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Ventilation in Schools

A Review of State Policy Strategies

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Building ventilation is a key strategy for improving indoor air quality. Well before the COVID-19 pandemic, research demonstrated the importance of outdoor air ventilation – and the related practice of air filtration – for reducing indoor exposure to viruses and to a host of common air pollutants. The pandemic highlighted both the need for proper ventilation and the fact that millions of students attend schools with inadequate ventilation and indoor air quality. The burden of these conditions is not distributed equally, due in part to disparities in school facilities funding by community wealth, rural location, and student race and ethnicity.

Heightened public awareness presents states with an unprecedented opportunity to advance new policies addressing school ventilation, to help ensure that existing school facilities are healthier now and better equipped to handle future emergencies. This report discusses key policy strategies for states to consider and describes how current state policies incorporate those strategies.

Ventilation and Filtration are Proven and Cost-Effective Measures for Reducing Indoor Exposures and Supporting Health and Learning. There are well-established methods for improving school ventilation and filtration to reduce indoor exposure to pollutants and infectious aerosols. These practices have been incorporated into national standards and guidance documents that provide a starting point for the development of state policies addressing school building design, construction, operation, and maintenance. There is also considerable evidence that improving ventilation and filtration in schools can improve student and teacher health, attendance, and performance, and at the same time can lower costs associated with both negative health outcomes and building system failures requiring major repairs.

State Policy is Vital to Advancing Good Ventilation and Indoor Air Quality in All Schools. Local education agencies have primary responsibility for managing their facilities, and many schools have taken important steps to implement ventilation and indoor air quality best practices, both before and during the COVID-19 pandemic. However, without statewide policies, facility practices and conditions may vary significantly from one school district to another. Policymakers can advance health and educational equity by establishing statewide ventilation and filtration standards and providing the resources needed to meet those standards.

Most States have Ample Authority to Address School Ventilation. The development of new or strengthened state policies generally begins with a review of policies and programs that already exist within the state, as well as those established in other states. Most states already have laws or regulations on the books that address school facility conditions in some manner, and those policies are found in several different areas of state authority. A majority of states have occupational safety and health rules for schools and other workplaces. Some states have public health policies governing a range of school sanitation and environmental health issues, and states that provide funding for school capital improvements commonly have education laws and regulations to ensure that school buildings are properly maintained. Where multiple agencies have policies addressing school ventilation and indoor air quality, a formal mechanism for interagency coordination may be needed to ensure a consistent

approach and effective use of state resources. Regardless of which areas of state authority are involved, it is critical for policymakers to provide adequate and sustained agency funding to implement the policies.

Stronger Statewide Policies are Needed to Address Ventilation in Existing Schools. The potential for state policy to advance ventilation and indoor air quality best practices in existing schools remains largely untapped. Most current state policies lack the foundational elements of an effective and comprehensive approach: clear ventilation and filtration requirements, oversight mechanisms for facilitating compliance, and equitable financial and technical assistance programs. While the decades before the COVID-19 pandemic saw relatively slow progress in the adoption of state policies governing school ventilation, the pandemic has produced a proliferation of such measures. Most of the new policies took the form of agency guidance, but a small number of states adopted new laws and regulations that established ventilation-related requirements, and several states created new funding policies and programs focused on school ventilation.

This report reviewed current state policies that address the following strategies for promoting good ventilation.

Ventilation and Filtration Standards and Practices for General Operations. The past few years have sparked increased public discussion of the need for stronger ventilation and filtration standards. New national standards may be on the way, but policymakers need not wait to reduce indoor air risks in existing schools. Ventilation and filtration requirements can be established as prescriptive standards (e.g., ventilation rate or filtration efficiency) or as required practices (e.g., facilities maintenance and reporting). The requirements should build on well-established technical best practices, set clear expectations for school districts, and be framed in a way that allows schools to document compliance. When integrated with measures to advance energy-saving maintenance and operations practices, stronger ventilation and filtration requirements can advance both health and environmental goals.

- Ventilation Assessment/Inspection. Regular facility reviews help ensure that ventilation and filtration are provided in accordance with system specifications and state requirements. Periodic comprehensive assessments, along with annual inspections, are important for documenting ventilation functioning, determining needed repairs, and identifying opportunities for improving ventilation and filtration as appropriate. Many states have school facilities assessment and/or inspection policies already in place that can be strengthened by establishing more detailed requirements and ensuring reporting of the results.

- Ventilation Maintenance Practices. Many states require schools to maintain their facilities, and several have adopted policies and guidelines that set forth specific maintenance practices. By requiring a written ventilation maintenance plan that meets statewide criteria, states can help ensure consistency across schools and can advance best practices, such those included in ASHRAE Standard 62.1 or the Environmental Protection Agency's Tools for Schools Action Kit. State policies can also establish criteria and guidance for using carbon dioxide monitoring or other methods to identify and correct ventilation problems.

- Ventilation Standards. Most states that establish ventilation standards for existing schools require compliance with the standard that applied at the time the building was constructed or

the system was installed. One step states can take is to ensure schools are meeting this minimum, facility-specific standard. States can go further by setting a ventilation standard that all schools must meet – e.g., the current state building code or ASHRAE 62.1 standard, or a higher standard, as has been recommended during the pandemic to further reduce indoor air risks. In adopting a ventilation standard for all existing schools, states could incorporate flexible implementation approaches that account for differences in school HVAC system capacity.

- Filtration. Few states have established minimum air filtration standards for existing schools other than the building code requirement in effect at the time of construction or system installation – and those building codes typically include minimal if any filtration efficiency standards. States have begun to establish policies incorporating a requirement for high-efficiency filtration, and more states should take this important step toward reducing indoor exposures. State policy can also provide support for in-room filtration – e.g., through portable air cleaners – as an alternate or supplemental approach where schools are unable to upgrade to high-efficiency filters due to system limitations. Regular maintenance and replacement of filters throughout the year is necessary for both central and in-room filtration and can be incorporated into school maintenance requirements.

Planning for Future Infectious Disease Emergencies. Most expert guidance during the COVID-19 pandemic has focused on three steps for enhanced ventilation to reduce transmission of the virus: assessing ventilation systems, increasing outdoor air ventilation, and using high-efficiency filters (supplementing with portable air cleaners as needed). The concept of "equivalent clean air delivery" – using a combination of outdoor air ventilation and filtration/air cleaning – has gained traction during the pandemic as a way to mitigate infection risk when increasing outdoor air is not feasible or sufficient. Some experts have proposed ventilation targets to reduce infection risk, and there is likely to be a new ASHRAE standard coming soon: the organization announced that it would be developing a "national indoor air quality pathogen mitigation standard" in 2023 that would apply to the design and construction as well as the operation of buildings.

State agencies addressed school ventilation during the COVID-19 pandemic mostly in the form of guidance documents that included recommended (and in some cases, required) best practices in connection with school reopening. A few states took the notable step of promulgating broad COVID-19 workplace regulations that included ventilation and filtration requirements. At least one state has enacted a law requiring employers to have in place an airborne infectious disease prevention plan, to be implemented during future emergencies. States can build on these initiatives to require all schools to develop, regularly update, and implement a written airborne infectious disease plan that incorporates both ongoing ventilation/filtration measures and enhanced measures to be activated at times of higher risk – e.g., during an emergency designated by the responsible agency or during an outbreak.

State Oversight of School Ventilation. Without effective oversight and accountability, state ventilation requirements may be implemented unevenly or not at all. Many state laws and regulations require a state or local agency to conduct school facility inspections, but these inspections vary in scope and minimum frequency. Where state or local agencies do not conduct inspections at least once each year, policymakers could require the school district to conduct a comparable inspection in intervening years and report the findings. Requirements for school recordkeeping and reporting of facility

information are also essential for facilitating effective state oversight of technical ventilation and IAQ measures.

State oversight should be supplemented by mechanisms for informing and engaging school communities. In addition to requiring public reporting of school facility information, some current state policies promote community involvement by requiring schools to designate an indoor air quality point of contact and to implement a facilities complaint process.

Financial and Technical Assistance. Many schools lack adequate funding for maintenance, operations, and capital improvements, and such schools are more likely to serve low-wealth communities, communities of color, and rural communities.

The infusion of federal pandemic funding has enabled some schools to improve ventilation and related conditions, but there remains a need for ongoing and sustained support. Policymakers should identify funding mechanisms for districts that require additional resources to comply with state ventilation requirements and improve indoor air quality. These funding sources might include existing federal programs, existing state programs where school ventilation work is allowed and/or prioritized, and new state programs that support school facilities generally or that focus on ventilation. Several states passed laws during the pandemic creating new programs or bolstering existing programs to fund school ventilation assessments and upgrades.

The pandemic has also underscored the need for ongoing technical assistance to schools as they work to improve ventilation in their buildings. This is especially the case for small, rural school districts and other schools that may not have the needed in-house technical expertise. State agencies have an important role to play both in helping individual schools address ventilation problems and in synthesizing best practice guidance. At least one state has created an education agency program that provides direct technical assistance on building ventilation. Many states have public health programs that already work with schools on a range of environmental health issues, and policymakers could provide funding to increase the capacity of those programs to address school ventilation and indoor air quality.

The policies highlighted throughout this report are not necessarily models for replication in whole, but they reflect current approaches to addressing key elements of a school ventilation policy. As states consider these and other strategies for improving indoor air quality in schools, broad consultation with the full range of stakeholders is essential to creating an effective and sustainable statewide policy.

PART ONE

INTRODUCTION

Since the onset of the COVID-19 pandemic in early 2020, indoor air quality (IAQ) has been the subject of public discourse in the U.S. as never before. As the pandemic neared its third year, top scientists emphasized that the "COVID-19 crisis is almost certainly an indoor air crisis; it is very likely a ventilation crisis."[1] Building ventilation is now widely recognized as an effective and essential strategy for reducing transmission of the SARS-CoV-2 virus. But the importance of ventilation extends well beyond the current pandemic.

Ventilation is the "process of supplying air to or removing air from a space for the purpose of controlling air contaminant levels, humidity, or temperature within the space."[2] Proper ventilation, along with the related strategy of filtering the air that enters and circulates within a building, can help protect people from a variety of respiratory viruses and reduce the buildup of indoor air pollutants. Common indoor pollutants that can pose serious health risks include particulate matter, nitrogen dioxide, and chemicals emitted from products. Fortunately, the technical tools for providing good ventilation and filtration to reduce harmful indoor exposures are firmly established and have been widely disseminated.

As the pandemic recedes, it is important to build on and sustain the considerable efforts of the past few years to improve ventilation and IAQ – especially in schools. The quality of the air inside school buildings directly affects one-sixth of the U.S. population – around 50 million students and several million school staff who spend their days in K-12 public school buildings.[3] Yet widespread deficiencies in school ventilation and IAQ are longstanding and well documented. As the White House recently noted, "many schools rely on outdated heating, ventilation, and air conditioning (HVAC) systems that make classrooms less comfortable and may pose health risks to students and teachers exposed to contaminants or particles in the air that can trigger allergies or asthma attacks and potentially spread infectious diseases – including COVID-19."[4]

State policy can play an important role in creating schools that are healthier now and better prepared for future emergencies. This report supports state development of school ventilation policies by highlighting key strategies and examples of current policies for states to consider. While many states have laws or regulations addressing school ventilation in some way, relatively few of those policies incorporate clear ventilation

[1] Y. Li, et al., The COVID-19 Pandemic is a Global Indoor Air Crisis that Should Lead to Change, Indoor Air 31(6):1683–1686 (2021), https://tinyurl.com/5ctse9fr.
[2] ASHRAE Standard 62.1-2022, Ventilation and Acceptable Indoor Air Quality, §3.1.
[3] Natl. Center for Educ. Statistics, Digest of Education Statistics, Tables 203.10, 213.10, https://tinyurl.com/4uswe9p9.
[4] The White House, Fact Sheet: The Biden-Harris Action Plan for Building Better School Infrastructure (Apr. 2022), https://tinyurl.com/bdfcjdvb.

requirements or robust state oversight mechanisms. Stronger statewide policies can help ensure that *all* schools – and not only those with greater wealth – are equipped to achieve good indoor air quality.

The pandemic has already prompted some states to act. Legislators have established new programs and dedicated funding for school ventilation upgrades and repairs. Agencies published COVID-19 guidance on school ventilation, and a few states promulgated detailed COVID-19 rules for workplaces that included ventilation measures. A small number of states have adopted laws or regulations that establish new ventilation standards and requirements independent of the pandemic.

Now is the time to use the lessons of the pandemic to rethink and expand the roles of state public health, education, labor, and other agencies in improving ventilation and related school facility conditions. There are political, financial, and practical challenges inherent in developing and implementing school ventilation policies, but the potential benefits of meeting those challenges are substantial. Decades of research have demonstrated the positive impacts of ventilation on health, comfort, and academic performance, as well as the overall cost-effectiveness of ventilation measures.

Health and Learning Benefits of Ventilation

Indoor air quality is affected by a wide variety of contaminants that are generated within a building or drawn into the building from outside. Ventilation supplies air to and/or removes air from an indoor space to control contaminant levels, while air filtration removes pollutants from the outside air entering a building or from the air circulating inside the space.[5]

Over the past few decades, public health research has contributed significantly to our understanding of the role of ventilation and indoor air quality in supporting health and learning and in reducing transmission of infectious diseases. As EPA has concluded: "Growing evidence of the positive impact of outdoor air ventilation suggests a clear opportunity for improving health and academic performance."[6]

The Benefits of Ventilation for Health and Academic Performance*.* Public health research has shown the potential adverse health effects from exposure to a variety of pollutants found indoors – from particulate matter and biological pollutants such as mold, to radon and volatile organic compounds such as formaldehyde.[7] Some people are at higher risk of suffering these impacts. Children are more susceptible to the health effects of air pollutants, in part because they breathe more air relative to their size than adults do.[8] Those who suffer from asthma – disproportionately Black, Hispanic, and American Indian and Alaska

[5] See generally U.S. EPA, Ventilation and Coronavirus (COVID-19), https://tinyurl.com/2k4yddnf and Air Cleaners and Air Filters in the Home, https://www.epa.gov/indoor-air-quality-iaq/air-cleaners-and-air-filters-home.
[6] U.S. EPA, Evidence from Scientific Literature About Improved Performance, https://tinyurl.com/22fcnyt5.
[7] See, e.g., U.S. EPA, Why Indoor Air Quality is Important to Schools, https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools; Lawrence Berkeley Natl. Lab., IAQ Scientific Findings Research Bank, https://iaqscience.lbl.gov/; W. Fisk, The Ventilation Problem in Schools, Indoor Air 27:6 (2017), https://escholarship.org/content/qt7kz5v64c/qt7kz5v64c.pdf [hereinafter "Fisk 2017"].
[8] U.S. EPA, America's Children and the Environment at 4 (2019), https://www.epa.gov/sites/default/files/2019-10/documents/ace2019-v17s.pdf.

Native populations – may also be at increased risk from indoor asthma triggers and other indoor pollutant exposures.[9] Around seven million school-age children have asthma, a leading cause of school absenteeism.[10]

The role of ventilation in reducing indoor exposure to pollutants and improving health is well demonstrated.[11] In their review of studies on ventilation and IAQ, researchers at Harvard's Healthy Buildings program concluded that ventilation is a "key determinant of health in buildings," and that lower ventilation rates are linked to an array of health-related adverse outcomes, including: missed school days caused by respiratory infections; greater prevalence and incidence of symptoms of sick building syndrome; more school nurse visits caused by respiratory symptoms; increased asthma symptoms; increased risk of viral infections; and transmission of airborne infectious diseases such as chickenpox, measles, and influenza.[12] Studies have also shown the health benefits of air filtration, which reduces indoor concentrations of airborne particles that are associated with respiratory and cardiovascular disease.[13]

Substantial research demonstrates the benefits of ventilation for academic performance.[14] Lawrence Berkeley National Laboratory summarizes the research findings this way: "Throughout the normal range of ventilation rates encountered in buildings, increased ventilation rates are, on average, associated with fewer adverse health effects and with superior work and school performance. There is also evidence that occupants of buildings with higher ventilation rates, particularly occupants of schools with higher ventilation rates, have lower rates of absence."[15] In its review of the research, Harvard's Healthy Buildings program noted, "Multiple studies have shown that when steps to mitigate poor [indoor environmental quality] are taken, students' academic performance improves," including evidence of an association between ventilation rates and student performance on math and reading tests.[16] A recent analysis estimating the size of the effect of

[9] Asthma and Allergy Fndn. of America, 2020 Asthma Disparities in America, https://tinyurl.com/5s43vdhm.
[10] Centers for Disease Control (CDC), Asthma, https://www.cdc.gov/healthyschools/asthma/index.htm; CDC, Most Recent National Asthma Data (2020), https://www.cdc.gov/asthma/most_recent_national_asthma_data.htm.
[11] See, e.g., P. MacNoughton, et al., Economic, Environmental and Health Implications of Enhanced Ventilation in Office Buildings, Int. J. Environ. Res. Public Health 12(11), 14709-14722 (2015), https://doi.org/10.3390/ijerph121114709 ("Three decades of research demonstrates the human health benefits of increased ventilation above" minimum code requirements") [hereinafter "MacNoughton, et al."]; Fisk 2017, supra, at Table 2 (summarizing over 20 studies of associations between health, performance or absence and ventilation rates or CO_2 concentrations in schools).
[12] Harvard T.H. Chan School of Public Health, Foundations for Student Success: How School Buildings Influence Student Health, Thinking, and Performance at 12-13 (2015), https://tinyurl.com/4vtykkmj.
[13] See J. Bueno de Mesquita, et al., Control of Airborne Infectious Disease in Buildings: Evidence and Research Priorities at 3, 21, Indoor Air 32(1) (2022), https://escholarship.org/content/qt4sr07537/qt4sr07537.pdf?t=r3hviz [hereinafter "Bueno de Mesquita, et al."]; ASHRAE, Filtration and Air Cleaning at 1 (rev. 2021), https://tinyurl.com/apamrskw; W. Fisk, Health Benefits of Particle Filtration at 11 (2013), https://tinyurl.com/5ee9sddp.
[14] See generally U.S. EPA, Evidence from Scientific Literature About Improved Performance, https://tinyurl.com/22fcnyt5; Lancet COVID-19 Commission Task Force on Safe Work, Safe School, and Safe Travel, Designing Infectious Disease Resilience into School Buildings through Improvements to Ventilation and Air Cleaning at 5 (Apr. 2021), https://tinyurl.com/2t32hun5 [hereinafter "Lancet COVID-19 Commission, Designing Infectious Disease Resilience"].
[15] Lawrence Berkeley Natl. Lab, Building Ventilation, https://iaqscience.lbl.gov/building-ventilation-topics and Ventilation Rates and School Performance, https://iaqscience.lbl.gov/ventilation-rates-and-school-performance.
[16] Harvard T.H. Chan School of Public Health, Foundations for Student Success: How School Buildings Influence Student Health, Thinking and Performance at 12-15 (2015), https://tinyurl.com/4vtykkmj (also finding that "[h]igher ventilation rates and low CO2 levels can positively affect cognitive function").

classroom air quality on student performance and sick leave suggested that increasing the ventilation rate in classrooms "can bring significant benefits in terms of learning performance and pupil attendance."[17]

The Importance of Ventilation for Infection Control*.* Viruses can be transmitted via fomites (surface contamination), droplets (larger respiratory particles in the air that travel short distances), and aerosols (small respiratory particles in the air that can stay suspended in the air and travel short or long distances).[18] From the early months of the COVID-19 pandemic, public health and building scientists have highlighted evidence showing that, "in addition to transmission via large droplets and fomites, SARS-CoV-2 is also transmitted via inhalation of aerosols."[19] It is now firmly established and widely accepted that "airborne transmission via inhalation of virus-laden aerosols is important, if not dominant, for COVID-19."[20]

Long before the COVID-19 pandemic, scientific studies demonstrated the association between ventilation and airborne transmission of infectious diseases in buildings.[21] Ventilation and other engineering controls can "remove particles from indoor air, thereby reducing the intensity of exposure and duration that respiratory aerosols stay aloft inside a room" and thus the likelihood that the particles will be inhaled.[22] Over the course of the pandemic, research studies have contributed evidence that enhanced ventilation and filtration can reduce airborne transmission of SARS-CoV-2.[23]

The Cost-Effectiveness of Ventilation. Many of the benefits of ventilation for occupant health and learning can be measured in economic and quantitative terms: "Absenteeism, productivity losses, and healthcare costs due to ventilation are estimated to have annual economic impacts in the hundreds of billions of dollars in the U.S."[24] Though it is not known precisely what percentage of viral infections are due to

[17] P. Wargocki, et al., The Relationships between Classroom Air Quality and Children's Performance in School, Building and Environment 173 (2020), https://tinyurl.com/yu2z9c27.

