SCHOOL VENTILATION:
A VITAL TOOL TO REDUCE COVID-19 SPREAD

MAY 2021

SUMMARY OF THE REPORT ISSUED BY THE JOHN HOPKINS BLOOMBERG SCHOOL OF PUBLIC HEALTH'S CENTER FOR HEALTH SECURITY

TECHNICAL AIR SYSTEMS, INC.
A Comfortable Choice

- The following is a summary by Technical Air Systems, Inc. of the Johns Hopkins Bloomberg School of Public Health's Center for Health Security's report entitled, School Ventilation: A Vital Tool to Reduce COVID-19 Spread issued May, 2021.
- The report in its entirety can be found at: https://www.centerforhealthsecurity.org/our-work/pubs_archive/pubs-pdfs/2021/20210526-school-ventilation.pdf
- Citation:
  - Olsiewski PJ, Bruns R, Gronvall GK, et al. *School Ventilation: A Vital Tool to Reduce COVID-19 Spread*. Baltimore, MD: Johns Hopkins Center for Health Security; 2021.
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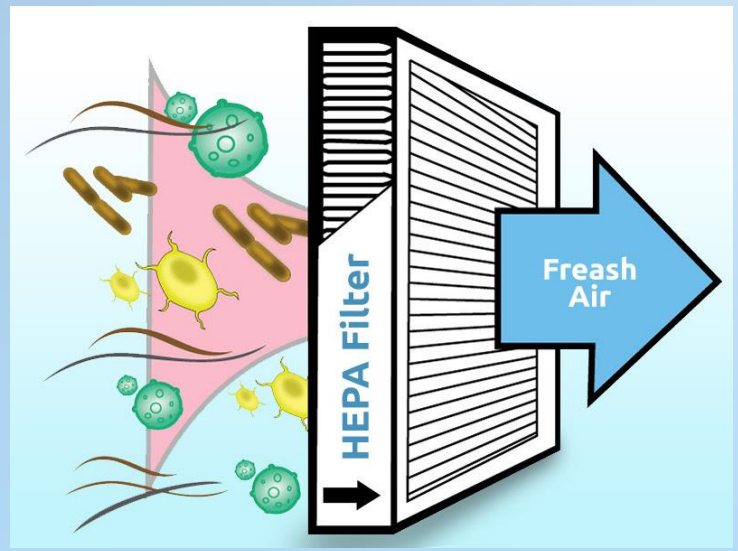
EXECUTIVE SUMMARY

- Many kindergarten through 12th grade (K-12) schools in the United States do not have good ventilation.
- During the COVID-19 pandemic, it is even more important that ventilation problems in K-12 schools be addressed now.
- This report focuses on an important component of cleaning and maintaining healthy facilities: ventilation. Improvements in ventilation can help reduce risk of transmission of SARS-CoV-2 and other infectious diseases and improve students' overall health and ability to learn.
- A broad conclusion of this research is that the benefits to investing in healthy air in schools have the potential to outlast the COVID-19 pandemic.

RECOMMENDATIONS

FLEXIBLE FUNDS ARE NOW AVAILABLE UNDER THE AMERICAN RESCUE PLAN TO INVEST IN K-12 SCHOOLS TO REDUCE RISKS RELATED TO COVID-19.



Our specific recommendations, in order of near- to long-term priorities, are:

1. **School administrators and decision makers should improve school ventilation now by bringing in as much outdoor air as the heating, ventilation, and air conditioning (HVAC) system will safely allow and upgrading filtration.**

2. School administrators and decision makers should purchase HEPA air filtration units to be placed in classrooms and common occupied spaces.

- Even if ventilation in a school already meets current building standards (many do not), additional air filtration from a portable device can help reduce the potential for SARS-CoV-2 transmission. Portable HEPA air filters are easy to use, HEPA filtration is a proven technology, and the units have the advantage of being always "on."

