



Guidance for Airflow, Ventilation, and Air Filtration

May 27, 2022

The following is a guide to improving airflow, ventilation, and air filtration to help prevent the transmission of SARS-CoV-2, the virus that causes COVID-19.

Transmission of COVID-19

COVID-19 spreads from person to person when an infected individual breathes out droplets and small particles that contain the virus. These droplets and particles can then be breathed in by other people or land on their eyes, noses, or mouths. In some circumstances, the droplets and particles may contaminate surfaces they fall on.

COVID-19 is mainly spread in three ways:

- Breathing in air when sharing an enclosed space with an infected person.
- Having small droplets and particles that contain the virus land on the eyes, nose, or mouth.
- Touching eyes, nose, or mouth with hands that have the virus on them.

[Click here for more information from the Centers for Disease Control and Prevention on how COVID-19 spreads.](#)

Best Practices for Improved Ventilation

- **Know your needs:** Each facility has different needs in terms of improving the ventilation and airflow in and out of the building/space. When assessing your ventilation practice, it is important to take into consideration the number of individuals coming in and out of the area at any given time, the level of activity transpiring in the area (e.g. are people breathing heavy, talking loudly, moving around, or sitting still), access to operable windows, as well as other factors. Knowing your facility and the factors that play into good or poor ventilation will help you develop an optimal ventilation plan to keep you and your customers safe.
- **Layer defenses:** There are ways to reduce and mitigate risk in order to increase safety and quality of air. A layered defense strategy means implementing several different approaches for reducing the spread of COVID-19 at the same time. Best practices suggest that this strategy, based on community transmission levels, will help mitigate and contain the spread of COVID-19 in our communities.
- **Know your systems:** Each building and situation is unique. Conducting full audits of the mechanical systems, air filtration and ventilation, plumbing systems, and space availability will provide the information needed to identify gaps, remedies, and opportunities to make spaces safer for everyone.
- **Improving air circulation:** Increasing outdoor air ventilation instead of using recirculated air and increasing air filtration as much as possible for the ventilation and filtration system, are the best approaches. Consider the use of outdoor spaces for activities as much as possible. Some jurisdictions use tents, platforms, and other temporary structures in spaces adjacent to buildings, such as courtyards, play areas and parking lots for such activities. In considering this approach, please ensure that you consult with the appropriate municipal or State authorities in planning.

Heating, Ventilation, and Air Conditioning (HVAC) Systems

For buildings with facility-wide HVAC systems, consider contracting with experts to assess and assist on how best to maximize those units. Transmission of COVID-19 in most commercial facilities at standard

densities of occupants should be acceptably limited if HVAC systems have a minimum of four to six air changes per hour (ACH) based on square footage/volume of space, no less than 15 cubic feet of ventilation air per minute (CFM) per person, and use filters that have a Minimum Efficiency Reporting Value of 13 (MERV13) or better and/or outside air.

HVAC systems with lower filtration should increase the use of outside air or add supplemental air filtration.

Key Strategies

Increase outdoor air ventilation by bringing in more fresh outdoor air indoors. For example, open windows and doors with or without added mechanical ventilation using exhaust/box fans, can provide large quantities of fresh air and are an excellent method for reducing transmission risk (weather permitting). When possible, orient open windows, doors and fans to create a flow of fresh air through the space by bringing air in on one side and exhausting it on the other.

Ensure ventilation systems are properly maintained.

When possible, filter indoor air by increasing the level of the air filter to MERV13 or higher for recirculated air. Retests are recommended after filter upgrade due to potential impact on air exchange efficiency.

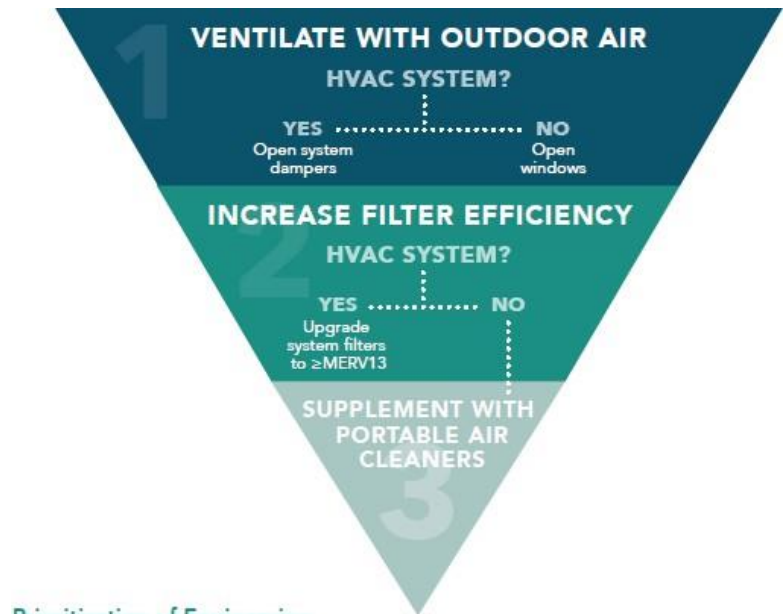
Inspect filters to ensure that they are properly installed, fit correctly, and are changed based on manufacturer's recommendation. Also, maintain indoor relative humidity between 40-60%. Dry air increases transmission of respiratory viruses. Run HVAC systems for at least one hour before occupancy and for two hours after a space is no longer occupied.

