



General Business Ventilation Guidance During the COVID-19 Pandemic

April 29, 2021

This guidance is based on currently available information and will be updated as needed.

Introduction

This guidance applies to all indoor non-healthcare businesses including, but not limited to, movie theaters, offices, restaurants, cafes, liquor stores, dispensaries, grocery stores, hair & nail salons, barber shops, boutiques, and shopping centers. This guidance is intended to aid indoor business owners, building engineers, and heating, ventilation, and air conditioning (HVAC) system professionals on ventilation and air filtration standards to reduce possible airborne exposure to coronavirus SARS-CoV-2 (the virus that causes COVID-19) in rooms and buildings.

This guidance should be used for determining the most effective combination of methods for increasing indoor ventilation and air filtration. The ventilation interventions that are discussed in this guidance come with a range of initial and operational costs, which along with risk assessment parameters such as community incidence rates of COVID-19, facemask compliance and occupancy limits, may affect decisions for which interventions are implemented by business owners²⁰. Be sure to consult with building engineering or HVAC professionals before making any changes to your mechanical ventilation system.

What is ventilation? Ventilation is the process of exchanging or replacing air in any space to provide high indoor air quality, which includes the removal of moisture, odors, smoke, heat, dust, airborne bacteria, carbon dioxide and other gases. Ventilation generally refers to the delivery of outside air into a building's indoor space to maintain satisfactory indoor air quality. This is done by diluting pollutants with clean air and by providing an airflow that removes polluted air from the building.

What is filtration? Filtration is the removal of particles from the air we breathe, such as pollen, mites, and toxins. Filtration works by trapping these harmful particles in a filter. Highly efficient filters can remove smaller particles such as the coronavirus SARS-CoV-2.

Answers to other frequently asked questions (FAQ) are located at the end of this guidance.



Definitions

- **SARS-CoV-2** is the virus that causes COVID-19.
- **Heating, Ventilation, and Air Conditioning (HVAC)**. HVAC is a mechanical ventilation system that is designed to provide temperature control and acceptable indoor air quality.
- **Minimum Efficiency Reporting Value (MERV)**. MERV is an air filter effectiveness measurement that is set and controlled in HVAC systems.
- **Clean Air Delivery Rate (CADR)** is the rate of particle removal from the air. For COVID-19 purposes the “Dust” CADR rating should be used²².
- **Air Changes per Hour (ACH)** is a calculation used to determine the appropriate air cleaning device for the specific room size. The formula for ACH is:
$$\text{ACH} = \text{CADR (cubic feet per minute)} \times 60 \text{ (minutes per hour)} \div \text{room volume (cubic feet)}$$
- **Commercial Exhaust Fans** work by pull or sucking air in one direction. Exhaust fans can be placed in windows or ceilings.
- **Portable Air Cleaners** are devices that can be placed within a building or room to provide air cleaning (filtration). For COVID-19 purposes High-Efficiency Particulate Air (HEPA) cleaners must be used.
- **Natural Ventilation** refers to ventilation that is achieved by opening windows and doors to allow outside airflow.
- **Ultraviolet Germicidal Irradiation (UVGI)** is a disinfection method that uses ultraviolet light to inactivate microorganism.

Ventilation and COVID-19

COVID-19 is the disease caused by the coronavirus SARS-CoV-2, which can spread by droplets and aerosols expelled when an infected person coughs, sneezes, talks, sings, or breathes. Droplets tend to fall within 3 to 6 feet, but aerosols may travel a greater distance and stay in the air for longer. A person can become infected when droplets land on the membranes of the mouth, nose, or eyes, or when air contaminated with the virus is inhaled. A person may also become infected by touching surfaces contaminated with the virus and then touching their nose, mouth, or eyes. Therefore, it is important to stay at least 6 feet away from others (physical distancing), wear a face covering, practice hand hygiene (frequent handwashing), check yourself regularly for COVID-19 symptoms, and stay home when sick or when you have been exposed to someone with COVID-19. Proper ventilation will likely provide added protection against the spread of COVID-19 when used in addition to the above recommended precautions.^{1,2,3}



Every building is different, and a variety of methods may be used to improve ventilation and filtration. Several of these methods are discussed below. It is recommended that businesses involve facility managers, building engineers and HVAC system professionals to reduce airborne exposure in buildings by optimizing ventilation and filtration. HVAC systems are designed according to the building features and occupancy. Any changes to building configuration, such as partitions, occupancy, HVAC system and supplemental equipment (e.g., exhaust fans or portable air cleaners) must be checked and implemented by a qualified HVAC or indoor air quality professional. Improvement in indoor air quality in buildings should be implemented immediately, before businesses reopen and continually throughout occupancy to reduce the risk of transmission of the virus.

