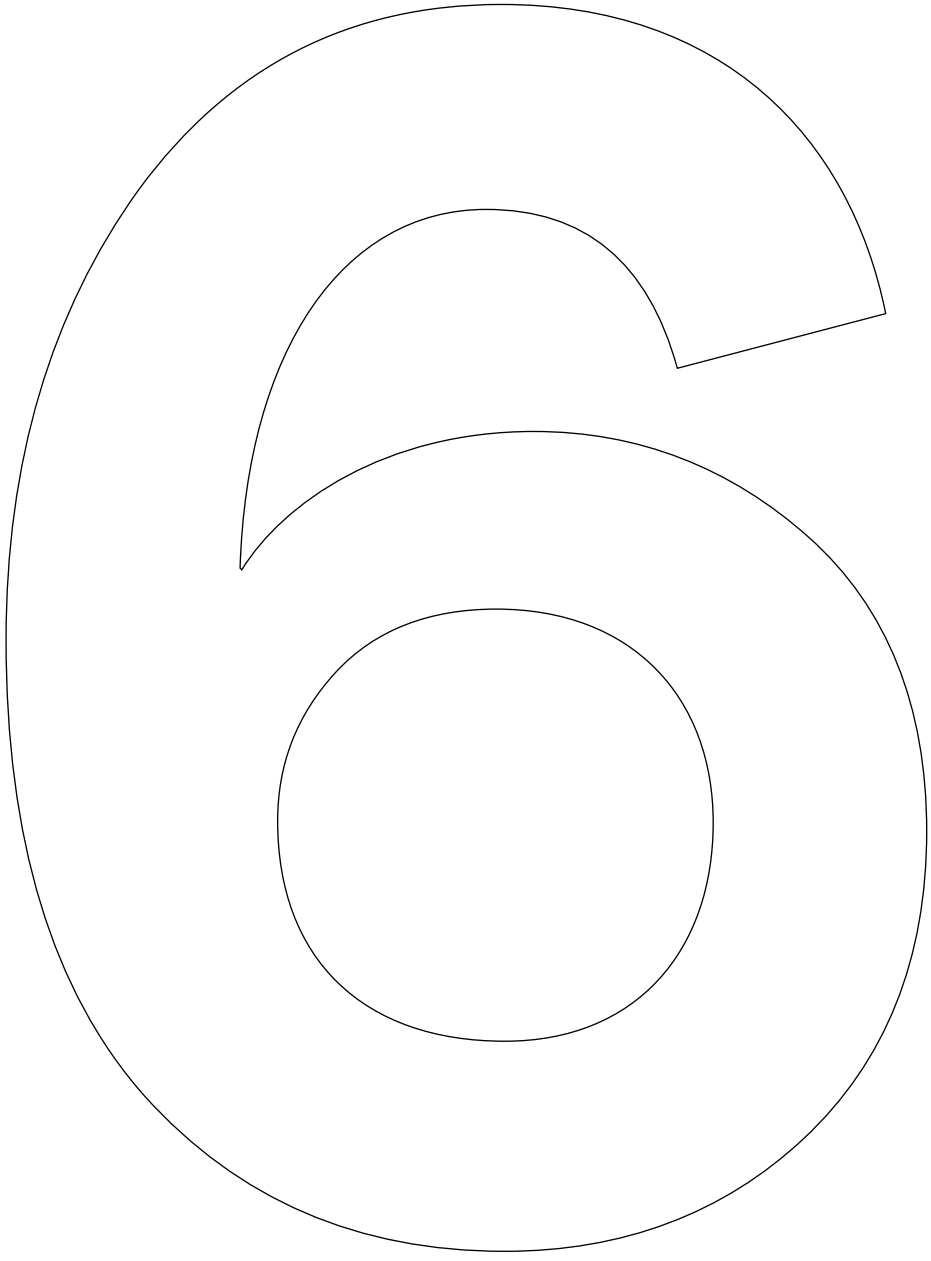
- Fewer people in the space.
- Mechanical ventilation provided by HVAC systems or exhaust fans.
- Opening windows and doors.

