



## **Guidance on Ventilation in School Buildings During the COVID-19 Pandemic**

This guidance is based on available information and may change as information continue to evolve.

COVID-19 is the disease caused by the coronavirus SARS-CoV-2 which is potentially spread by both large and small droplets expelled when an infected person coughs, sneezes, talks, sings, or breathes. Larger droplets tend to fall within 3 to 6 feet, but smaller droplets may travel a greater distance and linger in the air for a longer period. Susceptible persons can become infected when droplets land on the mucous membranes of the mouth, nose, or eyes; or when the person inhales air contaminated with the virus. A person may also become infected by touching contaminated surfaces and then touching their nose, mouth, or eyes. This is why it is important to stay at least 6 feet away from other individuals (physical distancing), wear a face covering, practice good hygiene (frequent handwashing and disinfection), check for COVID-19 symptoms regularly and stay home when sick. Proper ventilation should be addressed in addition to all the COVID-19 precautions recommended by public health agencies<sup>1,2,3</sup>.

Every building is different. It is recommended that school administrators involve facility managers, building engineers and heating, ventilating, and air conditioning (HVAC) system professionals to reduce airborne exposures in school buildings by optimizing ventilation and filtration. HVAC systems are designed according to the building features and occupancy. Any changes to the building configuration e.g., partitions, occupancy, HVAC system and supplemental equipment such as exhaust fans and portable air cleaners with high-efficiency particulate air (HEPA) filters to control the spread of the virus through indoor air, must be checked and implemented by a qualified HVAC or indoor air quality professional. Indoor air quality in schools impacts health and academic performance<sup>4</sup>. Improvement in indoor air quality in school buildings must be planned now to reduce the risk of transmission of the virus and enhance occupants' well-being in the long term. Implementation should start immediately and before re-opening schools.

**HVAC systems.** Follow recommendations by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)<sup>5</sup>. Before re-occupancy of school buildings,

- Thoroughly clean and disinfect the HVAC system and building 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 the new/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%)<sup>6</sup>. 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 Minimum Efficiency Reporting Value (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 pressure drop.
- Operate the HVAC system in occupied mode for a minimum of one week prior to occupancy.

Keep systems running during occupancy and in occupied mode for a minimum period of two (2) hours before and after occupancy of the building or longer hours, if possible 24 hours a day, 7 days a week. Implement a minimum of monthly active maintenance, a regular filter replacement frequency and frequent monitoring including pressure-drop sensor readings, building occupant complaints and COVID-19 symptom and case reports. 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 inside, maximize ventilation rate by opening windows and direct air flow away from occupants<sup>2,7</sup>. Supplemental equipment such as exhaust fans and portable air cleaners with HEPA filter may be employed to increase indoor air exchange rate and filter air pollutants. Decrease occupancy in areas where outdoor ventilation cannot be increased<sup>2</sup>. Temperature, humidity, noise, vector, and safety factors will also need to be addressed to maintain health and comfort of building occupants.

**Supplemental equipment.** Exhaust fans (not regular fans typically used in households) and portable air cleaners with HEPA filters, when used correctly, may help reduce risk of airborne exposure<sup>2,8</sup>. Exhaust fans must be positioned such that 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. Ensure fans are not blowing out of windows directly into walking paths or areas where individuals may congregate. Ceiling fans should be adjusted so that fins are rotating in a direction that draws air up toward the ceiling rather than down onto occupants. Do not recirculate exhaust air or direct air to flow from one person to another. 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). 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<sup>9,10</sup>.

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



Place portable air cleaners with HEPA filters where air intake and discharge are not impeded e.g., not near furniture or behind curtains. Direct the airflow of the air cleaner 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<sup>11</sup>.

**Isolation spaces.** Some rooms in schools may generate higher load of airborne pathogens including coronavirus. The school nurse office or clinic should have at least a dedicated HVAC capable of 100% outside air and ventilation rate of at least 12 ACH<sup>5</sup>. Toilets can be a risk of generating airborne droplets and droplet residues that could contribute to transmission of pathogens<sup>10</sup>. Flush all toilets, water taps and showers before the school reopens. 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; put toilet seat lid 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.

**Disinfection.** Building surfaces should be disinfected at the end of each day and high-touch areas disinfected more frequently. Close off areas used by individuals with COVID-19 symptoms or positive test results and wait at least twenty-four (24) hours before cleaning and disinfecting these areas<sup>2</sup>. Do not use these areas until cleaned and disinfected. Use disinfectants registered with the US Environmental Protection Agency for use against SARS-CoV-2 (COVID-19) and follow the product label directions<sup>12</sup>. Increase ventilation during and after cleaning including by opening windows and/or doors, when feasible<sup>13</sup>.