[18] See J. Samet, et al., Sars-COV-2 Indoor Air Transmission is a Threat that Can be Addressed with Science, PNAS v. 118 (2021), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8609226/pdf/pnas.202116155.pdf [hereinafter "Samet, et al."]. See also Lancet COVID-19 Commission Task Force on Safe Work, Safe School, and Safe Travel, Proposed Non-infectious Air Delivery Rates (NADR) for Reducing Exposure to Airborne Respiratory Infectious Diseases at 4 (Nov. 2022), https://tinyurl.com/5n8jkvev [hereinafter "Lancet COVID-19 Commission Proposed NADR"].

[19] J. Allen & L. Marr, Recognizing and Controlling Airborne Transmission of SARS-CoV-2 in Indoor Environments (June 2020), https://onlinelibrary.wiley.com/doi/10.1111/ina.12697. See also L. Morawska, et al., How Can Airborne Transmission of COVID-19 Indoors be Minimised?, Environ Int., 142:105832 (May 2020), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7250761/; Samet, et. al., supra, at 3; U.S. EPA, Evidence from Scientific Literature About Improved Performance, https://tinyurl.com/22fcnyt5.

[20] Lancet COVID-19 Commission Task Force on Safe Work, Safe School, and Safe Travel, The First Four Healthy Building Strategies Every Building Should Pursue to Reduce Risk from COVID-19 at 1 (July 2022), https://tinyurl.com/387pzrua; [hereinafter "Lancet COVID-19 Commission, First Four Healthy Building Strategies"]. See also Bueno de Mesquita, et al., supra, at 2; Johns Hopkins Bloomberg School of Public Health, School Ventilation: A Vital Tool to Reduce COVID-19 Spread at 20, https://tinyurl.com/wexztsed.

[21] See Y. Li, et al., Role of Ventilation in Airborne Transmission of Infectious Agents in the Built Environment – A Multidisciplinary Systematic Review, Indoor Air 17:2-18 (2007), https://onlinelibrary.wiley.com/doi/10.1111/j.1600-0668.2006.00445.x; Samet, et al., supra; Bueno de Mesquita, et al., supra, at 14-15; J. Allen and A. Ibrahim, Indoor Air Changes and Potential Implications for SARS-CoV-2 Transmission, JAMA 325(20):2112-2113 (2021), https://jamanetwork.com/journals/jama/fullarticle/2779062 [hereinafter "Allen and Ibrahim"].

[22] See Allen and Ibrahim, supra.

[23] See Lancet COVID-19 Commission Proposed NADR, supra, at 20-22.

[24] See MacNaughton, et al., supra. In 2002, a multidisciplinary study "estimated billions of dollars in economic savings in the US associated with health benefits from ventilation, an underestimate in today's population and economic terms." Bueno de Mesquita, et al., supra, at 21 (citing M. Mendell et al., Improving the Health of Workers in Indoor Environments: Priority

airborne transmission or exactly how much enhanced ventilation would reduce that risk in every building, the pandemic has highlighted the link between inadequate ventilation and viral infections that impose significant economic costs. An April 2022 report estimated the cost of "the total harms of COVID-19 to the U.S." to be about $16 trillion, while noting that a "full and accurate accounting of the social costs of COVID-19 will not be possible for decades."[25] Moreover, researchers have estimated the direct and indirect economic costs of influenza and other non-COVID respiratory infections in the U.S. to be in the tens of billions of dollars annually.[26]

In addition to cost savings realized at a societal level, reducing illness-based absenteeism may translate into measurable increases in a school's attendance-linked funding. For example, a 2013 study of California elementary schools estimated that increasing ventilation rates in classrooms would reduce illness-related absences by over three percent, resulting in a $33 million annual increase in funding for schools.[27]

A growing body of research suggests that "the costs of increasing ventilation are small compared with the health and wellness benefits" in U.S. schools and workplaces.[28] Compared with total annual spending per student – which averages around $13,500 nationwide[29] – the net annual cost of increasing school ventilation rates would be small, with researchers' estimates "ranging from a few dollars to about ten dollars per person."[30] Recent California legislation (2022 Ca. A.B. 2232) establishing stronger school ventilation requirements noted the estimated $45 billion in annual costs to the state resulting from indoor air pollution, along with the benefits of ventilation for student and teacher health, attendance, and productivity.

VENTILATION IN U.S. SCHOOL BUILDINGS

Although it is well established that good ventilation and IAQ are important for supporting health and academic performance, the pandemic has brought into stark relief the longstanding problem of deficient school facility conditions. Inadequate ventilation is often one of many issues that require attention.

In a 1995 survey of 10,000 schools by the U.S. Government Accountability Office (GAO), around 27 percent of schools reported unsatisfactory ventilation and almost 22 percent reported unsatisfactory IAQ generally. The survey indicated that over 15 million students attend schools with "less-than-adequate" HVAC systems and

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Research Needs for a National Occupational Research Agenda, Am. J. Pub. Health 92(9):1420-1440 (2002), https://pubmed.ncbi.nlm.nih.gov/12197969/). See also P. Wargocki & D. Wyon, Providing Better Thermal and Air Quality Conditions in School Classrooms Would be Cost-Effective, Building and Environment 59: 581-589 (2013), https://tinyurl.com/yaapvn37.

[25] R. Bruns and N. Teran, Weighing the Cost of the Pandemic (Apr. 2022), https://tinyurl.com/yn9rfkr2.

[26] See L. Morawska, et al., A Paradigm Shift to Combat Indoor Respiratory Infection, Science 372(6543): 691 (2021), https://www.science.org/doi/10.1126/science.abg2025.

[27] M. Mendell, et al., Association of Classroom Ventilation with Reduced Illness Absence: A Prospective Study in California Elementary Schools, Indoor Air 23(6):515-528 (2013), https://pubmed.ncbi.nlm.nih.gov/23506393/.

[28] Bueno de Mesquita, et al., supra, at 21 (citing W. Fisk, et al., "Benefits and Costs of Improved IEQ in U.S. Offices," Indoor Air 21:357-367 (2011)). See also L. Morawska, et al., A Paradigm Shift to Combat Indoor Respiratory Infection," Science 372(6543):691 (May 2021) ("economic costs of infections can be massive and may exceed initial infrastructure costs to contain them"), https://www.science.org/doi/10.1126/science.abg2025.

[29] U.S. Census Bureau, U.S. School System Current Spending Per Pupil by Region: Fiscal Year 2020, https://www.census.gov/library/visualizations/2022/comm/spending-per-pupil.html.

[30] Fisk 2017, supra, at 1. Studies have also estimated that filtering pollutants from outdoor air produces "financial benefits [that] far exceed the estimated costs." U.S. EPA, Residential Air Cleaners: A Technical Summary at 44 (3rd ed. 2018), https://tinyurl.com/yud7dxjr [hereinafter "EPA Residential Air Cleaners Technical Summary"].

more than 11 million attend schools with "inadequate" ventilation.[31] A 2020 GAO follow-up report on public school facilities produced even starker results: "an estimated 41 percent of districts need to update or replace [HVAC] systems in at least half of their schools, representing about 36,000 schools nationwide that need HVAC updates…"[32]

A 2017 review of several studies on school ventilation rates found that "ventilation rates in classrooms often fall far short of the minimum ventilation rates specified in standards."[33] Even schools with updated HVAC systems may not be functioning as designed and in accordance with the applicable code. A 2020 study of classrooms in California schools that had recently been retrofitted with new HVAC units found that many did not meet current code standards and 51 percent of the studied classrooms had HVAC equipment, fan control, and/or filter maintenance problems.[34]

According to the 1995 GAO report: "District officials…attributed the declining physical condition…to insufficient funds, resulting in decisions to defer maintenance and repair…expenditures from year to year. This has a domino effect. Deferred maintenance speeds up the deterioration of buildings, and costs escalate accordingly, further eroding the nation's multibillion dollar investment in school facilities."[35] A survey of 88 school districts undertaken during the COVID-19 pandemic found that "tremendous efforts were undertaken by schools to assess HVAC performance and implement ventilation and filtration strategies," however only 54 percent of surveyed districts indicated that they "have access to funding to implement additional ventilation and filtration strategies or to make other building changes in schools."[36]

Funding for ventilation and other capital improvements and repairs is largely the responsibility of local school districts.[37] The *2021 State of Our Schools* report noted that an estimated $85 billion shortfall in school facilities funding across the U.S. is not distributed evenly: the emphasis on local responsibility for school funding contributes to "substantial inequalities in how districts carry the burden" of this funding gap. The report found continuing disparities in funding by "community wealth, by student race or ethnicity, and by the geographic context of districts." Low poverty (higher wealth) districts spend considerably more on maintenance and operations and on capital investment than high and medium poverty districts, and in every income group "rural school districts have had, on average, lower [funding]…per school than any other geographic areas…" The report also found that "Native American, Black and Hispanic children…are

[31] U.S. Govt. Accountability Office (GAO), Condition of America's Schools at 10 (GAO/HEHS95-61, Feb. 1995), https://www.gao.gov/assets/hehs-95-61.pdf. See also U.S. GAO, America's Schools Report Differing Conditions (GAO/HEHS-96- 103, June 1996), https://www.gao.gov/assets/hehs-95-61.pdf.
[32] U.S. GAO, K-12 Education: School Districts Frequently Identified Multiple Building Systems Needing Updates or Replacement at 1 (GAO-20-494, June 2020), https://www.gao.gov/assets/gao-20-494.pdf (finding that an estimated 54 percent of school districts "need to update or replace multiple building systems or features in their schools").
[33] Fisk 2017, supra, at 1. See also, Calif. Dept. of Public Health, The Role of Building Ventilation and Filtration in Reducing Risk of Airborne Viral Transmission in Schools, Illustrated with SARS-COV-2 at 12 (Sept. 2020), https://tinyurl.com/4wu37hzu ("several existing studies have documented that the ventilation in California classrooms is usually inadequate…").
[34] W. Chan, et al., Ventilation Rates in California Classrooms: Why Many Recent HVAC Retrofits are not Delivering Sufficient Ventilation at 1, Indoor Air 167 (2020), https://escholarship.org/content/qt2j55896z/qt2j55896z.pdf.
[35] U.S. GAO, Condition of America's Schools at 16 (GAO/HEHS95-61, Feb. 1995), https://www.gao.gov/assets/hehs-95-61.pdf.
[36] Center for Green Schools, et al., Managing Air Quality During the Pandemic: How K-12 Schools Addressed Air Quality in the Second Year of COVID-19 at 23 (2022), https://tinyurl.com/5yd5kebz.
[37] See 21st Century School Fund, Inc., et al., 2021 State of Our Schools, https://www.wellcertified.com/state-of-our-schools [hereinafter "2021 State of Our Schools report"].

disproportionately represented in schools with lower facilities investments and maintenance and operations spending."[38]

Inequities in school facilities funding for ventilation and other measures to improve indoor environmental conditions exist alongside disparities in exposure to environmental pollutants. People of color and low-wealth families are more likely to be exposed to pollutants such as fine particles and to live in close proximity to polluting facilities.[39] People of color are also more likely to suffer from underlying health conditions, such as asthma, that increase their vulnerability to pollutant exposures that can be reduced through ventilation and filtration.[40] In announcing its 2022 action plan for upgrading school facilities, the White House recognized that reducing exposure to indoor pollutants and improving IAQ "will provide better health and educational outcomes – particularly in low-income communities and communities of color that have long faced underinvestment and the burden of high pollution.[41]

Multiple rounds of federal funding made significant sums available to assist schools in reopening and operating during the COVID-19 pandemic, and many schools have used or are planning to use some of the funds to make ventilation-related improvements. Nevertheless, this infusion of money represents only part of the solution, as school districts have many competing priorities that are eligible for the federal funding.

Scope of the Report

This report discusses state policies that address school ventilation for general operations, as well as policies established to address COVID-19 specifically. The report reflects ELI's review of these policies and is also informed by conversations with around a dozen state agency officials charged with implementing some of the policies described in the report. Although the report captures many current policies, it does not purport to cover all state policies that are relevant to school ventilation.

State Policy. The term policy as used here refers mainly to state laws and regulations. The discussion of policies related to the COVID-19 pandemic also describes several state executive orders and agency guidance documents issued during the pandemic. The report discusses three key areas of state policy: public health, education, and occupational safety and health. The focus is on policies that establish school ventilation requirements, though the report also describes state policies that provide financial or technical assistance for school ventilation improvements.

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[38] Id. at 38-40, 55.

[39] See, e.g., C. Tessum, et al., PM2.5 Polluters Disproportionately and Systematically Affect People of Color in the United States, Science Advances 7(18) (2021), https://www.science.org/doi/10.1126/sciadv.abf4491 ("Racial-ethnic minorities in the United States are exposed to disproportionately high levels of ambient" PM2.5); Amer. Lung Assoc., 2021 State of the Air at 11, https://legacy-assets.eenews.net/open_files/assets/2021/04/21/document_gw_01.pdf ("People of color are more than three times more likely to be breathing the most polluted air than white people"); S. Grineski and T. Collins, Geographic and Social Disparities in Exposure to Air Neurotoxins at U.S. Public Schools, Env. Research 161: 580-587 (2018), https://tinyurl.com/3sabr3bx (students attending schools in the top 10% for ambient neurotoxicant exposure "are significantly more likely to be eligible for free/reduced price meals, and to be Hispanic, Black, or Asian/Pacific Islander").

[40] Asthma and Allergy Fndn. of America, 2020 Asthma Disparities in America at 11 (2020), https://www.aafa.org/media/2743/asthma-disparities-in-america-burden-on-racial-ethnic-minorities.pdf ("the burden of asthma falls disproportionately on Black, Hispanic, and American Indian and Alaska Native populations" in the U.S.).

[41] The White House, Fact Sheet: The Biden-Harris Action Plan for Building Better School Infrastructure (Apr. 2022), https://tinyurl.com/bdfcjdvb.

It is beyond the scope of the report to discuss ventilation policies and programs adopted by school districts, though many districts implemented IAQ programs prior to the pandemic and many took steps to improve ventilation to reduce indoor transmission of the SARS-CoV-2 virus. There have also been notable federal policy and program developments over the past few years, including significant pandemic relief funding to schools; new funding and technical assistance programs at the Department of Energy; continued education and technical assistance from EPA's indoor environments program; and the Clean Air in Buildings Challenge, launched by the White House in 2022 as "a call to action and a set of guiding principles and best practices to assist building owners and operators with reducing risks from airborne viruses and other contaminants indoors."[42]

Building Ventilation. The report discusses policies for reducing indoor air contaminants through ventilation and air filtration. (General references to "ventilation" throughout the report are intended to include filtration as appropriate.) The report does not discuss special ventilation requirements for school spaces such as shops or rooms that provide health services.

Though not discussed here, a related and important strategy for improving indoor air quality is to control contaminants at the source – e.g., by eliminating the use of products that emit chemicals, preventing leaks that can cause mold and dampness, or installing radon mitigation systems.

Existing School Buildings. The report discusses policies applicable to *existing* school buildings, the vast majority of which will not undergo capital improvements for years. Policies for existing schools pose particular challenges because they must account for the varying condition and age of school buildings and the limited resources available to school districts. With limited exception, the policies described in the report apply to public PreK-12 schools; many apply, or could apply, to private schools as well.

Though not a focus of the report, stronger ventilation requirements for school design, construction, and renovation are also needed, as those standards may affect a school's indoor environmental conditions for decades into the future. Toward this end, it is important to reconsider the national standards and model code provisions that are commonly incorporated into state laws and regulations.

The remainder of the report is organized as follows:

Part Two. The second chapter summarizes prominent national standards and guidance that address ventilation and filtration, including both general standards established independent of the COVID-19 pandemic and recommendations issued during the pandemic for reducing the risk of SARS-CoV-2 transmission.

Part Three. The third chapter discusses the role of state policy in addressing school ventilation, outlining the principal areas of state authority (occupational safety and health, public health, education), the foundational elements of a policy, and other related considerations. The chapter provides a short summary of the current state of state policy.