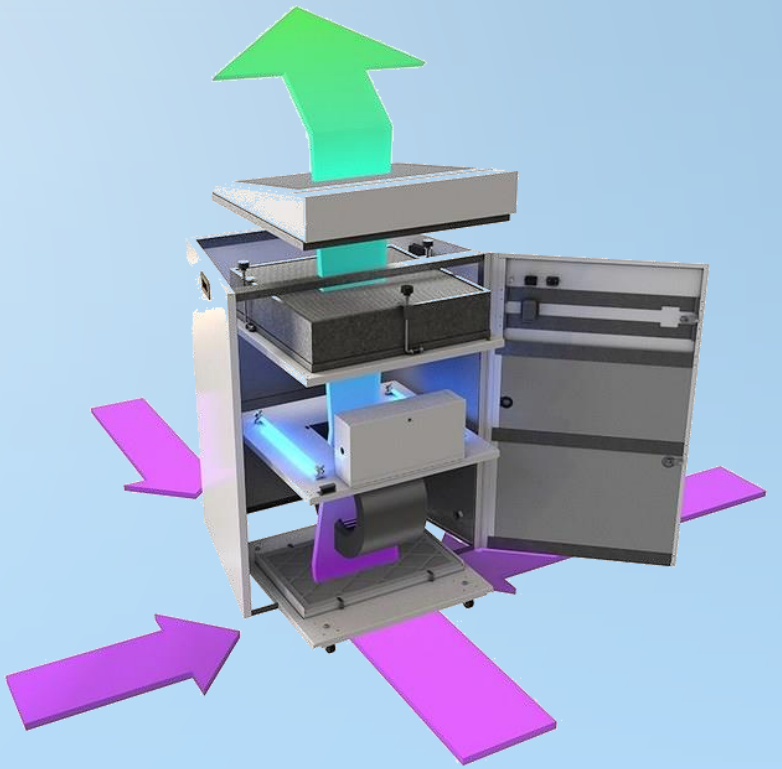
RECOMMENDATIONS

3. **School systems should use only proven technologies for improving indoor air quality: appropriate ventilation, HEPA filtration, or ultraviolet germicidal irradiation. They should not use chemical foggers or any "air cleaner" other than filtration and ultraviolet germicidal irradiation.**

- School systems should not use unproven technologies such as ozone generators, ionization, plasma, and air disinfection with chemical foggers and sprays. The effect of these cleaning methods on children has not been tested and may be detrimental to their health.

4. **School administrators and decision makers should stop enhanced cleaning, disinfecting, "deep clean" days, and any other expensive and disruptive cleaning.**

- School systems should regularly clean high-touch surfaces and disinfect spaces if a case is identified in the classroom or shared space, in accordance with CDC guidance. Schools should also provide proper hand hygiene resources. Fomite (surface) transmission is not a major driver of the spread of SARS-CoV-2. Investments in ventilation will provide more value in risk reduction.



RECOMMENDATIONS

5. School administrators and decision makers should install mechanical ventilation systems where none exist and upgrade those that do not meet current standards.

6. The US government should convene a federal task force dedicated to school air quality to develop guidance for long-term, sustainable, cost-effective improvements to indoor air quality in schools. This guidance should include accountability measures to assess improvements.

VENTILATION PROBLEMS IN US K-12 SCHOOLS PREDATE COVID-19

- Poor air quality in K-12 schools is a longstanding concern, predating COVID-19.
- According to a nationwide survey of school districts performed by the Government Accountability Office (GAO) in June 2020, 54% of public school districts needed to update or replace multiple building systems or features in their schools.
- The study did not investigate closures or conditions resulting from COVID -19.
- GAO visited 55 schools in 6 states, half of which reported HVAC-related problems.
- An estimated 41% of districts need to update or replace HVAC systems in at least half of their schools, which represents about 36,000 schools across the nation in need of updates to HVAC systems.

VENTILATION PROBLEMS IN US K-12 SCHOOLS PREDATE COVID-19

- The EPA has compiled extensive evidence supporting the correlation between indoor air quality and student performance, absenteeism, and even teacher retention
- For teachers, school facility conditions were noted as an important factor in teaching quality.
- In a teacher-reported survey of facility conditions in Chicago and Washington, DC, poor indoor air quality was the most frequently cited problem.