HVAC Systems Requirements. The following recommendations are from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)⁵:

- Thoroughly clean and disinfect the HVAC system and building indoor surfaces.
- Adjust the HVAC system to increase outside air to the indoor spaces to 100% or the maximum allowable per air handling unit.
- Use outdoor air quality sensors or reliable web-based data for outdoor pollution information as part of any new or modified ventilation operation.
- Maintain indoor comfort according to the design temperature and relative humidity. According to the World Health Organization (WHO) guidance, avoid setting climate control systems to “cold” low temperatures (below 70°F) and “dry” low humidity settings (below 40%)⁶. ASHRAE recommends a maximum indoor relative humidity of 60%.
- Disable demand-control ventilation (DCV) controls.
- Treat return air and/or supply air to indoor spaces via mechanical filtration. Apply the highest MERV filtration level the HVAC units will allow. ASHRAE recommends a minimum of MERV 13 and MERV 14 or higher is preferred if the equipment can accommodate this level of filtration.
- Operate the HVAC system in occupied mode for a minimum of one week prior to occupancy, if possible.

Keep the HVAC systems running during occupancy and in occupied mode for a minimum period of two (2) hours before opening and two (2) hours after occupancy of the building or longer. If possible, the systems should run in occupied mode 24 hours a day, 7 days a week to maximize ventilation and filtration. Implement a minimum of monthly active maintenance, regular filter replacement, and frequent monitoring, including pressure-drop sensor readings and building occupant complaints. Regularly verify that the system is operating according to current guidance and operating conditions.



Natural ventilation. For buildings that rely on openings such as windows and doors for outside air to enter, maximize the ventilation rate by opening windows and doors, and direct indoor air flow away from occupants to the greatest extent possible^{2,7}. Please note, do not open windows or doors if doing so poses any health or safety risks²⁰. Additionally, supplemental equipment such as exhaust fans and portable air cleaners with HEPA filters may be used to increase indoor air exchange and filter air pollutants. Decrease occupancy in all areas where outdoor ventilation cannot be increased². Temperature, humidity, pollution, noise, vector, security, and safety factors should also be addressed when relying on natural ventilation to maintain health and comfort of building occupants. Note that for buildings with operable windows and HVAC systems, the interactions between the two will need to be carefully considered²⁴.

Supplemental equipment. Commercial exhaust fans and portable air cleaners with HEPA filters, when used correctly, may help reduce the risk of airborne exposure^{2,8}. HEPA filter efficiency is better than MERV 16¹⁰. Exhaust fans must be positioned so they remove air from inside the room and release potentially contaminated air directly outdoors. Place exhaust fans at ceiling height to move air up and out. Window fans that are placed securely in windows and exhaust room air outdoors are also recommended²⁰. Ensure fans are not blowing out of windows directly into walking paths or areas where individuals may congregate. Do not recirculate exhaust air or direct air to flow from one person to another. Ceiling fans should be turned off unless they are necessary for the thermal comfort of the building's occupants²⁴. If ceiling fans are essential for thermal comfort, then adjust fans so that blades are rotating in a direction that draws air up toward the ceiling rather than down onto occupants. Portable air cleaners are rated by the Association of Home Appliance Manufacturers. The rate of particle removal from air is termed the clean air delivery rate (CADR). For the purpose of COVID-19, the **smoke** CADR rating is recommended²⁴. Determine the appropriate device according to the room dimensions and the CADR of the device to reach a desired air exchange rate in air changes per hour (ACH) of at least 5 using the following equation^{9,10}.

$$\text{ACH} = \text{CADR (cubic feet per minute)} \times 60 \text{ (minutes per hour)} \div \text{room volume (cubic feet)}$$

Place portable air cleaners with HEPA filters where air intake and discharge are not obstructed, for example away from walls, furniture, or curtains. Direct portable air cleaner airflow so it does not blow directly from one person to another. Regularly replace the HEPA filters. Portable air cleaners must be certified by the California Air Resources Board (CARB) to meet electrical safety and ozone emissions. For a list of air-cleaning devices that comply with California's ozone emissions limits, refer to the California Air Resources Board's list of California Certified Air Cleaning Devices at <https://ww2.arb.ca.gov/list-carb-certified-air-cleaning-devices>¹¹.