Part Four. The final chapter of the report describes some of the key ventilation and filtration measures to consider in establishing a state policy, highlighting examples of current policies. This chapter is divided into three sections:

[42] U.S. EPA, Clean Air in Buildings Challenge, https://www.epa.gov/indoor-air-quality-iaq/clean-air-buildings-challenge.

- Ventilation and filtration for general operations – policies that establish ventilation standards, operations and maintenance practices, and compliance oversight mechanisms;
- Enhanced ventilation and filtration during infectious disease emergencies – policies established during the COVID-19 pandemic and policy considerations for addressing future airborne infectious disease emergencies; and
- Financial and technical assistance for ventilation improvements – policies establishing funding and technical assistance programs that prioritize or focus specifically on ventilation.

Appendix. The Appendix provides citations to, and brief summaries of state laws and regulations referenced in Part Four. The Appendix follows the same organization as the material in Part Four: (1) state laws and regulations establishing school ventilation requirements and oversight mechanisms for general operations; (2) state laws, regulations, and guidance established to address COVID-19 and airborne infectious disease emergencies; and (3) state laws and regulations providing financial and technical assistance for school ventilation.

PART TWO

NATIONAL STANDARDS AND GUIDANCE ON VENTILATION IN THE U.S.

Over many decades, advances in building and public health science have contributed to the development and refinement of ventilation practices. There are now well-established methods for improving school ventilation and filtration to reduce indoor exposure to pollutants and infectious aerosols.

A variety of national standards and guidance documents address ventilation and can inform state policies for building design, construction, operation, and maintenance. Many states have incorporated model codes and consensus standards into their building codes governing the installation of ventilation systems in schools. Prior to the COVID-19 pandemic, governmental and non-governmental guidance for existing school facilities focused primarily on how to maintain and operate building systems in accordance with their design and installation. Guidance documents developed during the pandemic offer general and specific recommendations for existing schools on how to increase ventilation and filtration beyond minimum codes and standards to further reduce the risk of virus transmission indoors.

This section begins by describing prominent consensus standards, model codes, and guidance on ventilation and filtration for general operations and then discusses pandemic guidance on ventilation and filtration practices for infection control. The summary touches on key practices, but it is beyond the scope of this report to discuss fully the wide range of technical considerations that are important to achieving good ventilation and filtration in buildings.

NATIONAL VENTILATION/FILTRATION STANDARDS, CODES, AND GUIDANCE

The most widely-referenced ventilation standard in the U.S. is ASHRAE Standard 62. ANSI/ASHRAE 62.1-2022, Ventilation and Acceptable Indoor Air Quality, is a national industry consensus standard of practice applicable to schools and other commercial buildings.[43] (References here to ASHRAE 62.1 are to the 2022 version of the standard, unless otherwise noted.) The standard is "intended for regulatory application to new buildings, additions to existing buildings, and those changes to existing buildings that are identified in the body of the standard." ASHRAE 62.1 §1.2. Appendix H states that the standard should be applied to existing buildings when there are additions to the building or replacement of building components, but that "[r]epairing (making operational) existing equipment…does not require the building or any of its components to retroactively comply with [the] standard." ASHRAE 62.1 §H1.2.2.

ASHRAE 62.1 sets minimum ventilation standards "intended to provide [IAQ]…that is acceptable to human occupants and that minimizes adverse health effects." ASHRAE 62.1 §1.1. ASHRAE also co-authored an IAQ best practices guide that goes the beyond the minimum requirements of Standard 62.1, recognizing that

[43] ASHRAE is a member of the American National Standards Institute, which approved Standard 62.1 as an American National Standard. ANSI/ASHRAE Standard 62.1-2022, Ventilation and Acceptable Indoor Air Quality (front matter).

"many building owners and practitioners desire to achieve better-than-acceptable IAQ."[44] ASHRAE 62.1 is designed to be adopted into the building codes of states and other jurisdictions, so its provisions are framed in mandatory language.

The International Code Council is a non-governmental organization that publishes 15 different model building codes that are widely adopted by states and other jurisdictions. The International Mechanical Code (IMC) applies to the "design, installation, maintenance, alteration and inspection of mechanical systems." IMC §[A]101.3.

In addition to ASHRAE 62.1 and the IMC, there are a variety of third-party green building standards for schools and other commercial buildings that may include more stringent ventilation and IAQ measures for participating projects, and these standards have been incorporated into some state laws and regulations governing school construction.

Ventilation Performance – National Standards, Codes, and Guidance

Outside air can be introduced to an indoor space through natural (non-mechanical) or mechanical means, as well as through infiltration (unintentional air flow via openings or cracks in the building envelope).

Natural ventilation relies on openings such as windows and doors and thus is affected and limited by ambient conditions (temperature/humidity, air quality, noise, etc.), occupant behavior, and security concerns, among other things. "Natural ventilation is capable of achieving abundant air exchange but can also be much lower and is highly variable, dependent on wind speed, direction, and temperature."[45] Natural ventilation can be a designed system, and ASHRAE 62.1 includes natural ventilation compliance paths.[46] In many schools, however, natural ventilation may consist only of windows that can be opened and thus may be subject to individual choice and behavior.

Mechanical ventilation systems allow building managers greater control over the introduction of specified quantities of outside air. They typically deliver a combination of outside air and recirculated air from the indoor space served by the system. Whole-building HVAC systems may be designed as supply-only, exhaust-only, balanced (supply and exhaust), or heat/energy recovery systems. Heat/energy recovery systems incorporate supply and exhaust air, but also help save energy and costs by transferring energy between incoming and outgoing air.[47] Other types of mechanical ventilation systems that may be used in existing school facilities include unit ventilators (or univents) that serve individual spaces.

[44] ASHRAE, et al., Indoor Air Quality Guide: Best Practices for Design, Construction, and Commissioning at XV (2009), https://tinyurl.com/yr6n5ync.
[45] Bueno de Mesquita, et al., supra, at 15.
[46] Under ASHRAE 62.1, if the prescriptive compliance path for natural ventilation is followed, there must be full mechanical backup. If the engineered system compliance path is used, mechanical ventilation is not required. ASHRAE 62.1 §§6.4.1, 6.4.2.
[47] See generally U.S. Dept. of Energy (DOE), Whole-House Ventilation, https://tinyurl.com/yck2ckd6.

Ventilation Rate. A key element in providing ventilation is the ventilation rate – the amount of outside air delivered to the indoor space.

ASHRAE 62.1 specifies minimum ventilation rates and other measures for controlling temperature, odors, and perceived indoor air quality; mitigating infection risk is not an express goal of the standard.[48] Standard 62.1 offers different pathways for achieving the minimum required ventilation. The most commonly used approach is the Ventilation Rate Procedure,[49] a calculation that includes both a specified per-person amount and a per-unit-area amount (which vary based on the space type), as well as default values for occupant density when the design occupancy is not known. (If the occupant density is lower or higher, the result may be different per-person averages than the default values.) ASHRAE 62.1 Table 6-1.

The resulting ASHRAE 62.1 minimum ventilation rate using default densities is approximately 15 cubic feet per minute (cfm) per person in classrooms for students ages five to eight and around 13 cfm per person in classrooms for ages nine and older; for school offices, the minimum is around 17 cfm per person. ASHRAE ventilation rates have varied in the past, but the current minimum ventilation rate associated with the Ventilation Rate Procedure has been the same since the 1989 version of Standard 62.[50]

The International Mechanical Code incorporates the ASHRAE 62.1 Ventilation Rate Procedure. IMC chaps. 4, 15.

Green building criteria and rating systems also typically reference the ASHRAE 62.1 Ventilation Rate Procedure but may include enhanced ventilation options as well. For example, the Collaborative for High Performance Schools (CHPS) and the Leadership in Energy and Environmental Design (LEED) green building criteria – referenced in many state policies governing state-funded school construction – offer credits toward achieving certification if the project provides outdoor airflow at least 30 percent higher than the minimum ASHRAE 62.1 ventilation rates.[51] The International Code Council and ASHRAE have jointly produced the International Green Construction Code (IgCC), a model code that requires buildings such as schools to comply with the ASHRAE 62.1 Ventilation Rate Procedure.[52]

[48] See Allen and Ibrahim, supra; Lancet COVID-19 Commission, Designing Infectious Disease Resilience, supra, at 4; A. Persily, Challenges in Developing Ventilation and Indoor Air Quality Standards: The Story of ASHRAE Standard 62, at 8 (2015), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6605073/pdf/nihms-1526106.pdf [hereinafter "Persily 2015"].

[49] Other approaches allowed under Standard 62.1 are natural ventilation and the IAQ Procedure, a "performance-based design approach in which one controls contaminant concentrations rather than complying with a table of prescriptive ventilation rates…" Persily 2015, supra, at 15-16 (noting "significant challenges in using the IAQ Procedure").

[50] Id. at 6.

[51] Collaborative for High Performance Schools (CHPS), US-CHPS Criteria 2.0 at 47, https://tinyurl.com/4zsscb7n; U.S. Green Building Council, LEED v4 for Building Design and Construction at 116, https://tinyurl.com/y2d37v6p. For examples of state policies requiring green school construction, see Envtl. Law Inst., Healthy, High Performance School Construction, https://www.eli.org/buildings/healthy-high-performance-school-construction.

[52] Intl. Code Council, et al., International Green Construction Code (2018), https://www.iccsafe.org/products-and-services/icodes/2018-i-codes/igcc/. The IgCC incorporates the technical provisions of ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1, Standard for the Design of High Performance, Green Buildings.

At the international level, the World Health Organization (WHO) published guidance in 2021 recommending a ventilation rate for non-residential buildings of 10 liters per second (L/s) per person, equivalent to approximately 21 cfm per person.[53]

Ventilation During Occupancy and Other Operating Considerations. ASHRAE 62.1 (§8.3) requires that ventilation be provided in accordance with the standard "during periods of expected occupancy." Similarly, the IMC (§401.3) states that ventilation "shall be provided during periods that the room or space is occupied."

ASHRAE 62.1 covers many other aspects of a ventilation system design and operation not discussed here (and not incorporated into the IMC), including air distribution, air recirculation, location of outdoor air intakes, and duct materials/construction. The standard addresses the use of demand controlled ventilation to conserve energy, defined as: "Any means by which the breathing zone outdoor air flow…can be varied to the occupied space or spaces based on the actual or estimated number of occupants, ventilation requirements of the occupied zone, or both." ASHRAE 62.1 §3. ASHRAE 62.1 also includes a section on investigating whether outdoor air quality is suitable and establishes requirements for controlling outdoor particulate matter and ozone if a building is in a federal non-attainment area. ASHRAE 62.1 §§4, 5.

Ventilation Monitoring. In addition to the preventive maintenance practices described below, checking ventilation performance on a regular basis is important for verifying that the system is operating as designed and intended.[54] The International Green Construction Code requires mechanical systems, with some exceptions, to have "a permanently installed device to measure the minimum outdoor airflow," and sets criteria for the device and for conducting monitoring. IgCC §§8.3.1.2.2, 10.9.4.

Another strategy for monitoring ventilation is using indoor carbon dioxide (CO_2) levels to estimate ventilation performance. If a room is poorly ventilated, high levels of CO_2 from exhaled breath will build up. Thus, CO_2 levels are often used to gauge ventilation system functioning and as a feature of demand-controlled ventilation systems.[55] (This report does not discuss the potential impacts of CO_2 itself on health and cognitive performance.[56])

Technical Considerations for CO_2 Monitoring. With the onset of the COVID-19 pandemic and the availability of low-cost sensors, CO_2 monitoring has become more widely utilized and debated. ASHRAE issued a position document on the topic in 2022, which states: "Indoor CO_2 concentrations do not provide an

[53] World Health Org. (WHO), Roadmap to Improve and Ensure Good Indoor Ventilation in the Context of COVID-19 (2021), https://tinyurl.com/mr355283. See also Y. Li, et al., Poor Ventilation Worsens Short-Range Airborne Transmission of Respiratory Infection (2021), https://onlinelibrary.wiley.com/doi/epdf/10.1111/ina.12946.

[54] See Harvard T.H. Chan School of Public Health, Schools for Health: Risk Reduction Strategies for Reopening Schools at 35 (rev. Nov. 2020), https://tinyurl.com/ratsrfwm [hereinafter "Schools for Health: Risk Reduction Strategies"]; W. Chan, et al., Ventilation Rates in California Classrooms at: Why Many Recent HVAC Retrofits are Not Delivering Sufficient Ventilation, Building and Environment 167 (2019), https://escholarship.org/content/qt2j55896z/qt2j55896z.pdf.

[55] ASHRAE, ASHRAE Position Document on Indoor Carbon Dioxide at 1 (Feb. 2022), https://tinyurl.com/2p9kmx3b [hereinafter "ASHRAE CO2 Position Document"].

[56] For references to recent studies on this topic, see A. Persily and B. Polidoro, NIST Technical Note 2213 - Indoor Carbon Dioxide Metric Analysis Tool (2022), https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2213.pdf [hereinafter "Persily and Polidoro"]. See also X. Zhang, et al., Effects from Exposures to Human Bioeffluents and Carbon Dioxide, in Y. Zhang, et al. (eds.), Handbook of Indoor Air Quality (2022), https://tinyurl.com/5b8td78b.

overall indication of IAQ, but they can be a useful tool in IAQ assessments if users understand the limitations in these applications."[57]

Key technical considerations for effective CO_2 monitoring include sensor accuracy, location, and calibration.[58] Even where measurements are accurate, their interpretation is also important – e.g., determining whether CO_2 concentrations have reached a balance with the ventilation rate (steady state concentrations). Ongoing CO_2 monitoring that provides real-time data can help schools more effectively identify and correct ventilation problems. Experts have recommended the "use of sensors to monitor CO_2 concentrations in real-time as a proxy for ventilation…to ensure ventilation systems are performing as intended."[59] Recent guidance from the Center for Green Schools advises against one-time measurements: "To interpret the data correctly, CO_2 levels must be logged throughout the school day in a typically occupied classroom. CO_2 spot checks will not give you the maximum CO_2 or the general trend of the values."[60]

Another consideration is determining the indoor CO_2 benchmark, sometimes given as a stated value and sometimes as a stated value above ambient CO_2 levels. (Ambient CO_2 levels have been increasing in the post-industrial era and currently average over 400 parts per million by volume (written as ppmv or ppm)).[61] The federal government's OSHA personal exposure level for CO_2 of 5,000 ppm (8-hour time-weighted average) reflects exposures in industrial settings rather than school settings. 29 CFR 1910.1000, Table Z-1.

Outside the occupational/industrial context, 1,000 ppm is a commonly-cited value.[62] A 2015 review of green building certification systems around the world found that they incorporated concentration thresholds for CO_2 ranging from 530 to 1500 ppm.[63] ASHRAE notes that other countries have proposed mandatory or suggested indoor CO_2 limits, which "tend to be on the order of 1000 ppmv but range as high as about 1500 ppmv" and that the European Union's ventilation guidance establishes a range of CO_2 values for classrooms, with normal expectations corresponding to a level of 800 ppmv above outdoor levels.[64]

ASHRAE is often cited as a reference for CO_2 levels, however Standard 62.1 has not contained an indoor CO_2 value since the 1989 edition of the standard.[65] As a recent article noted, that version of Standard 62.1 included an informative appendix explaining "the connection between per person outdoor air ventilation rates and steady-state levels of CO_2….[and noting] that for specified values of CO_2 generation by a person and of the outdoor CO_2 concentration, a ventilation rate of 7.5 L/s (15 cfm) per person will lead to a steady-state

[57] ASHRAE CO2 Position Document, supra, at 2. See also Persily and Polidoro, supra, at 2 ("indoor CO2 concentrations depend primarily on the rate at which the occupants generate CO2, the outdoor air ventilation rate of the space, the time since occupancy began, and the outdoor CO2 concentration. If these factors are properly accounted for, indoor CO2 concentrations can serve as meaningful indicators of ventilation.").
[58] ASHRAE CO2 Position Document, supra, at 2.
[59] Lancet COVID-19 Commission, Designing Infectious Disease Resilience, supra, at 4-5. See also, Ca. Dept. of Public Health, The Role of Building Ventilation and Filtration in Reducing Risk of Airborne Viral Transmission in Schools, Illustrated with SARS-COV-2 at 31 (2020), https://tinyurl.com/4wu37hzu.
[60] Center for Green Schools, School IAQ Fact Sheet: Ventilation (Feb. 2022), https://www.usgbc.org/resources/school-iaq-fact-sheet-ventilation. See also Lancet COVID-19 Commission, Designing Infectious Disease Resilience, supra, at 6.
[61] Natl. Oceanic and Atmospheric Admin., Carbon Dioxide Now More Than 50% Higher than Pre-industrial Levels (June 2022), https://tinyurl.com/4vz2hwr2; Persily and Polidoro, supra, at 2.
[62] See Persily and Polidoro, supra, at 1.
[63] W. Wei, et al., Indoor Air Quality Requirements in Green Building Certifications, Building and Environment 92:10–19 at 30 (2015), https://hal-cstb.archives-ouvertes.fr/hal-02363627/document.
[64] ASHRAE CO2 Position Document, supra, at 10.
[65] Id. at 5. See also A. Persily, Please Don't Blame Standard 62.1 for 1000 ppm CO2 at 2 (2021), https://tinyurl.com/2p8r63xy.

CO_2 concentration of 1000 ppmv."[66] ASHRAE's 2022 CO_2 position document emphasizes that the "use of CO_2 as an indicator of outdoor air ventilation must reflect the fact that outdoor air ventilation requirements depend on space type, occupant density, and occupant characteristics...[and that] CO_2 concentrations can vary significantly within a building or space based on the details of how ventilation and air distribution are implemented."[67] The organization recommends the development of guidance and standards on CO_2 monitoring, as well as educational programs for practitioners.