VENTILATION PROBLEMS IN US K-12 SCHOOLS PREDATE COVID-19

- People emit carbon dioxide and other bioeffluents, but the impact of human emissions on indoor air quality is poorly understood
- A 2017 review of ventilation problems in schools found that ventilation rates in classrooms fell far short of minimum ventilation rates outlined in ASHRAE standards for air quality
- In 8 of 11 studies reviewed, researchers found an association between inadequate ventilation rates or elevated carbon dioxide concentrations and decreases in at least 1 metric of student performance.
- The 2017 review also reported that with increased ventilation rates or lower carbon dioxide concentrations, there were statistically significant improvements in student performance, including a decline in absence rates

VENTILATION PROBLEMS IN US K-12 SCHOOLS PREDATE COVID-19

- A 2020 study showed that increasing the ventilation rates in classrooms could bring significant benefits in learning performance and pupil attendance, providing a strong incentive for improving classroom air quality.
- Even when school districts invest in upgrading their HVAC systems, serious problems may still remain.
- The problems that were detected highlight the need for better oversight on HVAC system installation and commissioning to ensure adequate classroom ventilation, as well as the need for periodic testing of ventilation systems and ongoing maintenance checks.
- According to the GAO survey of the 50 states and District of Columbia, most states do not conduct statewide assessments. School districts are usually responsible for such assessments, with funding to address identified facility needs coming from districts that likely have already strained budgets.

PRIORITIZING VENTILATION DURING COVID-19

- Improvements to ventilation and indoor air quality in school buildings, which have not been sufficiently prioritized over the past year, should be used as a key mitigation tool.
- All too often, information regarding the importance and implementation of ventilation improvements to combat COVID-19 has been underemphasized, lacking sufficient detail, or left out entirely.
- This neglect has been attributed to either a reluctance to recognize aerosol SARS-CoV-2 transmission or the perception that ventilation improvements are highly technical and expensive, especially in comparison to more simple, straightforward recommendations such as universal masking or physical distancing.
- Schools should stop deep clean days as a matter of routine; investments in ventilation will provide more value in risk reduction.

EVIDENCE BASE FOR VENTILATION EFFECTIVENESS IN REDUCING SARS-COV-2 TRANSMISSION

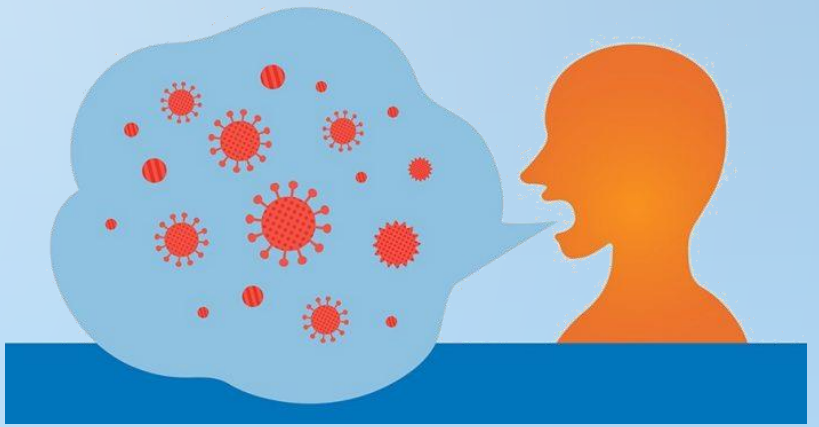
- Considerable evidence indicates that the primary means of SARS-CoV-2 virus transmission is through the air, that there is an increased risk of transmission in indoor environments, and that the risk from fomite transmission is low.
- There is extensive evidence that the SARS-CoV-2 virus can be spread through the air in a crowded indoor environment
  - For example, air samples from hospital rooms previously occupied by COVID-19 patients have yielded SARS-CoV-2 virus capable of infection in laboratory samples in low concentrations
- Actions such as exhaling, talking, and coughing release microdroplets that pose an exposure risk for individuals, even at distances over 1 to 2 meters from the infection source.

EVIDENCE BASE FOR VENTILATION EFFECTIVENESS IN REDUCING SARS-COV-2 TRANSMISSION

- Given typical indoor air velocities with HVAC systems, 5 micron droplets can evaporate and move over 10 meters when originating at a height of 1.5 meters.
- Experimental studies have shown that aerosolized particles of SARS-CoV-2 are stable and viable for several hours, with a half-life over 1 hour.
- When considering indoor environments where students are gathered for long periods of time, an emphasis should be made on reducing the likelihood of airborne transmission, particularly as schools will be following a combination approach (ie, masks, spacing, testing) to reduce risks.