**Outdoor air pollution: Wildfire smoke.** During wildfire season, smoke may pollute the air. Children are especially at risk for health effects from exposure to wildfire smoke and ash, mostly because their lungs are still growing<sup>14</sup>. 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 [www.airnow.gov](http://www.airnow.gov) for air quality information. For buildings with HVAC systems, install MERV 13 or higher filtration level that the HVAC units will allow<sup>15</sup>. Pressure gauges may be installed across the filter to indicate when the filter needs replacing, especially in very smoky or dusty areas<sup>16</sup>. 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<sup>15,17</sup>, 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<sup>9,18</sup>. 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.



## References

1. World Health Organization (WHO). Considerations for school-related public health measures in the context of COVID-19. May 10, 2020. Available online at <https://www.who.int/publications/i/item/considerations-for-school-related-public-health-measures-in-the-context-of-covid-19>
2. Centers for Disease Control and Prevention (CDC). Operating schools during COVID-19: CDC's Considerations. Sept. 1, 2020. Available online at <https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/schools.html>
3. California Department of Public Health (CDPH). COVID-19 INDUSTRY GUIDANCE: Schools and School-Based Programs. August 3, 2020. Available online at <https://files.covid19.ca.gov/pdf/guidance-schools.pdf>
4. United States Environmental Protection Agency (USEPA). Improve Academic Performance through Better Indoor Air Quality in Schools. Available online at <https://www.epa.gov/iaq-schools/improve-academic-performance-through-better-indoor-air-quality-schools>
5. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Reopening of Schools and Universities. Available online at <https://www.ashrae.org/technical-resources/reopening-of-schools-and-universities>
6. WHO. Q&A: Ventilation and air conditioning and COVID-19. July 29, 2020. Available online at <https://www.who.int/news-room/q-a-detail/q-a-ventilation-and-air-conditioning-and-covid-19>
7. WHO. Natural Ventilation for Infection Control in Health-Care Settings. 2009. Available online at [https://apps.who.int/iris/bitstream/handle/10665/44167/9789241547857\\_eng.pdf;jsessionid=2A4D0F38628F00F4392D92AE5F4AF89A?sequence=1](https://apps.who.int/iris/bitstream/handle/10665/44167/9789241547857_eng.pdf;jsessionid=2A4D0F38628F00F4392D92AE5F4AF89A?sequence=1)
8. USEPA. Air Cleaners, HVAC Filters, and Coronavirus (COVID-19). Available online at <https://www.epa.gov/coronavirus/air-cleaners-hvac-filters-and-coronavirus-covid-19>
9. Environment International. How can airborne transmission of COVID-19 indoors be minimised? Volume 142, September 2020, 105832. Available online at <https://www.sciencedirect.com/science/article/pii/S0160412020317876>
10. ASHRAE. Filtration/Disinfection. Available online at <https://www.ashrae.org/technical-resources/filtration-disinfection>
11. California Air Resources Board (CARB). California Certified Air Cleaning Devices. Available online at <https://ww2.arb.ca.gov/our-work/programs/air-cleaners-ozone-products/california-certified-air-cleaning-devices>
12. USEPA. List N: Disinfectants for Use Against SARS-CoV-2 (COVID-19). Available online at <https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2-covid-19>
13. USEPA. Ventilation and Coronavirus (COVID-19). Available online at <https://www.epa.gov/coronavirus/ventilation-and-coronavirus-covid-19>
14. USEPA. Wildfire Smoke Factsheet: Protecting Children from Wildfire Smoke and Ash. Available online at [https://www3.epa.gov/airnow/smoke\\_fires/protecting-children-from-wildfire-smoke-and-ash.pdf](https://www3.epa.gov/airnow/smoke_fires/protecting-children-from-wildfire-smoke-and-ash.pdf)
15. California Environmental Protection Agency (CalEPA). Guidance for Schools During Wildfire Smoke Events. Available online at <https://oehha.ca.gov/media/downloads/air/factsheet/wildfiresmokeguideschoolsada.pdf>



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16. USEPA. Wildfire Smoke: A Guide for Public Health Officials. Available online at <https://www3.epa.gov/airnow/wildfire-smoke/wildfire-smoke-guide-revised-2019.pdf>
17. AirNow. Available online at <https://www.airnow.gov/aqi/aqi-basics/>
18. CDC. COVID-19 Considerations for Cleaner Air Shelters and Cleaner Air Spaces to Protect the Public from Wildfire Smoke. <https://www.cdc.gov/coronavirus/2019-ncov/php/cleaner-air-shelters.html>