Tools and Guidance for CO_2 Monitoring. A number of tools for monitoring CO_2 have been developed by government and academic researchers to assist schools and other building managers. The National Institute of Standards and Technology developed a tool in 2022 – Quick Indoor CO_2 or QICO2 – that uses "a space-specific CO_2 concentration that can be used as an indicator of the outdoor ventilation rate." The tool provides CO_2 metrics for classrooms that incorporate space-specific factors such as intended ventilation rate per person, the number of occupants, and the rate at which they generate CO_2. Estimates of CO_2 concentration are made "at selected times after occupancy starts, which provides a more meaningful ventilation metric than a single value for all spaces."[68]

The Harvard T.H. Chan School of Public Health also published a tool in 2022 for checking ventilation in classrooms using various techniques, including using CO_2 monitoring to estimate the number of air changes per hour.[69] Governmental technical resources on CO_2 monitoring include EPA's longstanding and widely used IAQ Tools for Schools Action Kit and the California Department of Public Health's COVID-19 guidance on ventilation and filtration in schools.[70]

A recent survey of teachers suggested that CO_2 monitoring may be helpful during an emergency such as the COVID-19 pandemic in addressing staff concerns about safety.[71] In communicating CO_2 monitoring results, it may be necessary to point out that CO_2 levels will not necessarily indicate infection risk, because they do not reflect the school's use of air filtration and air cleaning to remove infectious particles.[72]

[66] A. Persily, Please Don't Blame Standard 62.1 for 1000 ppm CO2 at 2 (emphasis added) (2021), https://tinyurl.com/2p8r63xy. Later versions of Standard 62.1 (until the 2019 version) referenced a steady-state CO_2 concentration of 700 ppm above outdoor air levels as corresponding to the recommended ventilation rate in the standard. Id.

[67] ASHRAE CO2 Position Document, supra, at 6.

[68] Persily and Polidoro, supra, at i. See also Natl. Inst. of Standards and Technology, Quick Indoor CO2 (QICO2) Tool, https://www.nist.gov/services-resources/software/quick-indoor-co2-qico2-tool.

[69] See J. Allen, et al., 5-step Guide to Checking Ventilation Rates in Classrooms, https://tinyurl.com/4dvd6sex. One example provided in the guidance notes: "a 500 ft2, 10-ft ceiling classroom with 15 teenage students, and a ventilation rate of 4 ACH should have a steady state concentration around 800 ppm. That steady state concentration drops to ~700 ppm and ~650 ppm for 5 and 6 ACH, respectively."

[70] U.S. EPA, Tools for Schools Action Kit: Background Information for Ventilation Checklist at 7-8, https://www.epa.gov/sites/default/files/2014-08/documents/ventchklstbkgd.pdf; Ca. Dept. of Public Health, Ventilation and Filtration to Reduce Long-Range Airborne Transmission of COVID-19 and Other Respiratory Infections: Considerations for Reopened Schools, App. E (July 2021, rev. Feb. 2022), https://tinyurl.com/28wvm8ha.

[71] A. Sanguinetti, et al., Understanding Teachers' Experiences of Ventilation in California K-12 Classrooms and Implications for Supporting Safe Operation of Schools in the Wake of the COVID-19 Pandemic, Indoor Air, 32(2) (2022), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9111572/.

[72] Schools for Health: Risk Reduction Strategies, supra, at 35; see also ASHRAE, CO2 Position Document, supra, at 7.

Filtration – National Standards, Codes, and Guidance

Ensuring that an adequate amount of outside air is brought into a school building to dilute indoor contaminants is one key component of good indoor air quality. Another is air filtration – removing pollutants that are present in the outside air coming into the school or that are generated within the building.[73] (The next section of this chapter describes the concept of clean air delivery, which combines the effects of filtration and ventilation to reduce infectious particles in indoor air.)

In-Duct Filtration. A common method for filtering particles from the air is the use of fibrous filters in mechanical HVAC systems.[74] In mechanical systems that supply air to a space, filters can remove particles from the outside air entering the building and from the recirculated indoor air that moves through the system. Thus, filters work only while HVAC systems are running and moving air through the filters. For the filters to perform well, they must fit properly in the filter cabinet (to prevent air from bypassing the filter) and they must be replaced regularly.[75]

One key factor affecting filter performance is the efficiency rating of the filter. The most commonly used system in the U.S. for rating filter efficiency is the minimum efficiency reporting value (MERV) system, which is calculated according to ASHRAE Standard 52.2.[76] This MERV rating procedure tests performance in three particle size ranges and rates filters from MERV 1 to MERV 16; the higher the MERV rating, the higher the removal efficiency. MERV 13 filters are rated to capture at least half of particles in the 0.3–1 micron (µm) size range, 85 percent of particles that are 1–3 µm, and 90 percent of particles that are 3–10 µm.[77]

At the national level, consensus standards and model codes for new construction and HVAC installations have not yet established high-efficiency filtration as a minimum requirement. ASHRAE 62.1 currently requires only MERV 8 or higher filters "upstream of all cooling coils or other devices with wetted surfaces through which air is supplied to an occupiable space." In buildings located in PM2.5 nonattainment areas, outdoor air must be filtered with at least MERV 11 rated filters, while MERV 8 is required in PM10 nonattainment areas. ASHRAE 62.1 §§4.1—4.3, 5.5, 6.1.4.1, 6.4.1.2. (ASHRAE's ventilation standard for residential buildings requires MERV 11 filtration for recirculated air. ASHRAE 62.2-2022 §4.1.4.2.)

The International Mechanical Code (§605.1) requires heating and air-conditioning systems to be provided with "approved filters," that are "installed such that all return air, outdoor air, and makeup air is filtered upstream from any heat exchanger or coil." The IMC does not specify minimum filter efficiency.

Some green building rating systems have incorporated high-efficiency filtration. For example, the Collaborative for High Performance Schools national criteria requires MERV 13 or higher in all new HVAC systems (or MERV 8 for unit ventilators) and offers an optional credit where filtration media have a MERV 15

[73] See generally Persily 2015, supra, at 9 ("It is well recognized that for ventilation to have to have a positive impact on IAQ, the air brought into the building must be relatively free of contaminants generated indoors as well as key outdoor air contaminants."); Natl. Acad. of Sciences, Engineering, and Medicine, Health Risks of Indoor Exposure to Particulate Matter: Workshop Summary at 59 (2016), https://tinyurl.com/52r5byc6 (summarizing comments of William Fisk).
[74] For an overview of air cleaning technologies for removing particles and gases, see EPA Residential Air Cleaners Technical Summary, supra, at 44.
[75] Id. at 39-40; CDC, Ventilation in Buildings, (rev. June 2021), https://tinyurl.com/3jwv7w25.
[76] ANSI/ASHRAE Standard 52.2-2017, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
[77] See Id., Table 12-1.

value or higher.[78] In addition, the U.S. General Services Administration (GSA), which designs, constructs, and operates federal civilian buildings, has incorporated MERV 13 requirements into the mandatory facilities standards for construction, repair, and alterations of GSA buildings.[79]

Thus, many HVAC systems in existence today were designed to use MERV 6 or MERV 8 filters, and most schools were using such filters at the onset of the COVID-19 pandemic.[80] Recent EPA guidance outlining IAQ strategies not only during the COVID-19 pandemic, but also for school operations beyond the pandemic, recommends using higher-efficiency filtration: "Increase filter efficiencies in existing HVAC systems (use the highest…[MERV] rating possible according to equipment specifications). If possible, increase the level of the air filter to MERV-13 or higher. In some cases, minimal upgrades to existing systems can make it possible to use more efficient filters."[81]

An initial consideration for increasing filter efficiency in an existing school is whether the mechanical system can handle the new filter, in particular whether the filter resistance will impede airflow and affect the equipment. Research by the California Energy Commission found that MERV 13 filters are available that can "maximize filtration performance and capture of small particulates while having a minimal impact on pressure drop relative to current MERV 6 and MERV 8 filters."[82] While "higher efficiency filters can directly replace existing lower efficiency filters in air handling systems" in many cases, in some systems "the hardware holding the filters will need to be changed to allow installation of filters with a greater depth in the direction of airflow, so that the airflow resistance is not increased to an unacceptable level."[83] Washington's wildfire smoke guidance for schools notes that "[m]ost public HVAC systems should accommodate the recommended MERV 13 filters" and advises that "a professional engineer or HVAC specialist should be consulted to determine the best way to maximize the system's air filtration."[84] ASHRAE guidance offers a series of "practical steps an owner can take to evaluate the maximum MERV rating an HVAC system can accommodate while maintaining acceptable system performance."[85]

Portable Air Cleaners. Portable air cleaners – also sometimes called air purifiers – can provide high-efficiency filtration in lieu of or in addition to in-duct filters. Portable air cleaners are designed to filter the recirculating air in a single area or room using HEPA filters, which have a more than 99.9 percent removal

[78] CHPS, US-CHPS Criteria 2.0 at 46, https://tinyurl.com/4zsscb7n. The IgCC requires higher filtration than ASHRAE 62.1 for projects located in nonattainment areas for PM_{10} (MERV 11 required) or $PM_{2.5}$ (MERV 13 required). IgCC (2021), §801.3.1.3.
[79] See U.S. Gen. Services Admin., P100: Facilities Standards for the Public Buildings Service at 167 (Oct. 2021 w/ 2022 Addendum), https://www.gsa.gov/cdnstatic/P100%202022%20Addendum%20Final_.pdf.
[80] ASHRAE Epidemic Task Force, Building Readiness at 36 (rev. May 2022), https://tinyurl.com/y35ykhu6; Center for Green Schools and ASHRAE, Preparation in the Pandemic: How Schools Implemented Air Quality Measures to Protect Occupants from COVID-19 at 15 (2021), https://tinyurl.com/dtsywutn.
[81] U.S. EPA, Healthy Indoor Environments in Schools During the COVID-19 Pandemic and Beyond (rev. Dec. 2022), https://tinyurl.com/mryuydwx [hereinafter, "U.S. EPA, Pandemic and Beyond"].
[82] Calif. Energy Comm., 2019 Energy Code Initial Statement of Reasons at 135 (Jan. 18, 2018), https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=17-BSTD-02. The agency found that MERV 13 filters are broadly available in one-inch and two-inch forms with a negligible effect on pressure drop.
[83] Lawrence Berkeley Natl. Lab., National Benefits of Improved Particle Filtration, https://iaqscience.lbl.gov/improved-particle-filtration (the "largest challenges will be to upgrade filters in existing rooftop air handlers...Often, however, filter efficiency can be upgraded moderately without increasing filter depth").
[84] Wash. Dept. of Health, Improving Indoor Air Quality During Wildfire Smoke Events at 2 (June 2022), https://tinyurl.com/49emcken.
[85] ASHRAE Epidemic Task Force, Building Readiness at 45-50 (rev. May 2022), https://tinyurl.com/y35ykhu6.

efficiency for all particle sizes.[86] There is considerable evidence of the effectiveness of portable air cleaners that rely on fibrous filters to remove particles in the air.[87]

Prior to the COVID-19 pandemic, much of the guidance on portable air cleaners focused on their use during wildfire smoke events, especially in homes. EPA produced valuable technical and consumer guidance on residential air cleaners, which the agency updated in 2018.[88] In general, air cleaner guidance emphasizes that for the device to be effective, it must be appropriately sized for the space served and its filters must be replaced according to the manufacturer's instructions.[89] Another very important factor in selecting portable air cleaners for school classrooms is the amount of noise (decibel levels) produced by the equipment; if a unit is too loud when operating at the appropriate setting, it is not likely to be a viable solution.[90]

The Association of Home Appliance Manufactures (AHAM) has developed a standard, ANSI/AHAM AC-1, for measuring a portable air cleaner's efficacy using Clean Air Delivery Rate (CADR) as the metric. AC-1 certified CADR is widely used as an indicator of the volume of filtered air delivered by an air cleaner.[91]

Portable air cleaners are widely available commercially. There has also been increased interest recently in the use of less expensive do-it-yourself (DIY) portable air cleaners – created by attaching HVAC filters to a box fan. A study of one prominent model, the "Corsi-Rosenthal box," demonstrated that the device "efficiently reduces suspended particle concentrations in indoor environments."[92] EPA "does not recommend the routine use of DIY air cleaners as a permanent alternative to products of known performance (such as commercially available portable air cleaners)," but the agency provides tips on how to use the devices.[93]

Other Air Cleaning Technologies. In addition to air cleaners that employ filters to remove particles mechanically, a variety of other air cleaning technologies (not discussed here) are commercially available for removing particles or gases from indoor air. ASHRAE provides this general advice to building owners and managers in selecting an air cleaning device: "Only use air cleaners for which evidence of effectiveness and safety is clear."[94]

A 2021 report by the Lancet COVID-19 Commission task force addressed this issue in the context of air cleaners that use "additive" technologies: "Other strategies that have recently been implemented or

[86] U.S. EPA, What is a HEPA Filter, https://www.epa.gov/indoor-air-quality-iaq/what-hepa-filter.
[87] See, e.g., B. Singer, et al., Reducing In-Home Exposure to Air Pollution (2016), https://ww3.arb.ca.gov/research/apr/past/11-311.pdf; EPA Residential Air Cleaners Technical Summary, supra, at 7.
[88] See EPA Residential Air Cleaners Technical Summary, supra; U.S. EPA, Guide to Air Cleaners in the Home (2nd ed. 2018), https://www.epa.gov/indoor-air-quality-iaq/air-cleaners-and-air-filters-home.
[89] See, e.g., Wash. Dept. of Health, Improving Indoor Air Quality During Wildfire Smoke Events (June 2022), https://tinyurl.com/49emcken; ASHRAE, In-Room Air Cleaner Guidance for Reducing COVID-19 in Air in Your Space/Room (Jan. 2021), https://tinyurl.com/2p9dydux.
[90] See U.S. EPA, Pandemic and Beyond, supra; Center for Green Schools, In-Room Air Cleaners (Feb. 2022), https://www.usgbc.org/resources/school-iaq-fact-sheet-room-air-cleaners; ASHRAE, In-Room Air Cleaner Guidance for Reducing COVID-19 in Air in Your Space/Room (Jan. 2021), https://tinyurl.com/2p9dydux; Wash. Dept of Health, Improving Indoor Air Quality During Wildfire Smoke Events (June 2022), https://tinyurl.com/49emcken.
[91] See AHAM, Air Filtration Standards, https://ahamverifide.org/ahams-air-filtration-standards/.
[92] R. Dal Porto, et al., Characterizing the Performance of a Do-It-Yourself (DIY) Box Fan Air Filter, Aerosol Sci. and Tech. 56(6): 564-572 (2022), https://www.tandfonline.com/doi/full/10.1080/02786826.2022.2054674.
[93] U.S. EPA, Air Cleaners, HVAC Filters, and Coronavirus (COVID-19) (rev. July 2022), https://tinyurl.com/bdf8xmst.
[94] ASHRAE, Core Recommendations for Reducing Airborne Infectious Aerosol Exposure (Oct. 2021), www.ashrae.org/covid19.

considered in many schools (such as bipolar ionization, plasma systems, portable air cleaning units with ionizers or UV, dry hydrogen peroxide, photocatalytic oxidation) are generally considered less scientifically defensible due to their often unproven efficacies and due to their potential for degrading the quality of the air through the generation of harmful secondary pollutants."[95] EPA's 2018 guide to air cleaners notes that some of these air cleaning technologies have been shown to emit formaldehyde, acetaldehyde, nitrogen dioxide, and carbon monoxide and that many can generate high amounts of ozone.[96]

In light of the recognized adverse health effects associated with ozone, some organizations have established ozone emissions standards for air cleaners. Two national standards for testing ozone emissions from air cleaners use the same test procedure but have different standards for compliance – UL 867 (50 ppb above ambient concentration) and UL 2998 (5 ppb above ambient concentration).[97] ASHRAE 62.1 (§5.9.1) requires air cleaning devices to be listed and labeled in accordance with UL 2998. The state of California adopted ozone standards for air cleaning devices available for sale in California and requires such devices to be certified by the state as meeting the rule's 50 ppb standard.[98]

The COVID-19 pandemic has raised the profile of a different approach to air cleaning – ultraviolet germicidal irradiation (sometimes referred to as UVGI or GUV), which uses ultraviolet energy to kill viral, bacterial, and fungal organisms. UVGI has been in use for decades and has been shown to be effective at inactivating airborne pathogens.[99] Nevertheless, the technology is relatively complex compared to other air cleaning options and has not been a common strategy in schools. The systems require professional design and installation to ensure they are "installed properly so UV energy is directed above occupied space and operates safely."[100] The Centers for Disease Control and Prevention (CDC) suggests considering the use of upper-room UVGI to eliminate airborne pathogens "in spaces with insufficient or no mechanical HVAC systems or where adequate natural ventilation cannot be maintained year-round."[101] Increased research on UVGI technology and installation may lead to broader application in the future.

Ventilation Assessment and Maintenance – National Standards, Codes, and Guidance

Because school facilities vary widely in the age, type, and capacity of their ventilation systems, guidance for existing schools tends to focus less on achieving specified ventilation/filtration standards and more on operations and maintenance practices that can help ensure schools are providing ventilation in accordance with the design of their systems. In addition to supporting good IAQ, "a well-maintained HVAC system can help…[schools] save money from unexpected repairs."[102] Maintenance can also save money by keeping

[95] Lancet COVID-19 Commission, Designing Infectious Disease Resilience, supra, at 6. See also Center for Green Schools, School IAQ Fact Sheet: Electronic Air Cleaners (Feb. 2022), https://tinyurl.com/33jej8e2.
[96] EPA Residential Air Cleaners Technical Summary, supra, at 9.
[97] See UL Solutions, Zero Ozone Emissions Validation, https://tinyurl.com/3rmbkrxz and Revised Standard for UL 867 – Electrostatic Air Cleaners, https://tinyurl.com/2942yamk.
[98] 17 Ca. Code Regs. §§ 94800–94810. See also Calif. Air Resources Board, Air Cleaner Information for Consumers, https://ww2.arb.ca.gov/our-work/programs/air-cleaners-ozone-products/air-cleaner-information-consumers.
[99] See CDC, Upper-Room Ultraviolet Germicidal Irradiation (UVGI) (rev. Apr. 2021), https://tinyurl.com/bdcmb334.
[100] Id.
[101] Id.
[102] U.S. EPA, Indoor Air Quality Tools for Schools: Preventive Maintenance Guidance Documents (rev. May 2022), https://tinyurl.com/yhedc845.

equipment operating efficiently, avoiding premature replacement, and reducing the amount of time staff spend responding to complaints and emergencies.[103]

Ventilation Assessment. A common recommendation for schools is to have a qualified person regularly assess the ventilation system to make sure it is functioning as designed. Assessing the performance of ventilation systems is important because "[m]echanical HVAC systems in buildings tend to get out of tune. Within several years of construction, ventilation airflows may change from how they were designed."[104]

EPA's Clean Air in Buildings Challenge advises building operators: "Work with an HVAC expert to assess and inspect systems for ventilation, filtration, and air cleaning. Verify through commissioning, testing, and balancing that building systems are functioning as designed."[105] The U.S. Department of Energy also recommends that "the practices of recommissioning or ongoing commissioning be applied."[106] ASHRAE describes commissioning of existing buildings as focusing on "planning, investigating, implementing, verifying, and documenting that the facility and/or its systems and assemblies are operated and maintained to meet the Current Facility Requirements," which "may differ from the original project requirements when the building was originally designed and built."[107]

Thus, regular ventilation assessments can determine the capacity of the system to provide outside air and to filter the air; identify needed repairs and maintenance for proper functioning; and note potential operational changes for providing ventilation and filtration above the original minimum code/design requirements.