EVIDENCE THAT VENTILATION EFFECTIVENESS IN REDUCING SARS-COV-2 TRANSMISSION

- HVAC systems with proper filtration remove exhaled viral particles in indoor air and lower the concentration of virus particles in the room, allowing people to use the room longer at the same infection risk.
- Ventilation alone may also be more effective as a mitigation tool than low-quality or poorly fitted masks, and in combination with other mitigation measures (eg, the use of good quality, well-fitted masks; physical distancing), it can greatly decrease the probability of SARS-CoV-2 infection.
- One modeling study found that an infected person speaking for 1 hour in a poorly ventilated room could lead to infection risk levels of 10% to 20%, but this risk would be reduced by a factor of at least 3 if the ventilation system was increased to 10 air changes per hour.



GUIDANCE ON ALTERING VENTILATION TO REDUCE COVID-19 RISKS

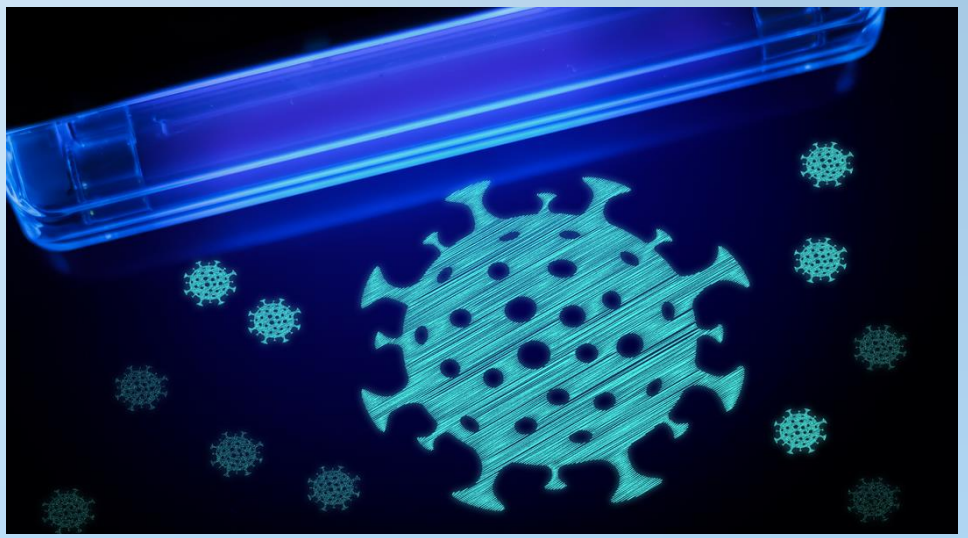
- CDC recommendations on ventilation in schools and childcare programs reflect ASHRAE guidance.
- CDC and ASHRAE guidance focus on providing and maintaining outdoor airflow, increasing ventilation with HVAC system settings, and filtering the air.
- In addition, ASHRAE and the CDC recommend that building managers verify that HVAC systems are properly operated and maintained.

GUIDANCE ON ALTERING VENTILATION TO REDUCE COVID-19 RISKS

- For schools with natural ventilation, opening windows and doors when possible to bring in outdoor air is an effective way to enhance airflow and reduce the concentration of virus particles.
- To refresh air in occupied spaces, an HVAC system should be run for 2 hours before the building is occupied.
- To increase filtration, especially in high-risk areas, air filter units that use HEPA filters can be added to the space to enhance air cleaning.

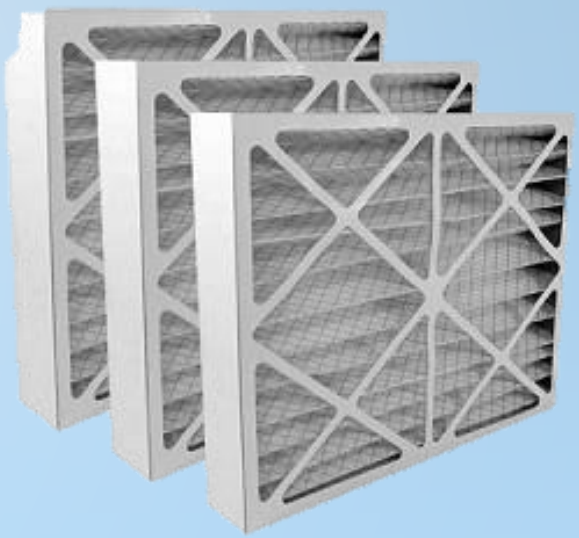
GUIDANCE ON ALTERING VENTILATION TO REDUCE COVID-19 RISKS

- If ventilation and filtration options are limited, CDC guidance recommends that ultraviolet germicidal irradiation be considered as a supplemental treatment to inactivate the virus that causes COVID-19.
- There are a number of commercially available technologies that claim to disinfect air using ozone, bipolar ionization, oxidation, plasma, or foggers, but they have not been shown to be safe and effective in the peer-reviewed literature.