☐ **Interpret the results.** First, it's important to remember that CO_2 only relates to ventilation (i.e. outdoor air), not to filtration. Many factors will impact CO_2 levels in a room. Monitoring will help capture trends over time, and can help evaluate the results of your work to improve ventilation. A high CO_2 reading in a space that usually has lower readings is an indication that you may need to take action such as reduce occupancy, increase ventilation or inspect your HVAC system.

☐ **Other considerations.** If you are using a monitor with a display that everyone in the building can see, communicate with people in advance. Let them know what the different readings mean, and what to do and who to talk to in the case of high readings. **Make sure the monitoring process does not interfere with privacy for residents and workers, or with important activities that may briefly impact indoor air quality but do no harm.**

More information about the use of CO_2 monitors and other indoor air quality monitors is available in the resources section.

The People in the Space



It's important to make sure improvements to indoor air quality work for everyone. And it's important to centre the comfort and rights of the people who use the space. Here are a few tips for making sure that improvements to indoor air quality are sustainable, and work for everyone:

- ☐ **Communicate what you are doing** and why you're doing it at every stage to people who are regularly in the space. Use opportunities like orientation, training and meetings to talk about indoor air quality measures. Post signs with clear language, and let people know who to ask if they have any questions.

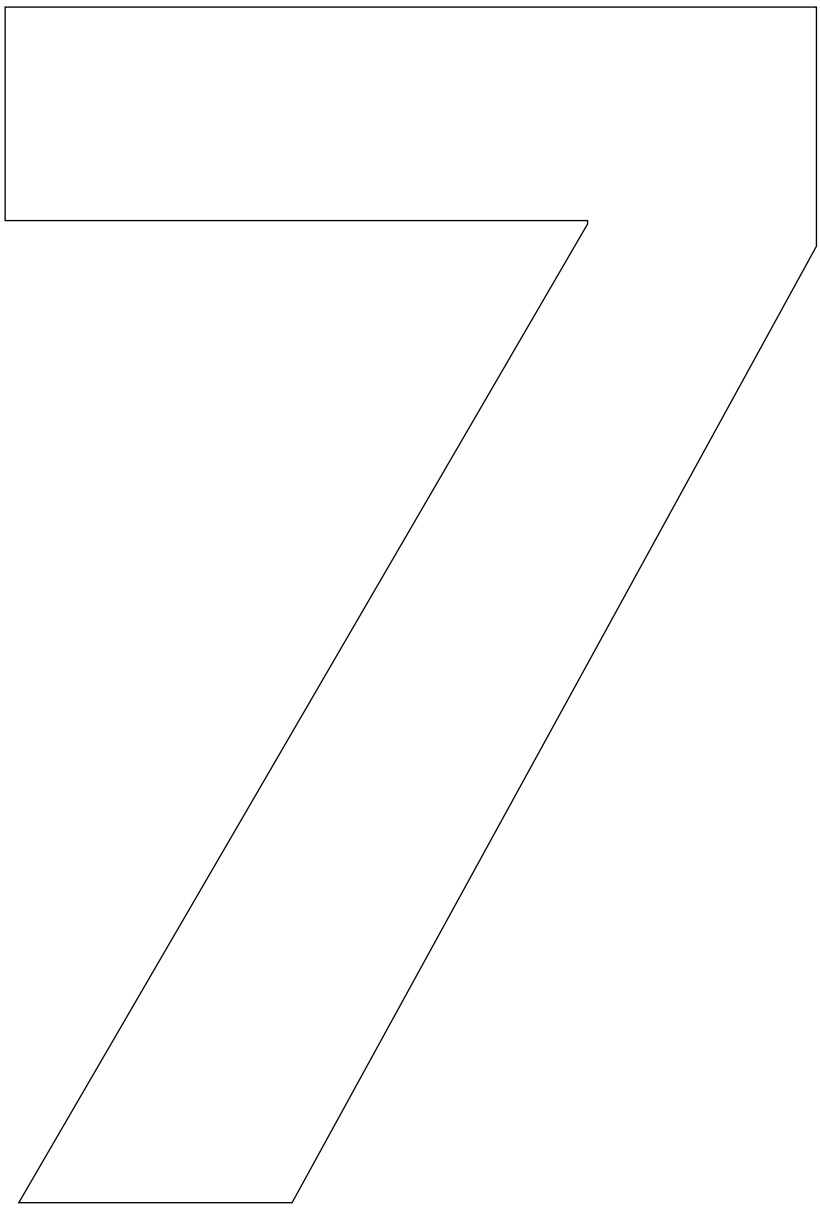
- ☐ **Talk to people about portable air filters.** Explain how they contribute to the safety of the space, and why they are placed where they are. Ask people if they have any concerns. For example, portable air filters make noise, and this may bother some people in their living or working space. Work with everyone to resolve any concerns. Maybe the portable air filter can be placed in a different spot in the room; maybe you can run multiple portable air filters on lower settings; or maybe you can choose a portable air filter that is oversized for the room and run it on a lower setting.