System Inspections and Other Preventive Maintenance Practices. In addition to having an HVAC professional conduct a ventilation assessment, it is important for schools to develop and carry out a routine "scheduled inspection and maintenance program for HVAC systems to allow for repair, modification, or replacement of equipment."[108] ASHRAE has published standards for the maintenance of ventilation systems.

- ASHRAE 62.1 (§8) requires buildings/HVAC systems constructed or renovated pursuant to the standard to develop an operations and maintenance manual and to maintain the system in accordance with the manual. The standard lists 31 inspection and maintenance tasks that must be included in the manual and gives the frequency at which they should be performed (e.g., monthly, quarterly, semi-annually, annually).

- ASHRAE Standard 180-2018, Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems, applies to both new and existing HVAC systems and includes over 300 inspection and maintenance items – listed by equipment type – along with required frequency and recommended corrective actions. Written in "code-intended language," the standard establishes

[103] See CHPS, Best Practices Manual Vol. 4: Maintenance and Operations at 129-130 (2004), https://chps.net/best-practices-manual.
[104] Schools for Health: Risk Reduction Strategies, supra, at 35.
[105] U.S. EPA, Clean Air in Buildings Challenge (March 2022), https://tinyurl.com/2v22nukt.
[106] U.S. DOE, Energy Star Building Manual, ch. 5 at 2 (2007), https://www.energystar.gov/sites/default/files/buildings/tools/EPA_BUM_CH5_RetroComm.pdf (commissioning includes ensuring a system is "capable of being operated and maintained according to the owner's operational needs").
[107] ASHRAE, The Strategic Guide to Commissioning at 14, 17 (2014), https://tinyurl.com/3p5rvftr. See also ASHRAE Standard 202-2018, Commissioning Process for Buildings and Systems. ASHRAE has published a number of widely-used guidelines on commissioning, including Guidelines 0-2019, 0.2-2015, 1.1-2007, 1.2-2019, and 1.3-2018.
[108] U.S. EPA, Pandemic and Beyond, supra.

> "minimum HVAC inspection and maintenance requirements that preserve a system's ability to achieve acceptable thermal comfort, energy efficiency, and indoor air quality in commercial buildings." The standard "considers the integration of [system] components and the way they interact, as well as each component separately."[109]

The International Mechanical Code states that owners are responsible for maintenance of mechanical systems and requires existing and new systems to be "maintained in proper operating condition in accordance with the original design and in a safe and sanitary condition...[Devices must be] maintained in compliance with the edition of the code under which they were installed." The IMC does not incorporate the ASHRAE 62.1 (§8) maintenance provisions; however, it provides that the "inspection for maintenance of HVAC systems shall be performed in accordance with ASHRAE/ACCA/ANSI Standard 180." IMC §102.3. Another model building code that is not as widely adopted by states, the Uniform Mechanical Code (UMC), also references ASHRAE Standard 180: "Commercial HVAC systems, both existing and new…shall be inspected and maintained in operating condition in accordance with ASHRAE/ACCA 180." IAPMO/ANSI UMC 1-2021 §102.3.1.

A variety of guidance documents offer detailed recommendations for maintaining ventilation systems. The most prominent and widely used governmental resource on comprehensive school IAQ management, EPA's IAQ Tools for Schools Action Kit, includes extensive information on preventive HVAC maintenance, including a sample maintenance plan, a detailed ventilation maintenance checklist, and other technical HVAC information. The resource is designed to walk school districts "through straightforward steps to develop and implement a sustainable indoor air quality (IAQ) preventive maintenance plan…"[110]

Guidance on Ventilation/Filtration During the COVID-19 Pandemic

During the COVID-19 pandemic, state policies and programs have relied heavily on governmental and non-governmental recommendations for reducing indoor transmission of the virus. Among the most widely referenced ventilation guidance documents are those published by ASHRAE's Epidemic Task Force, which include recommendations addressed to schools. ASHRAE provides core recommendations as well as detailed discussion of considerations for implementing the core strategies.[111] Many other non-governmental organizations and academic institutions with longstanding ventilation and IAQ expertise published research and practical guidance that has informed state policy during the pandemic.

At the federal government level, CDC's pandemic guidance has been widely cited by state agencies.[112] EPA's Indoor Environments program has been a central hub for materials and programming on ventilation and IAQ

[109] ANSI/ASHRAE/ACCA Standard 180-2018 at Forward, §1. Standard 180-2018 updates the 2012 version of the standard. See also ASHRAE Guideline 32-2012, Sustainable, High-Performance Operations and Maintenance, https://www.ashrae.org/technical-resources/bookstore/guideline-32-2012 (providing "strategies that go beyond ASHRAE Standard 180, to meet the "minimum standards of care" of ASHRAE Standard 189.1").

[110] U.S. EPA, Indoor Air Quality Tools for Schools: Preventive Maintenance Guidance Documents, https://tinyurl.com/yhedc845. See also CHPS, Best Practices Manual Vol. 4: Maintenance and Operations at 129-182 (2004), https://chps.net/best-practices-manual (describing elements of an HVAC maintenance plan, strategies for evaluating HVAC performance, and maintenance task lists for different kinds of systems); Wash. Dept. of Health, School Indoor Air Quality Best Management Practices Manual (2003), https://tinyurl.com/3kpmwfj6.

[111] See ASHRAE, Coronavirus (COVID-19) Response Resources from ASHRAE and Others, www.ashrae.org/covid19.

[112] See, e.g., CDC, Ventilation in Schools and Child Care Programs (rev. Feb. 2021), https://tinyurl.com/ykrmft5w.

in schools throughout the pandemic, building on its longstanding indoor environments work and its flagship IAQ Tools for Schools Action Kit.[113] In 2022, the White House issued the Clean Air in Buildings Challenge, a landmark in recognition of the importance of IAQ at the highest level of government. The Challenge is a "call to action for organizational leaders and building owners and operators…to assess their indoor air quality and make ventilation, air filtration, and air cleaning improvements to help keep building occupants safe."[114] As part of the initiative, EPA published a best practices guide containing key steps for reducing indoor air risks – not only from viruses, but from other contaminants as well.[115]

Other notable initiatives to review and advance the state of knowledge on indoor airborne transmission include a series of workshops from the National Academies of Science, Engineering and Medicine and a series of reports from the Lancet COVID-19 Commission.[116]

During the pandemic, many leading experts called for a "paradigm shift…toward a new ventilation standard accounting for managing infection risk."[117] There currently are no consensus-based building ventilation standards for infectious disease control outside the healthcare setting.[118] ASHRAE has not, to date, defined specific building ventilation rates that it recommends for infection risk mitigation in non-healthcare settings. However, this may be changing soon. In late 2022, ASHRAE announced the development of a "national indoor air quality pathogen mitigation standard" that would apply to the design and construction as well as the operation of buildings. ASHRAE's goal is to "finalize the consensus-based, code enforceable standard within six months."[119]

Pandemic guidance has emphasized three key steps to improving ventilation and filtration, as part of a layered approach to reducing the risk of indoor transmission: (1) ventilation assessment; (2) increased filter efficiency and/or use of air cleaners; and (3) increased outside air.[120] Experts have also advanced a strategy of achieving "equivalent clean air delivery" by using a combination of outdoor air ventilation and filtration/air cleaning.

Ventilation Assessment. Commissioning or recommissioning building systems during the pandemic is important "to ensure that existing buildings are operating as designed and to determine what additional enhancements are needed."[121] The ASHRAE Epidemic Task Force's Core Recommendations include system

[113] See, e.g., U.S. EPA, Pandemic and Beyond, supra; U.S EPA, Ventilation and Coronavirus (COVID-19), https://tinyurl.com/2k4yddnf.
[114] The White House, Clean Air in Buildings, https://www.whitehouse.gov/cleanindoorair/. See also U.S. EPA, Pandemic and Beyond, supra.
[115] U.S. EPA, Clean Air in Buildings Challenge: Guidance to Help Building Owners and Operators Improve Indoor Air Quality and Protect Public Health, https://www.epa.gov/indoor-air-quality-iaq/clean-air-buildings-challenge.
[116] Natl. Acad. Of Science, Engineering and Medicine, Indoor Air Management of Airborne Pathogens: A Virtual Workshop Series, https://tinyurl.com/27je4ztw; Lancet COVID-19 Commission, Safe Work, Safe School, and Safe Travel, https://covid19commission.org/safe-work-travel.
[117] Y. Li, et al., The COVID-19 Pandemic is a Global Indoor Air Crisis that Should Lead to Change: A Message Commemorating 30 Years of Indoor Air, Indoor Air 31(6):1683–1686 (2021), https://tinyurl.com/5ctse9fr.
[118] See Lancet COVID-19 Commission Proposed NADR, supra, at 3.
[119] ASHRAE, ASHRAE Commits to Developing an IAQ Pathogen Mitigation Standard (Dec. 2022), https://tinyurl.com/4t3pkaph.
[120] Related strategies recommended in pandemic guidance but not discussed here include flushing buildings before and after occupancy, ensuring air is well mixed and distributed, and limiting reentry of contaminated air. See, e.g., W. Bahnfleth, Reducing Airborne Infectious Aerosol Exposure, ASHRAE Journal (May 2021), https://tinyurl.com/yyxps8k5.
[121] Lancet COVID-19 Commission, First Four Healthy Building Strategies, supra, at 4. See also U.S. EPA, Pandemic and Beyond, supra.

commissioning to "[v]erify that HVAC systems are functioning as designed." ASHRAE's Building Readiness guidance provides detailed information on implementing the core recommendations, including a building systems evaluation to check that the building "is operating in proper order (per design conditions or current operational strategies) [and] is capable of being modified to align with HVAC mitigation strategies, and to identify deficiencies that should be repaired."[122]

Increased Air Filtration/Use of Portable Air Cleaners. A core recommendation for reducing indoor virus transmission is the use of filters rated MERV 13 or higher, which can effectively remove airborne particles from recirculated indoor air.[123]

As CDC notes: "Most of the respiratory droplets and particles exhaled during talking, singing, breathing, and coughing are less than 5 µm in size."[124] A MERV 13 filter is rated to be 85 percent efficient at capturing particles in the 1 µm to 3 µm size range, whereas MERV 8 is only 20 percent efficient; a MERV 13 filter is also rated to be at least 50 percent efficient at capturing particles in the smaller 0.3 µm to 1.0 µm size range, whereas MERV 8 filters are not rated in that size range.[125]

Where it is not possible to use in-duct MERV 13 filters or higher, including where a ventilation system does not recirculate indoor air, guidance documents typically recommend supplementing with portable air cleaners equipped with HEPA filters that are properly sized for the space. HEPA filters "are more than 99.97% efficient at capturing airborne viral particles associated with SARS-CoV-2."[126] Many organizations and agencies published information about air cleaners during the pandemic. The National Institute of Environmental Health Sciences (NIEHS), for example, published guidance "to help employers, building operators, and union officials select and use portable air cleaners to remove virus-contaminated air in indoor spaces."[127]

Increased Outside Air. A common recommendation during the pandemic has been to ensure that a facility is meeting the minimum ventilation required in the applicable building code and to increase outside air ventilation beyond that minimum level as feasible. Numerous pandemic guidance documents framed this recommendation in general terms, rather than specifying a quantity of outside air.[128] "Given the challenges of developing precise ventilation standards to effectively reduce airborne infection (specific beyond 'more

[122] ASHRAE, Core Recommendations for Reducing Airborne Infectious Aerosol Exposure (rev. Oct. 2021), www.ashrae.org/covid19 and Building Readiness (rev. May 2022), https://tinyurl.com/y35ykhu6.
[123] See, e.g., U.S. Dept. of Educ., Improving Ventilation in Schools, Colleges, and Universities to Prevent COVID-19, https://www.ed.gov/coronavirus/improving-ventilation; U.S. EPA, Pandemic and Beyond, supra; Lancet COVID-19 Commission, First Four Healthy Building Strategies, supra, at 5. ASHRAE has stated: "Our current recommendation is to use a filter with a [MERV] of 13, but a MERV 14 (or better) filter is preferred." ASHRAE, Filtration and Disinfection FAQ, https://www.ashrae.org/technical-resources/filtration-and-disinfection-faq.
[124] CDC, COVID-19: Ventilation in Buildings (rev. June 2021), https://tinyurl.com/3jwv7w25.
[125] See ASHRAE Standard 52.2, Table 12-1.
[126] ASHRAE, Filtration and Disinfection FAQ, https://www.ashrae.org/technical-resources/filtration-and-disinfection-faq.
[127] Natl. Inst. of Envtl. Health Sciences, Selection and Use of Portable Air Cleaners to Protect Workers from Exposure to SARS-CoV-2, https://tools.niehs.nih.gov/wetp/public/hasl_get_blob.cfm?ID=13021.
[128] See, e.g., U.S. Dept. of Educ., Improving Ventilation in Schools, Colleges, and Universities to Prevent COVID-19, https://www.ed.gov/coronavirus/improving-ventilation (bring in "as much outdoor air as possible"); CDC, Ventilation in Schools and Childcare Programs, https://tinyurl.com/ykrmft5w ("bring in as much outdoor air as your system will safely allow"); U.S. EPA, Pandemic and Beyond, supra ("outdoor ventilation maintained at or above design minimum values"); Lancet COVID-19 Commission, Designing Infectious Disease Resilience, supra, at 6 ("maximize outdoor air delivery and minimize or eliminate recirculation of unfiltered air").

ventilation is better'), the collective wisdom of infectious disease experts and building engineers generally emphasizes some level of increased ventilation to mitigate SARS-CoV-2 spread, while maintaining thermal comfort, to reduce airborne transmission risk."[129] ASHRAE COVID-19 guidance states: "Follow current ASHRAE 62 standard or local ventilation standards for minimum outside air requirements…Consider increasing outside air capacities beyond code minimum based on analysis completed by a qualified HVAC professional."[130]

A variety of factors may limit the extent to which a school district can increase the delivery of outside air. These factors include the capacity of the ventilation system itself, ambient conditions (temperature, humidity, air quality, etc.), and the related increased energy use and cost of bringing in and conditioning more outside air. As the Lancet COVID-19 Commission task force has noted: "Appropriate professionals, such as HVAC engineers, can determine how best to modify HVAC controls and what additional HVAC modifications may be possible to increase outdoor airflow to a building."[131]

Equivalent Clean Air Delivery. Over the course of the pandemic, the concept of equivalent clean air delivery – commonly expressed as equivalent air changes per hour (sometimes abbreviated as ACH*e*) – has gained traction as a way to mitigate infection risk in a space when increasing outdoor air is not feasible or sufficient. (ACH is the number of times the air volume of a room is replaced by outside air.) ACH*e* is calculated by determining the equivalent clean air supply (in ACH) from filtration and air cleaning and adding that amount to the air changes achieved through ventilation.[132] This approach can be effective in reducing infectious aerosols in the air, though it does not itself incorporate a minimum amount of outside air ventilation that may be needed to address other indoor pollutants and conditions.[133]

One widely-referenced recommendation proposed during the pandemic has been to achieve 4 to 6 ACH or ACH*e*.[134] (The current ASHRAE 62.1 minimum ventilation standard of 15 cfm per person in classrooms (using default densities) corresponds to about 3.5 ACH.)[135] In November 2022, the Lancet COVID-19 Commission

[129] Bueno de Mesquita, et al., supra, at App. 4. As noted earlier, the World Health Organization published guidance in 2021 recommending a ventilation rate of 10 L/s per person, or about 21 cfm per person. WHO, Roadmap to Improve and Ensure Good Indoor Ventilation in the Context of COVID-19 (2021), https://tinyurl.com/mr355283.

[130] ASHRAE Epidemic Task Force, Schools and Universities at 18 (rev. May 2021), available at: www.ashrae.org/covid19. See also ASHRAE Epidemic Task Force, Core Recommendations for Reducing Airborne Infectious Aerosol Exposure (rev. Oct. 2021), available at www.ashrae.org/covid19.

[131] Lancet COVID-19 Commission, First Four Healthy Building Strategies, supra, at 4. See also U.S. EPA, Ventilation and Coronavirus, (COVID-19) (rev. July 2022), https://tinyurl.com/2k4yddnf (while "increasing ventilation and filtration is usually appropriate…a professional should interpret ASHRAE guidelines for their specific building and circumstances").

[132] See Schools for Health: Risk Reduction Strategies, supra, at 31-33; W. Bahnfleth, Reducing Airborne Infectious Aerosol Exposure, ASHRAE Journal (May 2021) at 18, https://tinyurl.com/yyxps8k5; Johns Hopkins Bloomberg School of Public Health, School Ventilation: A Vital Tool to Reduce COVID-19 Spread at 20, https://tinyurl.com/wexztsed. ASHRAE provides guidance and examples on applying the concept of equivalent outdoor air. ASHRAE Epidemic Task Force, Building Readiness at 26-35 (rev. May 2022), https://tinyurl.com/y35ykhu6.

[133] ASHRAE has found "only limited scientific evidence showing that outdoor air ventilation intake flow can be partially or completely replaced by filtration and air cleaning." ASHRAE, Position Document on Filtration and Air Cleaning at 12-13 (rev. Feb. 2021), https://tinyurl.com/apamrskw.

[134] Allen and Ibrahim, supra (noting "this approach is consistent with what is used in hospitals to minimize risk of transmission"). Using this framework, 6 ACH is ideal, 5–6 is excellent, 4–5 is good, and 3–4 is a bare minimum. Schools for Health: Risk Reduction Strategies, supra, at 31. See also Lancet COVID-19 Commission, First Four Healthy Building Strategies, supra, at 4.