GUIDANCE ON ALTERING VENTILATION TO REDUCE COVID-19 RISKS

- The ASHRAE guidance describes in detail the recommended ventilation rates, temperature, and filtration.
- In terms of ventilation, the highest achievable air change rate that will not generate excessive noise or have a negative impact on space air distribution should be used, while also ensuring flow patterns maximize appropriate circulation of air in classrooms.
- In terms of filtration, ASHRAE recommends selecting a filtration level that is maximized for the equipment capabilities, while assuring the pressure drop is less than the fan's capability.
- A MERV 13 or better should be used if equipment allows, but MERV 14 or better is preferred per filtration and disinfection guidance.
- ASHRAE also has a 2-page guide for selecting in-room air cleaners for reducing SARS-CoV-2 in the air.



GUIDANCE ON ALTERING VENTILATION TO REDUCE COVID-19 RISKS

Brief Summary of ASHRAE's Recommended Actions for Schools

1. Schools should use the best filters that the HVAC system can handle, selecting MERV 13 or higher if equipment allows.
2. Schools should place terminal/fixed or portable HEPA filtration devices in each classroom, targeting the highest achievable air change rate that will not generate excessive noise.
3. Schools should maximize outdoor airflow by delivering design ventilation to all occupied spaces, rather than using demand-controlled ventilation systems using carbon dioxide sensors.
4. Schools should apply and use outdoor air quality sensors or reliable web-based data for outdoor pollution information as part of the new ventilation operation. If outdoor air is not healthy, more filtration will be needed.
5. Schools should perform monthly checks of air-handling units and rooftop units, especially checking for particulate accumulation on filters, in order to verify that HVAC systems are functioning as designed

PRIORITIZING RECOMMENDATIONS

- Any analysis or policy recommendation on cost-effectiveness must be based on likely costs and effectiveness under variable real-world conditions, not laboratory conditions.
- Two principles are important: (1) incentives matter and (2) what gets measured gets done.
- Researchers have shown that school administrators are often unaware of technical issues related to building maintenance.
- The failure to continuously monitor HVAC maintenance increases the probability that performance will be at the lower end of the laboratory-measured range.

PRIORITIZING RECOMMENDATIONS

- In contrast, it is much easier for nontechnical school staff and teachers to verify that the portable filter units are turned on and that filters were changed than to troubleshoot an HVAC system.
- As the maintenance requirements are much easier to communicate than the more technical messaging required for HVAC upgrades, and because air filtration units are mass-produced and delivered ready-to-use (ie, unbox and plug in), there is less chance of significant failure or underperformance with portable filter units,
- There is a high probability that they will work in a classroom about as well as they do in the lab.

SCHOOL AIR QUALITY TASK FORCE

- Many people in agencies across government have complementary knowledge and skills to contribute to improving school air quality, and they can and should be gathered to form a working group to share this knowledge.
- A longer-term solution to the problem of poor air quality in schools is needed, as well as the establishment of a set of minimum standards for states and local governments to adopt for K-12 schools, which should include maintenance.

RECOMMENDATIONS

Given the information we have presented in this report, our recommendations are:

1. School administrators and decision makers should improve school ventilation now by bringing in as much outdoor air as the HVAC system will safely allow and upgrading filtration.

2. School administrators and decision makers should purchase HEPA air filtration units to be placed in classrooms and common occupied spaces.

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CONCLUSION

- Airborne transmission of SARS-CoV-2 virus, the virus responsible for the COVID-19 pandemic, can be reduced by improving ventilation.
- Federal funds are now available to enable schools to make the needed changes. These changes will make our schools healthier during the current pandemic.
- If improved ventilation is properly installed, operated, and maintained, students and educators will benefit for years to come.
- The evidence-based recommendations described in this report can help schools and school districts to address COVID-19-related and longstanding ventilation problems.
- The report can provide a foundation for infrastructure investments that reliably use proven technology to raise the air quality in schools, which will improve student learning and the health of everyone in school buildings for decades to come.