Additional supplemental equipment. Research suggests that Upper-room UVGI can inactivate SARS-CoV-2 while it is suspended in the air²¹. The CDC recommends considering the usage of Ultraviolet Germicidal Irradiation (UVGI) as an additional supplement to help inactivate coronavirus



SARS-CoV-2, particularly when options for increasing room ventilation are limited²⁰. The design and sizing of Germicidal Ultraviolet (GUV) or UVGI systems requires expertise. Consult a reputable manufacturer or an experienced system designer prior to installation²⁰.

Isolated rooms and spaces. Some rooms and spaces in buildings may generate higher load of airborne pathogens including SARS CoV-2.

- Restrooms can be a risk of generating airborne droplets and droplet residues that could contribute to transmission of pathogens¹⁰. Flush all toilets, water taps and showers before the business opens. Keep bathroom exhaust systems running all day, every day (24 hours a day, 7 days a week). Keep toilet room doors closed, even when not in use, and windows closed unless it directly opens outside; since the virus can be present in fecal matter²⁴, put toilet seat lids down **if there is one, before flushing**; and vent separately where possible (e.g., turn exhaust fan on if vented directly outdoors and run fan continuously).
- Inspect and maintain local exhaust ventilation in support areas, such as laundry rooms and cooking areas, such as the kitchen²⁴. Operate local exhaust ventilation in the cooking area any time this space is occupied and consider operating this system even when the area is not occupied to enhance overall ventilation within the building²⁰.
- In conference rooms and private offices keep doors open to allow airflow and consider placing portable HEPA filters²³.
- In elevators, limit riders, turn on elevators cab (lift) ventilation fans where possible, and consider putting portable HEPA filters in elevators that have vulnerable riders (e.g., senior citizens)²³. For low rise buildings consider having elevators stop at every floor, and advice riders to always keep masks on and to limit talking²³.
- In stairways, turn on fans if they are accessible (e.g., stairwell pressurization), open windows where outside conditions allow, and install portable HEPA filters²³.

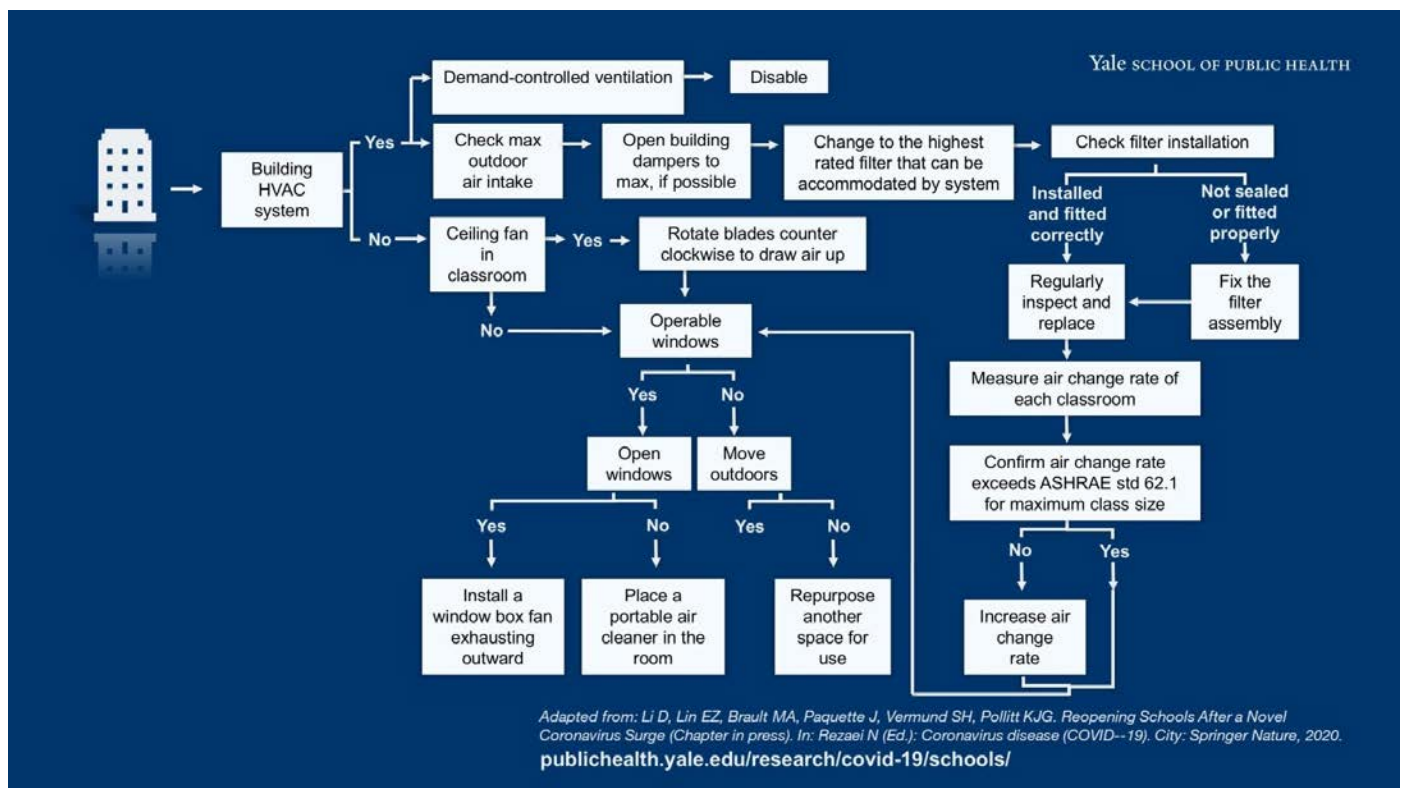
HVAC System Maintenance: HVAC system maintenance and filter replacement guidance during the COVID-19 pandemic, which includes PPE guidance for HVAC maintenance staff can be viewed at <https://www.ashrae.org/technical-resources/filtration-disinfection>.