[135] See Allen and Ibrahim, supra.

task force issued a report expanding on this recommendation in proposing targets for "non-infectious air delivery rate" – i.e., air free of infectious bioaerosols.[136] The proposed targets (for non-healthcare settings) exceed current minimum ventilation standards and are stated in multiple metrics, including *equivalent air changes per hour* (where 4 is good, 6 is better, and more than 6 is best), *cfm per person* (where 21 is good, 30 is better, and more than 30 is best), and *volumetric flow rate per floor area* (ASHRAE 62.1 minimum plus a specified amount of outdoor air ventilation).[137] The Lancet report was issued to address the "urgency in setting new minimum standards that can help reduce respiratory disease risk indoors and promote better health overall."[138]

In announcing that it will develop a new national indoor air quality pathogen mitigation standard in 2023, ASHRAE stated that the standard would include "[a]lternative paths (prescriptive or performance), in which equivalent clean air would be the goal."[139]

[136] Lancet COVID-19 Commission Proposed NADR, supra, at 1, 17-20.
[137] Id. at 1. While the targets expressed in these three metrics are not necessarily equivalent to one another, the report notes that they are "largely in agreement" and all exceed current minimums. Id at 20. As noted earlier, the WHO recommends a ventilation rate of 10 L/s/person (21 cfm/person).
[138] Lancet COVID-19 Commission Proposed NADR, supra, at 1.
[139] ASHRAE, ASHRAE Commits to Developing an IAQ Pathogen Mitigation Standard (Dec. 2022), https://tinyurl.com/4t3pkaph.

PART THREE

THE ROLE OF STATE POLICY IN ADDRESSING VENTILATION IN SCHOOLS

Many school districts around the country have taken important steps to implement ventilation, filtration, and other IAQ best practices, both before and during the COVID-19 pandemic. Nevertheless, without a statewide school ventilation policy – and an active state program to oversee the policy – indoor environmental standards and conditions may vary from one school district to another, potentially exacerbating inequities that result in part from differences in district wealth. Research shows that ventilation and IAQ conditions can impact student and staff productivity, health, and well-being. State policies that set standards and provide resources for improving ventilation can advance health and educational equity by reducing virus transmission and pollutant exposures for children and staff in *all* schools in the state.

Statewide policies can also help clarify the practices needed to ensure good ventilation and filtration. As technical information and best practices evolve, states can incorporate new recommendations into their laws, regulations, and guidance documents and can facilitate technical support for schools to improve facility conditions. The existence of state ventilation and filtration requirements may enable school districts to prioritize ventilation and filtration in the use of existing school resources and future funding from federal, state, and other sources.

States have broad authority to protect public health and welfare and oversee the state system of public education. States have used this authority to adopt laws, regulations, and guidance addressing a range of school environmental health issues, including ventilation and IAQ. This chapter begins with a short overview of the principal state agencies that oversee school facility conditions. The chapter then describes foundational elements of a state policy (along with other related considerations) and provides a general overview of state policies, before turning to a detailed discussion of policy strategies in Part Four.

KEY AREAS OF STATE AUTHORITY

The majority of states have at least some laws or regulations relating to school ventilation. A starting point for developing a new school ventilation policy is to determine the relevant state laws and regulations that are already in place. This review can identify opportunities to build on those existing measures and help ensure that any new requirements are consistent with – and ideally, integrated with – other existing policies. Where multiple agencies within a state are charged with implementing school ventilation and IAQ policies, an interagency working group or other formal mechanism may be needed to ensure effective interagency communication and support.

This report discusses policies in three areas of state authority most relevant to existing school facilities: (1) occupational safety and health; (2) public health; and (3) education. Other agencies – e.g., building code, energy, or general services – may also play a role, particularly with respect to the funding of school facility improvements. Although agency roles vary from state to state, there are some general characteristics of each sphere of authority that suggest both opportunities and constraints for implementing a school ventilation policy.

Occupational Safety and Health. A majority of states have laws and regulations that address occupational safety and health (sometimes referred to in this report as "workplace" policies).

The federal Occupational Safety and Health Administration (OSHA) implements federal regulations governing worker safety in most *private* workplaces throughout the country. 29 U.S. Code chap. 15; 29 Code Fed. Regs. pt. 1910. States may apply to OSHA for approval to implement the federal requirements in lieu of the federal agency; to receive this approval, the "state plan" must cover state and local government workplaces, including schools.[140]

A total of 27 states (along with Puerto Rico and Guam) currently have received federal approval of their state plans governing public workplaces (including public schools); 21 of those plans also cover private workplaces (including private schools).[141] The federal government provides up to 50 percent of the funding for an approved state program.[142] Some states that do not have approval to implement federal OSHA standards (and thus remain subject to federal enforcement of OSHA requirements in private workplaces) nonetheless have adopted their own occupational safety and health rules and requirements, which may or may not be comparable to the federal OSHA provisions.[143]

States with approved plans must incorporate standards that are at least as stringent as those contained in federal OSHA law and regulations, and under federal law states *may* include provisions that are more stringent, including in areas not covered by federal law and regulations. 29 U.S.C. §667. This discretion to go farther is significant for school ventilation because the contaminant limits and ventilation requirements in federal OSHA rules address the exposures of workers in an industrial setting, rather than the typical exposures in workplaces such as schools. Most state occupational safety and health agencies have authority under their own state laws to strengthen the ventilation provisions in their workplace rules beyond what is included in federal OSHA rules.[144]

The federal occupational safety and health framework is notable for incorporating clear and detailed oversight and enforcement provisions. Approved state plans must incorporate inspections, complaint response, citations, and other enforcement procedures. 29 U.S.C. §667(c). One limitation in addressing school ventilation through workplace rules is that oversight and enforcement focus on employee complaints and injuries, rather than impacts to students and other non-employees.

Public Health. State laws authorize and direct public health agencies generally to prevent and control conditions that affect or endanger the public health. Many state health agencies address a range of school sanitation and environmental health issues, including drinking water quality, food safety, and some individual indoor air contaminants. These programs may derive from the general authority established in state public health statutes or from more specific legislative directives. In some cases, state laws and regulations require state (or local) health departments to inspect schools to ensure compliance with statutory and regulatory

[140] U.S. Occup. Safety and Health Admin. (OSHA), Frequently Asked Questions, https://www.osha.gov/stateplans/faqs.
[141] U.S. OSHA, State Plans, https://www.osha.gov/stateplans/. State plans must cover state and local government workplaces, but they are not required to cover private workplaces that fall under federal OSHA jurisdiction.
[142] 29 U.S.C. §672; U.S. OSHA, Frequently Asked Questions, https://www.osha.gov/stateplans/faqs.
[143] See, e.g., Mt. Admin. Code §24.30.102; 43 Pa. Stat. §25-2; Wis. Admin. Code §SPS 332.15.
[144] A minority of states have laws that limit agencies from adopting a regulation that is more stringent than a *corresponding* federal rule, though some such laws provide an exception in cases where the agency demonstrates the need for a stricter requirement.

requirements. States can build on their existing public health laws and regulations – or build on models from other states – to establish stronger ventilation and IAQ requirements and oversight mechanisms.

Although public health agency staff have expertise to address indoor environmental exposures, many agencies have only limited resources to oversee school environmental health requirements. A recent report noted that public health in the U.S. is chronically underfunded and that "an annual infusion of $4.5 billion is needed to fully support core public health foundational capabilities at the state, territory, local, and tribal levels nationwide."[145] An important consideration for enacting or strengthening school ventilation requirements under public health authorities is ensuring adequate resources for state (or delegated local) health departments to effectively implement the new measures.

Education. State constitutions establish the right to a free education, typically framed in very general language.[146] State laws authorize and/or require state education agencies to act in a variety of ways to administer the state education system, and the policies may expressly include functions related to school facilities. A considerable number of states have education laws and regulations that establish ventilation and other preventive maintenance requirements for existing schools. Many of these policies flow from the agency's role in funding school capital improvements and aim to help ensure effective use of state resources and to identify capital funding needs.

Foundational Elements of a State Policy Strategy

In developing the contours of a new state policy addressing school ventilation, it is vital for policymakers to consult with those who will be impacted by the policy – including school officials and staff, parents, ventilation/IAQ professionals, and the state and local agencies that already implement school facility policies. This input can be gathered through the regular rulemaking or legislative processes or through the creation of a special working group or task force. Legislators in many states have set up such task forces over the years to make recommendations on IAQ-related policy.

Most recently, the *Connecticut* legislature established a working group on school IAQ comprising multiple state agencies, medical and industrial hygiene experts, and organizations representing school employees, school officials, and HVAC professionals. The working group is charged with studying and making recommendations on, among other things, optimal HVAC performance benchmarks for minimizing the spread of infectious disease; optimal humidity and temperature ranges to ensure healthy air and promote student learning; and best practices for the inspection and proper maintenance of school HVAC systems. 2022 Ct. H.B. 5506, §370 (Public Act No. 22-118).

The strategies discussed in this report advance three foundational elements that should be addressed in a school ventilation policy: (1) required standards and practices; (2) oversight mechanisms for ensuring compliance with the requirements; and (3) financial and technical assistance for school districts to meet the

[145] Trust for America's Health, The Impact of Chronic Underfunding on America's Public Health System: Trends, Risks, and Recommendations at 8 (Apr. 2020), https://tinyurl.com/4rm9br9k.
[146] See generally M. Ciolino, The Right to an Education and the Plight of School Facilities: A Legislative Proposal, Univ. of Penn. Journal of Law and Social Change v. 19.2 (2016), https://tinyurl.com/mrxxz4df.

requirements. Taken together, these elements can help improve ventilation while also accounting for the considerable variation in school facility infrastructure and school district resources.

Required Standards and Practices. Ventilation and filtration requirements can be established as prescriptive standards (e.g., ventilation rate or filtration efficiency) or as practices that schools must undertake (e.g., HVAC maintenance). The requirements should build on well-established technical best practices, set clear expectations for school districts, and be framed in a way that allows schools to document compliance. A general reference to, or requirement for complying with, ASHRAE Standard 62.1 alone may be too broad – and potentially confusing – for this purpose, as there are numerous detailed technical requirements incorporated into that standard. Flexibility – e.g., through phase-in periods or alternate compliance options – is also important in light of the varying conditions of school facilities and the practical challenges in completing needed improvements.

Compliance Oversight Mechanisms. Without adequate state oversight, ventilation standards and requirements may be implemented unevenly throughout a state. State oversight in the school facility context typically involves a combination of state inspections and school district reporting of facility information. Ventilation requirements should be enforceable, though state enforcement actions and the imposition of penalties against schools are not common and generally should be reserved for situations involving serious and prolonged noncompliance. State oversight should be supplemented by measures to inform and engage school communities, so that they can participate in supporting good ventilation and IAQ.

Financial and Technical Support. Many school districts lack adequate funding for maintenance and operations and for carrying out capital projects needed to address an array of facility deficiencies, and students of color are disproportionately represented in those schools. When establishing stronger ventilation requirements and oversight, policymakers should identify funding mechanisms – e.g., federal funding programs; existing state funding programs where school HVAC work is allowed and/or prioritized; and new state funding programs that support school facilities generally or that focus on school ventilation assessment and upgrades. Policymakers should also consider creating and funding agency programs to provide technical assistance to school districts in implementing state ventilation requirements and in making related school facility improvements.

Other Considerations for Developing a State Policy

Though not discussed in Part Four, the following related goals are important considerations for policymakers in developing comprehensive approaches to improving ventilation in schools.

Integrating Ventilation and Other IAQ Issues. Policy strategies for improving ventilation can also improve IAQ more broadly. For example, state policies requiring schools to implement preventive maintenance plans or IAQ management programs provide an opportunity to address ventilation and a range of IAQ issues. Policymakers can also establish source control measures. Many states have established requirements for preventing and reducing exposure to a wide range of specific indoor contaminants, such as lead, asbestos, radon, and mold.[147]

[147] For information about state policies addressing individual indoor contaminants in schools, see Envtl. Law Inst., Topics in School Environmental Health, https://www.eli.org/buildings/topics-school-environmental-health-overview-state-laws.

Strengthening Requirements for New Construction and Renovation. Although this report focuses on ventilation in existing school facilities, it is also important to incorporate stronger ventilation and filtration requirements into state policies governing school construction and renovation. Those requirements will likely affect how ventilation is provided in schools for the useful life of those systems and beyond. The COVID-19 pandemic has highlighted an ongoing debate about of the adequacy of the minimum ventilation provisions in current model standards and codes.[148] Though state building codes are based largely on national model codes and standards, state policymakers need not wait for change at the national level before they take action. Most states have the authority to change or add provisions to model codes in order to advance state priorities. California did so in 2019 when it established a statewide requirement of MERV 13 filtration for mechanical ventilation and space conditioning systems in non-residential and residential new construction, additions, and alterations. 24 Ca. Code Regs. Pt 6, §§150.0(m)(12), (o); 120.1(b).

Integrating Ventilation and Energy/Decarbonization Goals. Commercial and residential buildings consume a large share of the energy used in the United States. According to a 2021 report, "energy consumption in buildings contributes over 30 percent of U.S. greenhouse gas emissions."[149] It is necessary to advance both environmental and health goals in policies aimed at improving school facilities. As leading scientists put it during the pandemic: "Health is an essential element of sustainability, and developing carbon neutral indoor air technologies is essential."[150]

In school construction and renovation, it is possible to advance health and environmental goals by incorporating renewable energy sources and by using energy/heat recovery ventilation systems, which provide outside air while minimizing energy loss.[151] Federal agencies and green building organizations offer guidance on best practices for ventilation in new construction, and EPA has created a guide to incorporating HVAC upgrades and many other IAQ measures in school energy retrofits.[152] Some states have enacted laws expressly requiring agencies to consider indoor environmental quality when developing new construction and energy retrofit policies and programs.[153]

For existing schools, the need to increase ventilation rates generally or during an emergency may increase energy costs and carbon emissions, especially during heating and cooling seasons. ASHRAE's pandemic guidance for schools recommends: "In selecting mitigation strategies, consideration should be given to

[148] See generally Persily and Polidoro, supra at 4 ("The adequacy of the minimum outdoor air ventilation requirements in [ASHRAE 621. and 62.2]…has been debated for decades and those discussions continue."); White House Summit on Indoor Air Quality (Oct. 2022), recording available at: https://www.youtube.com/watch?v=q1HCG1aXaBg (remarks by Joseph Allen: "Standard-setting organizations like ASHRAE, CDC, and others must develop health-based ventilation targets and IAQ standards for our buildings rather than [the current]…bare minimums.").

[149] Resources for the Future, Federal Climate Policy 106: the Buildings Sector (2021), https://tinyurl.com/22wedxme.

[150] Y. Li, et al., The COVID-19 Pandemic is a Global Indoor Air Crisis that Should Lead to Change, Indoor Air 31(6):1683–1686 (2021), https://tinyurl.com/5ctse9fr.

[151] See MacNoughton, et al., supra (concluding that "relatively minor" environmental costs of increased ventilation "should be offset by the incorporation of energy recovery systems, advanced ventilation strategies, and other green building design strategies.").

[152] Whole Building Design Guide, Optimize Energy Use, https://www.wbdg.org/design-objectives/sustainable/optimize-energy-use; CHPS, US-CHPS Criteria 2.0, https://tinyurl.com/4zsscb7n; ASHRAE, et. al, Indoor Air Quality Guide: Best Practice for Design, Construction, and Commissioning, ch. 8 (2009), https://tinyurl.com/yr6n5sync; U.S. EPA, Energy Savings Plus Health: Indoor Air Quality Guidelines for School Building Upgrades, https://tinyurl.com/4jtd7y65.

[153] See, e.g., Ar. Stat. §22-2-108, Ar. Admin. Code §234.02.2-2-800; Ca. Public Res. Code §25402.8; Co. Stat. §40-8.7-109; 20 D.C. Mun. Regs. 3518, 3521; Mn. Stat §326B.118; Mo. Stat. §8.851; Or. Stat §276.915.

energy use as there may be multiple ways to achieve performance goals that have greatly different energy use impact."[154] In addition to using natural ventilation when feasible, schools can employ energy saving maintenance and operation practices such as adjusting HVAC system controls to ensure the system is only running when needed, installing efficient and properly sized fan motors, ensuring economizers are working properly, and increasing filter efficiency to supplement ventilation.[155]

The Current State of State Policy on School Ventilation

Most states currently have longstanding laws or regulations that address ventilation in schools in some fashion. But most of these policies lack the foundations of an effective and comprehensive policy strategy: clear ventilation requirements, oversight mechanisms for facilitating compliance, and equitable financial and technical assistance programs to assist schools in carrying out needed improvements.

- Over half of the states have occupational safety and health laws and regulations that apply to workplaces of many types and sizes, including schools. These policies include a detailed framework for overseeing health and safety standards. While they all require schools generally to provide a workplace that is safe and free from recognized hazards, only a small number – including *New Jersey*, *California*, and *Minnesota* – establish specific ventilation requirements relevant to the school environment. New Jersey is unique in having adopted a separate IAQ rule for schools and other public workplaces; among other things, the rule establishes preventive maintenance requirements for ventilation systems.

- Several states have public health laws or regulations that require state or local health agencies to inspect schools for sanitary and environmental health conditions. For the most part, though, these policies establish only general ventilation criteria, and some do not specify the frequency of inspections. *Indiana* is notable for having a state law that requires the health department to conduct IAQ inspections of schools upon complaint and for establishing criteria that govern the inspection, including specific HVAC maintenance practices and a requirement for schools to keep HVAC maintenance logs.

- A number of states have education laws or regulations that establish facility requirements either generally or as a condition of receiving capital funding. The ventilation measures in these education policies often reference compliance with the building code at the time of installation and/or require preventive maintenance plans and procedures. Agency oversight of these requirements tends to be structured around medium- and long-term capital planning, rather than ongoing compliance with facility standards. *West Virginia* is unusual in requiring the education agency to conduct annual inspections of school facilities built with state funds, and *New Hampshire*'s education law requires

[154] ASHRAE, Guidance for the Reopening of Schools, https://tinyurl.com/49bxcwjp. Some researchers have suggested that "building managers tend to overestimate the energy costs related to ventilation." MacNoughton, et al., supra.
[155] See U.S. EPA, Framework for Effective School IAQ Management, https://www.epa.gov/iaq-schools/framework-effective-school-iaq-management; CHPS, Best Practices Manual Vol. IV: Maintenance and Operations at 132-133, https://chps.net/best-practices-manual; MacNoughton, et al., supra.

schools to conduct an annual IAQ inspection and to submit an inspection checklist to the state education agency.