Supplement with air cleaning devices including portable air cleaners with high efficiency particulate air (HEPA) filters. Devices should be sized appropriately for the space. This is especially helpful when there are no operable windows and during times when it is not possible to bring in outside air. (e.g., during the winter or inclement weather.)

- When combined with the outdoor or MERV13-filtered air, if available, portable air cleaners with HEPA filters should provide four to six ACH for a room based on square footage and volume of the space. Rooms of reasonable size may require more than one unit in order to achieve four to six ACH.
 - For facilities without HVAC capability, evaluate the options to open windows and doors safely as well as the feasibility of increasing outdoor air intake with box fans in windows.
- Note that devices that simply recirculate the same indoor air without filtering it or replacing it with fresh air are not effective at reducing airborne viruses present in the room. This includes most window air conditioning units, fans used in rooms with closed windows, and fan coils and radiators.

Ensure compliance with State codes. It is important to remember that all improvements and changes must meet the requirements of the State building code and the State fire safety code. For questions regarding these codes, contact your local building official or fire marshal.

- A common issue that may require increased attention is that some of the recommended changes may constitute building systems modifications under the code. Particularly, increases in electrical loads can cause challenges for older buildings. The increase in demand on these existing systems may lead to circuit overloads.



Prioritization of Engineering Controls to Reduce Long-Range Airborne Transmission

Figure 1: Harvard Healthy Buildings Program

Equipment Guide

HEPA Purifier

Air purifiers with HEPA filters and no additional purification features (like ultraviolet or electrostatic precipitations) are the best choice for providing local air purification. They will remove essentially all COVID-19-containing particles. Other technologies, including HEPA filters with added features, can produce a small amount of ozone, which increases asthma risks.

In selecting a unit, look at the CFM it provides. Some units report a clean air delivery rate in cubic meters per hour which will need to be converted to CFM by multiplying by 0.589. In addition to flow rate, other considerations include the amount of noise the unit generates and size and shape of the unit. If noise is not a concern, an industrial purifier or “HEPA scrubber” may provide high air purification rates at relatively low costs.

Air purifiers should be placed as close to the center of the space they are intended to purify as possible and should have clear space around them to allow the free flow of air.

Fans

Box fans, or other portable fans, should be positioned to exhaust air from the space and should have clear space in front and behind. Do not point fans so that the airflow will blow across one person to another. The flow rate of a box fan on high is typically substantial (2000 to 2500 CFM). Exhaust fans are typically found in bathrooms and locker rooms and can be installed in walls or ceilings. They should run constantly, at least when the building is occupied.

Carbon Dioxide Monitors

If you are relying on outdoor air for ventilation, carbon dioxide monitors can provide an estimate of how well ventilated a space is relative to the number of occupants. If carbon dioxide readings in a space exceed 800 parts per million, consider approaches to increase the availability of fresh and/or filtered air. A portable or wall-mounted carbon dioxide monitor can be purchased for \$200 or less. Measurements for a portable monitor should be taken in a central area of the space and tested in multiple locations in large spaces. Carbon dioxide monitoring may be part of your building’s HVAC system. If so, purchasing additional monitors is not necessary.

Frequently Asked Questions

What is the best ventilation practice when using a form of public transportation like a bus?

Ventilating with outside air (no recirculation) and full fans is recommended. Busses should operate with at least one front window and at least one middle window (between the midpoint and the third window from the back) on an opposite side of the bus fully open, or all windows opened at 25%. Open any roof hatches, if available. Also, open bus doors during extended stops to further improve ventilation.

If we are using air purifiers or an HVAC system with MERV-13 or better filtration, should doors remain closed to maximize its use?

Generally, more airflow is better and outdoor air is better than filtered air, so the recommendation is to keep doors and windows open as much as is feasibly possible. There may be cost or safety reasons to close doors and windows, but for COVID-19, the more ventilation, the better. If open doors and windows allow for a cross breeze, you will generally get much more clean air than you would from filtration by the HVAC system and any portable purifiers, especially when combined with fans.

Is it okay to utilize fans that blow across individuals who are in a room?

When practical, we recommend that fans be positioned to exhaust air from a space and avoid blowing air across one person directly to another. However, the benefits of mixing airflow and airflow from additional fans outweigh the potential harm even if those fans blow air from one person to another.

Do ceiling fans provide increased ventilation?

Ceiling fans are beneficial to overall ventilation in an area. They should be set in the reverse/counterclockwise/winter direction so that they pull aerosols up and away from breathing zones and into the air current created by the HVAC system or other fans.