- ☐ If you have CO_2 and other indoor air quality measurement devices posted publicly, **explain to people what they're doing there,** and what the measurements mean. Let them know what to do and who to alert if they notice unusual readings or have concerns.

- ☐ Sometimes, indoor air quality measures such as opening windows or increased use of outdoor air through ventilation systems can interfere with comfortable temperatures. As mentioned earlier, **consider Heat Recovery Ventilators or Energy Recovery Ventilators**—they can help keep temperatures comfortable while you bring in lots of outdoor air through your HVAC system. In the meantime, **keep open communication with people who use the space, and remember that comfort is always important,** in particular during extremely hot or cold weather.

- ☐ Make sure that indoor air quality measuring and rules **do not interfere with people's privacy, rights, or regular daily activities.** Indoor air quality measurement should not become a way of policing or stigmatizing anyone. Nor should it interfere with the rights of residents, workers or visitors.

Resources and References



General information

- Core recommendations for reducing airborne infectious aerosol exposure from the American Society of Heating, Refrigerating and Air-Conditioning Engineers.
- COVID-19 guidance from the Federation of European Heating, Ventilation and Air Conditioning Associations.
- Position document on filtration and air cleaning from the American Society of Heating, Refrigerating and Air-Conditioning Engineers.

HVAC systems

- Guidance on ventilation and COVID-19 from the Public Health Agency of Canada.
- Guidance on COVID-19 risk reduction in residential buildings from the American Society of Heating, Refrigerating and Air-Conditioning Engineers.
- Ventilation in Buildings from Centers for Disease Control and Prevention.
- Information on heat and energy recovery ventilators from Natural Resources Canada.
- Information on ensuring combustion gases don't enter the building from Natural Resources Canada.

Portable air filters

- Portable air filter buying guide from the Clean Air Crew.
- Twitter thread comparing portable air filters by Dr. Marwa Zaatari.
- CADR calculator for portable air cleaners.
- Use of portable air filters and transmission of COVID-19 from Public Health Ontario.

UV disinfection

- Upper-Room Ultraviolet Germicidal Irradiation (UVGI) from Centers for Disease Control and Prevention.

Measuring indoor air quality

- "So you want to buy an indoor air quality monitor" by Dr. Dustin Poppendieck.

Masks

- How to Find a Quality Mask (and Avoid Counterfeits) from the New York Times.
- Mask testing data by "Mask Nerd" Aaron Collins.
- How often can you safely reuse your KN95 or N95 mask? from the Washington Post.
- Effectiveness of Face Mask or Respirator Use in Indoor Public Settings for Prevention of SARS-CoV-2 Infection by Andrejko et al.