The decades before the COVID-19 pandemic saw relatively slow progress in the adoption of state policies addressing school ventilation. Over the past few years, however, there has been a proliferation of such policies – mostly in the form of non-binding guidance, but also including laws and regulations establishing requirements for schools.

- Some recent state policies established school ventilation requirements specifically to address the COVID-19 emergency. In addition to several states that published binding guidance, three states – *California, Oregon*, and *Virginia* – adopted COVID-19 workplace rules that included ventilation requirements applicable to schools for at least for some period of time during the pandemic.

- A few states adopted measures that go beyond addressing COVID-19. *California* enacted an education law that requires all existing schools to meet stricter ventilation and filtration standards where feasible and builds on the state's existing workplace rule requiring employers to conduct annual ventilation inspections. A new *Connecticut* law requires schools to conduct and document comprehensive ventilation system assessments every five years. *New York* enacted a law requiring private workplaces to adopt plans to address future airborne infectious disease emergencies.

- Several states adopted new laws and regulations that provide funding specifically for assessing and improving school ventilation. Some of these laws established new programs, while others allocated funding for this purpose to an existing agency program. Though many states provide some type of technical assistance to schools, *West Virginia* is notable for enacting a law that establishes a school HVAC technical assistance program within the education agency.

PART FOUR

STATE POLICY STRATEGIES TO ADDRESS VENTILATION AND FILTRATION IN EXISTING SCHOOLS

This chapter describes some of the ways state policies can incorporate school ventilation requirements, oversight mechanisms, and financial/technical assistance measures, highlighting examples of current policies. The state examples noted here do not necessarily represent models to be replicated in whole, but they include elements for other states to consider in developing school ventilation laws, regulations, and guidance. ELI did not evaluate how states have implemented their policies, though the discussion reflects conversations with agency officials in several states.

The chapter is divided into three sections:

- Ventilation/Filtration for General Operations – operations and maintenance requirements and oversight mechanisms.
- Enhanced Ventilation/Filtration during Infectious Disease Emergencies – ventilation requirements addressing COVID-19 specifically and future infectious disease emergencies more broadly.
- Financial and Technical Assistance – funding programs that prioritize or focus specifically on ventilation, as well as those that provide technical assistance.

> CITATIONS TO POLICIES HIGHLIGHTED IN THIS CHAPTER
>
> The Appendix includes citations to most of the state laws and regulations described in this chapter. In the discussion that follows, citations are included only for those policies that are not included in the Appendix.

POLICIES ADDRESSING VENTILATION/FILTRATION FOR GENERAL OPERATIONS

This section highlights policy strategies for addressing key measures related to ventilation (assessment/inspection, maintenance, standards) and filtration. The last part of the discussion reviews compliance oversight mechanisms. While educational materials and non-binding guidance documents are needed for improving ventilation practices, the focus here is on state requirements. For many of the strategies discussed below, technical and financial assistance will be an important complementary measure for ensuring that all schools can meet state requirements and provide good ventilation.

Ventilation Requirements

Ventilation Assessment and Inspections

Regular reviews of school ventilation systems are important for ensuring that ventilation and filtration are provided in accordance with system specifications and state requirements. Many states already have policies in place that require school facility condition assessments and/or routine inspections, and these policies can be strengthened by specifying the minimum frequency and components of the review.

Comprehensive Ventilation Assessment/Evaluation. An important ventilation best practice is to re-commission or assess ventilation systems regularly to help systems operate more effectively and efficiently and to identify capital funding needs and priorities.

State policymakers could require periodic ventilation system assessments, conducted by qualified professionals at a stated interval (e.g., every three to five years), to be supplemented by routine annual inspections conducted by schools. The policy should establish minimum components of the assessment, such as: documenting whether the system is operating properly in accordance with system specifications; indicating whether the system is capable of meeting applicable state and/or ASHRAE ventilation standards; identifying opportunities for improving ventilation and filtration; and highlighting steps that would be needed to provide enhanced ventilation and filtration during infectious disease emergencies or outbreaks.

A notable policy development along these lines is a 2022 *Connecticut* law requiring schools to conduct comprehensive five-year HVAC inspections and evaluations. The law specifies detailed components of the evaluation, including:

> "(A) testing for maximum filter efficiency,
> (B) physical measurements of outside air delivery rate,
> (C) verification of the appropriate condition and operation of ventilation components,
> (D) measurement of air distribution through all system inlets and outlets,
> (E) verification of unit operation and that required maintenance has been performed in accordance with the most recent standards promulgated by [ASHRAE]…,
> (F) verification of control sequences,
> (G) verification of carbon dioxide sensors and acceptable carbon dioxide concentrations indoors..."

The HVAC evaluation must identify the extent to which a school's current ventilation system is "operating in such a manner as to provide appropriate ventilation to the school building in accordance with most recent indoor ventilation standards promulgated by" ASHRAE. The evaluation must be performed by a certified testing, adjusting, and balancing technician, a certified industrial hygienist, or a mechanical engineer, and schools must follow up on any recommendations resulting from the inspection. (Another 2022 Connecticut law, described at the end of this chapter, establishes a grant program for school HVAC installation, replacement, upgrades, or other IAQ improvements.)

New school ventilation grant programs in *California* and *New Jersey* (discussed at the end of this chapter) provide funding for HVAC assessments, and state agencies have developed detailed minimum requirements as well as guidance for conducting those assessments.[156]

As an alternative to adopting new legislation, some states may be able to revise an existing requirement for a school facilities assessment to include more detailed information about ventilation/filtration functioning and capacity. Some states that fund capital improvements in schools already have education laws or regulations that require a facilities condition assessment or survey every few years, often focused on the condition and useful life of building systems and whether the systems are being maintained in working order.

For example, in *New York*, the education law and rules require schools to carry out five-year building condition surveys, which are eligible for state funding. The state surveys must utilize a state-created form, be conducted by a team that includes at least one licensed architect or engineer, and review ventilation and other building systems "for evidence of movement, deterioration, structural failure, probable useful life, need for repair and maintenance and need for replacement." *Washington*'s education law requires schools participating in the state's Asset Preservation Program to submit to the state and present at a public school board meeting each year the results of an annual building condition assessment, which includes a rating of common building components as excellent, good, fair, poor, or unsatisfactory. The law also requires six-year building condition evaluations conducted by a "certified evaluator."

In some states, the education agency itself conducts the required facilities condition evaluation. *West Virginia* is unusual in requiring such inspections *annually* for facilities funded wholly or partly by the state. The goal of the inspection is to "ensure compliance with the county board's facilities plan and school major improvement plan as related to the facilities; to preserve the physical integrity of the facilities to the extent possible; and to otherwise extend the useful life of the facilities." West Virginia's policy is also noteworthy because the inspections are carried out by agency HVAC technicians who are charged with providing technical assistance to schools. Other states require the education agency to conduct school facility condition surveys less frequently – e.g., *Arkansas* (random unannounced on-site inspections), *Arizona* (every five years), and *Maryland* (every four years).

Annual Ventilation System Inspection. Alongside periodic ventilation assessments, it is important for schools to inspect ventilation systems at least annually to ensure the system is operating properly to provide the required outside air and to check the condition of system features and components. Annual inspections are closely linked to routine preventive maintenance activities (described below), many of which are recommended to be carried out on a more frequent basis than once each year.

A considerable number of states have education, health, or workplace laws and regulations that require schools to conduct routine facility inspections (including ventilation), and some of these expressly require inspections annually. As noted earlier, a *New Hampshire* education law requires schools to conduct annual IAQ inspections, and the education agency has created an annual IAQ survey checklist that includes several HVAC questions. *Indiana* IAQ rules require school maintenance plans to include annual HVAC inspections and a schedule for inspecting and changing filters. In *Arkansas*, the legislatively-mandated Public School Facilities

[156] See Calif. Energy Comm., California Schools Healthy Air, Plumbing, and Efficiency Ventilation Program Guidelines (2nd ed. 2022) and HVAC Assessment Worksheets (Oct. 2021), https://tinyurl.com/3uphaf7e; N.J. School and Small Business Energy Efficiency Stimulus Program Guidelines V1.2 (Dec. 2021) and HVAC Worksheet, https://tinyurl.com/mry9ckjd.

Custodial, Maintenance, Repair, and Renovation Manual developed by the school facilities agency requires school districts to inspect ventilation systems annually, including certain specified items. *Montana's* school health rules were revised in early 2020 to require schools to conduct an annual ventilation system check, as well as an annual IAQ inspection using the walk-through inspection checklist from EPA's Indoor Air Quality Tools for Schools Action Kit or other form approved by the health department.

In *California,* OSHA rules also require workplace HVAC systems to be inspected at least annually. The rules do not specify the components of the inspection; however, a 2022 education law uses this inspection report as the vehicle for schools to provide documentation if their HVAC systems cannot meet the ventilation standard in the current state building code.

Ventilation Maintenance Practices

Preventive maintenance of ventilation systems, including the system filters, is essential to providing good ventilation and IAQ in accordance with state standards and equipment specifications. Many states have adopted policies addressing school facility and HVAC maintenance in some fashion, including states that condition capital funding on adequate preventive maintenance. This section highlights requirements for a written maintenance plan and specific maintenance practices, which can help ensure consistency across the state and can facilitate state and community oversight. State policies can also strengthen school facility maintenance practices by requiring training for maintenance personnel.

Ventilation Maintenance Practices and Plans. State building codes likely include at least some type of maintenance requirement that applies to buildings constructed pursuant to the code. As noted earlier, ASHRAE Standard 62.1 sets forth a table of minimum HVAC maintenance activities and frequencies that are to be included in an operations and maintenance manual. The International Mechanical Code, commonly adopted into state building codes, does not incorporate these maintenance provisions of Standard 62.1, though states may elect to affirmatively adopt ASHRAE 62.1 requirements.[157] The IMC does provide that an "inspection for maintenance of HVAC systems" must be carried out in accordance with ASHRAE Standard 180.

At least a few states, including *Connecticut, Colorado,* and *Maine*, have health or education regulations requiring existing schools to maintain ventilation systems in accordance with ASHRAE 62.1, though the policies do not say explicitly that schools are to follow the schedule of maintenance practices set forth in the standard. State policies could be strengthened by referencing the relevant provisions of ASHRAE 62.1 or by incorporating specific maintenance measures – e.g., from ASHRAE 62.1 or from EPA's Tools for Schools Action Kit – into agency rules, guidance, or checklists. Calibration of indoor air monitoring devices should also be included as a required maintenance practice to help ensure the accuracy of measurements.

Some state policies expressly require schools to develop a written maintenance plan or procedure addressing ventilation – examples include *Arkansas, Florida*, *Indiana*, *Maine*, and *New Jersey*. To varying degrees, these policies set forth specific items that must be included in the maintenance plan. Another state, *Arizona*, has developed a detailed HVAC Task Sheet for schools, with quarterly, semi-annual, and annual tasks; the

[157] Maine is one example of a state that expressly incorporates by reference ASHRAE 62.1-2016 into its building code. 16 Maine Code Rules 642, chap. 7.

education agency requires districts to complete the checklists for each school, and the agency reviews the information during its periodic inspection of the school.

Training for Maintenance Personnel. In some states, building codes or other school construction policies require training for facility maintenance personnel on new HVAC and other building systems. Under *Connecticut* law, for example, the state may not approve a school building project plan if the plan does not provide for building maintenance staff training in the appropriate areas of plant operations, including training on operating HVAC systems as required by state law and "specific training relative to indoor air quality." For Connecticut schools built or renovated after 2003, required three-year IAQ inspections must address "the provision of indoor air quality maintenance training for building staff."

State policies may also require training for school facilities staff outside the school construction context. *New Jersey's* IAQ rule for public workplaces requires employers to designate and train a staff member to oversee implementation of the rule, and the state has developed presentation materials for the training.[158] A 2022 *Vermont* law requires school districts to designate a person with responsibility for facilities management and to provide them training and certification in accordance with guidelines to be developed by the state.

In *Minnesota*, to qualify for long-term facilities maintenance revenue, school districts must annually update and submit a 10-year facility plan that includes "provisions for implementing a health and safety program that complies with health, safety, and environmental regulations and best practices, including indoor air quality management…" Although this law does not expressly require facilities maintenance training, the state health department has developed an IAQ Management Plan Development Package that builds on the EPA's IAQ Tools for Schools Action Kit, and the department provides training for designated school IAQ coordinators. The training, which covers IAQ best practices, laws, guidance, and resources, is available online and in-person and may be eligible for continuing education credits.[159]

Ventilation Standards

State public health, education, and workplace laws and regulations often establish the general responsibility of school districts to ensure their facilities are safe and in good repair. The most common example is the "general duty" clause or equivalent adopted by the majority of states that have federally approved OSHA plans: "Every employer shall furnish…employment and a place of employment which are safe as well as free from recognized hazards." 29 U.S.C. §654. Public health and education laws and regulations may also include a general requirement for schools to provide safe or healthy facilities.[160]

Such general standards are important. However, while they may be broad enough to encompass ventilation and IAQ, they are unlikely to be implemented to address school ventilation conditions outside of exceptional circumstances. Some state policies go further by establishing a performance standard for ventilation, but

[158] N.J. Dept. of Health, PEOSH Program, Designated Person Indoor Air Quality Training Program, https://www.state.nj.us/health/workplacehealthandsafety/documents/peosh/dptraining.ppt.
[159] Minn. Dept. of Health, School Indoor Air Quality (IAQ) Training, https://tinyurl.com/5xd3j3ex; Minn. Dept. of Health, Indoor Air Quality (IAQ) Plans in Schools, https://tinyurl.com/2pux3tvh.
[160] See, e.g., Nv. Stat. §393.100 (districts must "keep the public school buildings…in such repair as is necessary for the comfort and health of pupils and teachers"); N.H. Code Admin. R. Ed §306.07; N.H. Rev. Stat. §189:24 (school boards must "provide a clean, healthy, and safe learning environment for all areas of the school building").

these are also typically framed in very general terms – e.g., requiring "adequate," "proper," or "sufficient" ventilation – that makes implementation challenging for both schools and state agencies.[161]

This section describes policy strategies for establishing a more specific ventilation standard for general school operations in order to reduce indoor air risks.

Ventilation Standard for Existing Schools. Currently, the most common type of statewide ventilation standard for existing school facilities is a mandate to provide ventilation in accordance with the building code or standard that was in effect when the building was constructed and/or the ventilation system was installed.[162]

A fairly common source of this type of ventilation requirement is the state building code. The International Mechanical Code provides: "Mechanical systems, both existing and new, and parts thereof shall be maintained *in proper operating condition in accordance with the original design* and in a safe and sanitary condition. Devices or safeguards that are required by this code shall be maintained in compliance with the edition of the code under which they were installed." IMC §102.3 (italics added). Although this section of the IMC also gives code officials authority to require reinspection of mechanical systems, the code states that "a provision in this code shall not require the removal, alteration or abandonment of, nor prevent the continued utilization and maintenance of, a mechanical system lawfully in existence at the time of the adoption of this code." IMC §[A]102.2.

State and local building code agencies are not necessarily tasked with ongoing oversight of ventilation performance during building operations, and many school buildings may not be meeting even this minimum, facility-specific standard. Several states have made such a standard more prominent by incorporating it into state health, education, and/or workplace safety policies. In *Maine*, for example, the education law provides that HVAC systems must be "[m]aintained and operated to provide at least the quantity of outdoor air required by the state building standards code in effect at the time the building permit was issued or the...system was installed, whichever is later."

A requirement for conducting and reporting on comprehensive ventilation assessments and regular HVAC inspections can help ensure that a facility-specific standard is met. Nonetheless, this approach may result in more or less stringent requirements being applied across the state and even within school districts, depending on the age of the school or HVAC system and the state standard in effect at the time.

To strengthen ventilation requirements for existing schools, policymakers could establish a minimum ventilation standard that applies to all schools throughout the state, *regardless* of when they were built or when the ventilation system was installed. For example, states could require all schools to meet the ventilation rate established in the state's *current* building code or in ASHRAE 62.1. *Minnesota* has taken this approach. The state's occupational safety and health rule requires employers (including schools) to provide 15 cfm per person, which is in line with Minnesota's current building code requirement.

[161] See, e.g., La. Admin. Code t. 51, Pt. XVII, §103 (schools must be "adequately" ventilated); Mo. Stat. §177.031 (school boards must provide "proper" ventilation); Tx. H&S Code §341.065 (school buildings must be "properly" ventilated). Some policies are even less specific, requiring HVAC systems to be "capable of" being properly maintained and operated.

[162] EPA recommends that schools ensure HVAC systems operate "with outdoor ventilation maintained at or above design minimum values" during regular operations. U.S. EPA, Pandemic and Beyond, supra.

Another option is to require a ventilation rate that is *higher* than current building code or industry standards. As described in Part Two, some experts have recently proposed higher ventilation standards to more effectively reduce exposure to infectious aerosols, and ASHRAE is developing a new IAQ pathogen mitigation standard that is expected, among other things, to address ventilation rates.

Whether a uniform ventilation standard is set at or above current codes and standards, it will likely result in an increased ventilation requirement for at least some schools. Since schools that lack adequate mechanical ventilation systems may not be able to meet a higher standard, states could adopt a flexible approach to applying a uniform standard. Policymakers might, for example, provide a delayed implementation date, by which time schools would identify (through a ventilation assessment) and implement the steps needed to meet the higher standard. Schools that *document* that their facilities cannot meet the standard without capital improvements would be required to achieve as close to the higher standard as feasible within existing system capacity. Documentation of school HVAC capacity for meeting the standard could be integrated with state programs for funding school capital improvements.

A 2022 *California* law incorporates a similar strategy. The law requires existing schools that have HVAC systems to ensure that their "facilities, including, but not limited to, classrooms for students, have HVAC systems that meet the minimum ventilation rate requirements set forth in [the current state building code]…unless the existing HVAC system is not capable of safely and efficiently providing the minimum ventilation rate." The current state building code includes a classroom ventilation requirement of at least 15 cfm per person. 24 Ca. Code Regs Pt. 6 §120.1(b). A school that cannot meet this standard must ensure that the HVAC system meets the minimum ventilation rates in effect when the HVAC system permit was issued. A key element of the new law is that a school must document the HVAC system's inability to meet the new ventilation standard; this is to be done through the annual HVAC inspection that has long been required by the state occupational safety and health rules.

Washington took a similar approach when it revised its school health and safety rules (though the rules are currently not being implemented, pursuant to a moratorium imposed by the legislature). The revised rules would set a goal of meeting the ventilation standard in the current state building code if feasible. Schools would be required to conduct "standard operation best practices...and setting system controls so that, to the extent possible given the design of the ventilation system, outdoor air is provided consistent with" the current state building code (which currently incorporates the 2018 IMC).