Outdoor air pollution: Wildfire smoke. During wildfire season, smoke may pollute the air. Outdoor air pollution such as wildfire smoke must be addressed in addition to implementing the indoor air quality improvements above. When wildfires are nearby, check <https://www.airnow.gov/> for air quality information. For buildings with HVAC systems, install MERV 13 or highest filtration level that the HVAC units will allow¹⁵. Pressure gauges may be installed across the filter to indicate when the filter needs replacing, especially in very smoky or dusty areas¹⁶. Monitor the HVAC system to replace the filters as often as necessary. When the Air Quality Index (AQI) is higher than 100 or outdoor air



quality is unhealthy^{15,17}, use portable air cleaners with HEPA filters and CADR that can achieve an ACH of at least 5 using 2/3 of the room volume^{9,18}. If the recommended ventilation and filtration standards are not achieved, stay home to limit potential transmission/exposure of coronavirus outside of the household during days with unhealthy outdoor air quality. For further guidance on wildfire smoke and outdoor pollution refer to the Alameda County Air Quality Communications Protocol at <http://www.acgov.org/sustain/what/resilience/documents/201911AlamedaCountyAQCommProtocol.pdf>.

Use this flow diagram¹⁹ as a guide to determine how to address ventilation and filtration in your building.





Ventilation Frequently Asked Questions (FAQ)

1. Can we use partitions to separate room spaces?

Partitions affect the air flow inside a room. The HVAC system must be designed to account for any partitions or room configuration; for example, placement of furniture such as bookshelves. If you are re-configuring rooms in your building, involve your building engineer or HVAC professional. Proper ventilation is important and must be used together with using masks and staying at least 6 feet away from one another.

2. What can we do if our building's HVAC system cannot accommodate MERV 13 filters?

Use a combination of methods included in this guidance to reduce potential exposure to airborne viruses inside the building. Use portable air cleaners with HEPA filters according to the **supplemental equipment** section above. Decrease occupancy or move outdoors if the recommended level of filtration is not achieved.

3. What can we do if our building does not have a HVAC system?

Use a combination of methods included in this guidance to reduce exposure to potential airborne viruses inside the building. Follow the **natural ventilation** and **supplemental equipment** sections above to increase outside air and filter air inside the building. Decrease occupancy or move outdoors if the required level of ventilation and filtration is not achieved.

Carbon dioxide measurement is a useful screening method for determining whether adequate quantities of outside fresh air have been introduced and distributed into the building. Carbon dioxide measurements should be conducted by an indoor air quality or environmental professional qualified to perform this evaluation according to Occupational Safety and Health Administration (OSHA), ASHRAE and USEPA guidance.

4. What can we do if our building does not have a HVAC system and windows?

Confirm with the local building and fire departments that your building is compliant with building and fire codes. If there is no ventilation in the rooms, move outdoors or find another space with proper ventilation. Look into obtaining funding to achieve indoor air quality that promotes occupant health and well-being.



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