The state of *Texas* developed voluntary IAQ guidelines for schools that include a similar recommendation: "The HVAC systems should be operated to provide acceptable outside air with quantities in conformance with the most current and accepted standard, such as ASHRAE Standard 62, up to the equipment capabilities. Proper operation and flow rates should be verified annually." 25 Tx. Admin. Code §§297.5, 297.1.

Providing Ventilation While Schools are Occupied*.* Regardless of how a school ventilation requirement is stated, policymakers can specify that ventilation must be provided continuously while buildings are occupied.

It is likely that many states already include such a requirement in their building codes, as both ASHRAE 62.1 (§8.3) and the IMC (§401.3) incorporate provisions to this effect. Several states have also established this requirement in their public health, education, and workplace policies – typically applying the standard during school activity hours or while the school is occupied (which would incorporate times when school maintenance staff and other personnel are present after regular hours).

These policies usually include an exception for emergency maintenance and repairs, as well as for times when the school can demonstrate that non-mechanical means are providing adequate ventilation as defined in the law or regulation. For example, *Connecticut* education law requires ventilation systems to be "operated continuously during the hours in which students or school personnel occupy school facilities, except (A) during scheduled maintenance and emergency repairs, and (B) during periods for which school officials can demonstrate to the local or regional board of education's satisfaction that the quantity of outdoor air supplied by an air supply system that is not mechanically driven meets the Standard 62 requirements for air changes per hour." *California*'s OSHA rule, which includes a similar exception to its continuous ventilation requirement, requires schools and other employers to have available their calculations or measurements showing the adequacy of non-mechanical ventilation in such situations.

Ventilation Monitoring. Monitoring ventilation performance can help ensure that schools are providing ventilation in accordance with applicable requirements and best practices. The use of CO_2 monitoring, while raising some important technical issues, has been recommended by a variety of agencies and experts as a tool for identifying and correcting ventilation problems.

CO_2 Benchmarks. A central issue for incorporating CO_2 monitoring into state policies is establishing a CO_2 benchmark. States that implement the federal OSHA law and regulations must establish a CO_2 workplace exposure standard at least as stringent as the federal standard of 5,000 ppm. 29 CFR 1910.1000, Table Z-1. However, that standard addresses dangerous impairment of function in occupational settings, rather than CO_2 considerations for K-12 schools.

Some states have adopted public health, education, or workplace policies that include CO_2 benchmarks and monitoring provisions more relevant to the school setting. As noted earlier, ASHRAE's 2022 position document on CO_2 emphasized that its standards have not included an indoor CO_2 value since 1989. Nonetheless, the levels referenced in earlier ASHRAE standards are widely cited. Several states have laws or regulations setting CO_2 benchmarks of 1,000 to 1,200 ppm or 700 ppm above background levels.

CO_2 Monitoring. For the most part, current state policies do not require existing schools to conduct ongoing CO_2 monitoring.

In *Connecticut*, newly required five-year school ventilation evaluations must include "verification of carbon dioxide sensors and acceptable carbon dioxide concentrations indoors," but the law doesn't expressly require schools to install continuous CO_2 monitors. The state of *Delaware* will be developing school air quality monitoring requirements pursuant to legislation enacted in 2022. The new law requires the state health agency to establish "a routine indoor air quality monitoring program and standards," to include testing procedures, protocols, and frequency. The law directs the agency to consider IAQ industry best practices, such as Standard 62.1, though it currently specifies only temperature and humidity as required parameters.

Even where state laws and regulations establish CO_2 benchmarks, they do not necessarily require schools to measure CO_2 levels on an ongoing basis or at a stated frequency. In some states, CO_2 benchmarks are used by state health or education agency inspectors during their school facility visits. The CO_2 standards are described as levels that schools may not exceed (*Arizona*, *Indiana*) or as levels that the HVAC system must be capable of maintaining (*Maryland, New Mexico*). Since high CO_2 levels are an indication of a potential ventilation problem, a more strategic approach might be to establish a CO_2 benchmark as a trigger for schools to investigate and correct any ventilation deficiencies. This is the approach incorporated into *New Jersey*'s public workplace IAQ rule; if a school's CO_2 levels exceed 1,000 ppm, the employer must "check to make sure

the HVAC system is operating as it should" and take any necessary preventive maintenance actions. The rule does not, however, explicitly require employers to conduct CO_2 monitoring.

In *California*, schools that receive funding under the state's recently-established HVAC grant program must install in all classrooms CO_2 monitors that meet the program's specifications and must conduct continued monitoring. The monitors must provide a notification through a visual indicator or other alert system when the CO_2 levels in the classroom have exceeded 1,100 ppm; if that level is exceeded more than once a week "the classroom ventilation rates shall be adjusted by qualified testing or adjusting personnel…"[163] The grant program pays for the monitor, installation, and initial adjustment of the device. *New Jersey's* new ventilation grant program includes a similar requirement for installing CO_2 monitors in classrooms of funded schools. (State ventilation funding policies are described at the end of this chapter.)

Some states include CO_2 monitoring provisions in their building codes governing new construction – for example, requiring schools and other facilities to maintain specified CO_2 levels in connection with demand-controlled ventilation systems installed under the code. *California* has gone further by updating its CalGreen building code in 2022 to require that each new K-12 classroom be equipped with a CO_2 monitor. The monitor must meet the specifications listed in the code and must "provide notification through a visual indicator on the monitor when the carbon dioxide levels have exceeded 1,100 ppm." 24 Ca. Code Regs. Pt. 11, §5.506.3. In addition, 2022 state legislation directed the California Building Standards Commission and the Division of the State Architect to "research, develop, and propose for adoption mandatory standards for carbon dioxide monitors" in school classrooms in connection with the state's next triennial building code update.

State Ventilation Guidance*.* As discussed above in Part Three, there are a number of important technical factors to consider in connection with CO_2 monitoring, including calibration of the devices and how to conduct the monitoring. In establishing requirements related to CO_2 monitoring, a state law or regulation could require the implementing state agency to develop guidance that draws on existing technical recommendations and tools. State guidance can be updated more easily than laws or regulations to reflect changes to recommended CO_2 standards or monitoring procedures. Such guidance can also address other common indoor environmental parameters, such as temperature, humidity, and particulate matter. As sensors become more sophisticated and more affordable, policymakers will likely be called on to develop standards and provide guidance for monitoring a wider range of air contaminants in schools and other buildings.

State agency guidance can also help ensure effective implementation of school ventilation requirements. States that have policies setting a very general ventilation performance standard can develop guidance to clarify what is required and to provide information and resources to assist schools in complying. States like California that waive compliance with a uniform ventilation standard for schools lacking system capacity can develop criteria and guidance for making the determination of whether compliance is feasible.

In *Washington*, the state's revised school health and safety rule (currently not in effect) would require the Department of Health to update the state's Health and Safety Guide for K-12 Schools in Washington every four years, to serve as "the primary source of guidance for local health officers and school officials implementing" the rules. In *Indiana,* the Department of Health has created, pursuant to state law, a best

[163] Calif. Energy Comm., California Schools Healthy Air, Plumbing, and Efficiency Ventilation Program Guidelines at 19-20 (2nd ed. 2022), https://tinyurl.com/2bxcpekz.

practices manual "to assist schools in meeting the requirements of" the state's IAQ inspection rule, which includes ventilation measures.

Filtration

Adequate filtration is important for school indoor environments, even beyond infection control and the COVID-19 pandemic. It is a proven strategy not only for reducing virus transmission, but also for reducing exposure to pollutants that enter a school with the outside air, as well as pollutants generated indoors.

Few states, however, have established minimum filtration standards for existing schools other than the building code requirement in effect at the time of construction or system installation – and those building codes very likely include minimal, if any, filtration efficiency standards. States can address this clear policy gap by adopting a requirement for high-efficiency filtration in new schools and, as feasible, in existing schools. Regular maintenance and replacement of filters throughout the year are also necessary to ensure good performance of the equipment.

High-Efficiency Filtration. Most state building codes incorporate the International Mechanical Code (no minimum filter efficiency established) or ASHRAE 62.1 standard (MERV 8 required in most places).

In 2019, *California* became a leading example for states considering stronger filtration standards. The state now requires MERV 13 or higher filtration in mechanical ventilation and space conditioning systems in new construction, additions, and alterations of schools and other buildings. 24 Ca. Code Regs. Pt 6, §§150.0(m)(12), (o); 120.1(b). The California Energy Commission developed the new MERV 13 standard "to ensure that filtration requirements were set at a level appropriate for our current understanding of human indoor air quality needs and the effects of particulate pollutants on human health" and recognizing that "filters meeting current MERV 6 and 8 requirements are only moderately effective at filtering out airborne particulates (PM10) and are unable to capture or filter out fine particulates (PM2.5)."[164] The state's air quality agency commented that adopting the requirement statewide was important to "provide equal protection to all areas and population groups of concern."[165] In November 2022, the *Washington* State Building Code Council followed suit by approving adoption of the 2021 IMC with an amendment that requires MERV 13 filtration.[166]

In addition to requiring MERV 13 filtration in new and replacement HVAC systems, state policymakers can advance better air filtration in existing schools by requiring that they use MERV 13 filters or as close to that standard as their HVAC system will allow. Even older systems may be able to support an upgrade to medium- or high-efficiency filters. The state could link this requirement to an HVAC system assessment that determines and documents the maximum filter efficiency appropriate to the system.

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[164] Calif. Energy Comm., 2019 Energy Code Initial Statement of Reasons at 37-38, 135 (Jan. 18, 2018), https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=17-BSTD-02.

[165] Calif. Air Resources Board, Air Resources Board Staff Comments on Proposed 2019 Residential Standards at 2 (June 26, 2017), https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=17-BSTD-01.

[166] See Wash. State Building Code Council, Proposed Rule Making CR-102 (July 2022), https://tinyurl.com/5xm863rs (revising WAC 51-52-0605.4); Wash. State Building Code Council, Summary Meeting Minutes (11/4/22), https://tinyurl.com/5n9xurt2. The Council noted that the anticipated incremental cost of upgrading to MERV 13 would be about $5.00 per filter or an annual cost of $20 per air handler if filters are replaced every three months.

With the 2022 enactment of Assembly Bill 2232, *California* became the first state to take this approach independent of the COVID-19 pandemic. According to the legislation, existing schools must "install filtration that achieves MERV levels of 13 or higher to the extent determined to be feasible and appropriate for the existing HVAC system, as determined by the school." If a school determines that upgrading to MERV 13 is not feasible, it must "install filtration that achieves the highest MERV level that the school determines is feasible without significantly reducing the lifespan or performance of the existing HVAC system."

In *Connecticut,* the 2022 law requiring five-year ventilation evaluations may lead to the use of high-efficiency filters in some existing schools over the course of the next several years. The law requires the five-year inspection to include "testing for maximum filter efficiency," and the inspection report must describe corrective actions, including "installation of filters meeting the most optimal level of filtration available for a given [HVAC] system."

In-room filtration – through portable units or devices installed at ceiling level – is an alterne approach for schools that are unable to upgrade to high-efficiency filters due to system limitations. The only state policies identified by this report as requiring schools to use – or consider the use of – portable air cleaners were state COVID-19 guidance documents and COVID-19 workplace rules adopted in a few states during the pandemic (see below).

Compliance Oversight

Regardless of how state ventilation and filtration requirements are framed, a central question for policymakers is how to oversee compliance. Without effective oversight and accountability, ventilation requirements may be implemented unevenly or not at all.

Labor, public health, and education agencies have different approaches to overseeing school conditions. Labor agencies have detailed regulatory frameworks and programs for workplace compliance and enforcement. Some state health and education laws and regulations establish regular state inspections and related oversight practices, while education agency oversight is often tied to capital planning and funding frameworks. Most agencies contacted for this report emphasize the importance of working with schools to resolve facility problems.

This section provides policy examples focusing on four oversight mechanisms: (1) recordkeeping and reporting; (2) state inspections; (3) enforcement; and (4) community involvement.

The potential for these oversight measures to improve ventilation in schools depends in large part on whether the state maintains an active program with trained staff who can implement state policies. Adequate and sustained state funding for this purpose is vital.

Recordkeeping and Reporting

School recordkeeping and reporting of facility information are essential tools for effective state agency oversight and can help direct state resources and assistance to key areas of concern. Facility information can also help school communities stay informed about and monitor indoor environmental conditions.

To facilitate oversight, state policies should be as specific as possible about what information must be maintained by schools. State laws and regulations variously require schools to prepare and keep ventilation-related information such as maintenance plans, maintenance logs/records, and assessment/inspection

reports. Some states have required schools to certify in writing that they are operating their ventilation and other building systems in accordance with state requirements, to the best of their knowledge. Agency forms, templates, and other guidance can assist schools in reporting information and promote consistency across districts.

State policies should also be explicit about *how* ventilation information is to be reported, and current state policies demonstrate different approaches.

Making Information Available upon Request. Some state policies expressly require schools to make certain ventilation-related information available to the public *upon request*. Such policies can be especially helpful where applicable law does not otherwise establish public access to the information or where they establish time- and resource-intensive processes for obtaining the information. States can consider incorporating additional measures in their policies or programs to make employees and other members of school communities aware that the information is available.

An express requirement for schools to make HVAC maintenance and operations records available to the state upon request can be helpful where the state conducts inspections of schools to determine compliance with state ventilation requirements. For example, *Indiana* IAQ (health) rules provide: "Schools shall establish and maintain written maintenance logs covering cleaning and filter changes of the HVAC systems for a minimum of three (3) years. These logs shall be available for the state inspector's review." In *Arizona*, the Division of School Facilities requires detailed HVAC maintenance checklists to be completed and filed for each school within the district, and the agency notes that it reviews those files during state inspection of the school.[167]

In *New Jersey,* the state's public employer IAQ rule requires schools to provide a variety of documents if requested by the state, including construction documents and HVAC commissioning and testing reports. The rule also requires employers to keep maintenance logs and to make them available to both the state *and* to employees upon request: "The records required to be maintained by this section shall be made available to employees and employee representatives for examination and copying upon written request as soon as possible after receipt by the employer of the written request, but no later than 10 working days from the date upon which the employer has received the request."

Reporting to a State Agency. An express requirement for schools to report information to the state can also be useful if the state has an active mechanism for reviewing the information and working with schools to address any identified ventilation problems. In *Colorado*, school health rules allow for school district self-inspections in lieu of health department inspections and require that the school submit a self-certification checklist to the health department. *Delaware*'s 2022 law requiring schools to conduct annual inspections directs school districts to submit inspection findings and a board-approved repair and maintenance plan annually to the state education agency and other state executive and legislative entities. In *Maine,* the education agency's basic school approval process requires schools to submit annually a checklist self-certifying compliance with ventilation and other code provisions.

States can follow *New Hampshire's* lead and make reported school facility information available to the public. The state education law requires schools to submit annual IAQ inspection survey reports by June 30th each

[167] See Ariz. School Facilities Oversight Bd., Preventive Maintenance, https://tinyurl.com/3s8cnrt4.

year; in addition to reviewing those checklists in connection with five-year inspections, the education agency posts the checklist information on its website.[168]

Reporting Directly to the School Community. Some state policies require schools to provide ventilation-related information directly to the school community. The effectiveness of such policies in promoting community oversight and involvement depends in part on how the information is reported. Some options used by states include posting on a school web page in a prominent place where other facility information is provided; presenting the information at a school board meeting and/or including it in the meeting minutes; or announcing the availability of information on a message board at the schools.

Ventilation and IAQ information reported to the public should be clear and easy to understand by people without technical expertise. Toward that end, state agencies could develop templates for schools to use that summarize key information and indicate whether schools are meeting state standards and maintenance requirements.

A small number of states, including *California, New York*, and *Washington*, require schools to provide a "report card" or rating of the facility using terms such as excellent-good-fair-unsatisfactory. While such general ratings may help alert the community to facility problems, they may also lead to both under- and over-reaction to facility conditions.

Since many schools require some type of ventilation assessment or inspection, those reports are an important opportunity to inform the school community of facility conditions and planned corrective action. Standardized reporting forms can help ensure consistency and an appropriate level of detail. *Washington*'s revised school health and safety rules (not currently implemented) would require schools to "prepare a report to the public and the school board at least annually about environmental health and safety conditions in the schools." According to the rules, the report would include an explanation of, among other things, the dates of environmental health and safety inspections, any deficiencies not corrected within the time frame established by the local health agency, and any imminent health hazards identified.

Two recent laws requiring schools to conduct facility inspections also require reporting of inspection results to the school community. In *Delaware*, school districts must "annually present the completed inspection findings and assessments at a public school board meeting." *Connecticut*'s law requiring schools to conduct five-year comprehensive HVAC evaluations requires the local board of education to post the results on the school web site and to make them available at a regularly scheduled board meeting. Additionally, *Indiana* requires schools to post a state IAQ inspection report for 14 consecutive days "in a conspicuous location: (1) on the school's…website…and (2) at the location of the school…building stated in the report" and to post the school's response as well.

State law could also require state agencies to make their own inspection reports – as well as a school's response to the report – publicly available. Even in the absence of such a requirement, states could choose to post the information on their websites. The *Arizona* School Facilities Board, which administers capital funding programs for schools, conducts detailed five-year inspections of schools and has posted those inspection

[168] N.H. Dept. of Educ., School Safety and Facilities Mgmt. Bureau (Survey Results), https://tinyurl.com/2zj7vcfj (last viewed: Dec. 22, 2022).

reports in the past.[169] The state health agency in *Massachusetts* implements a program of IAQ inspections in schools and other public buildings and posts its reports on the agency website.[170]

Indoor air quality monitoring data is another potential resource for informing the school community, though care must be taken to explain the data. In conjunction with any requirements for monitoring CO_2 and other parameters, state policymakers should establish guidelines that help ensure clear and consistent presentation of the data through device displays, monitoring reports, and/or web-based tools. In 2021, Boston Public Schools installed monitors in its schools to measure CO_2, PM10, PM2.5, carbon monoxide, temperature and relative humidity, and the district provides the color-coded results on an online dashboard. The district also created a detailed plan for how to interpret and use the data in its operations and maintenance activities.[171] The *Vermont* Department of Health recently partnered with Efficiency Vermont to conduct a pilot project installing air quality sensors in schools and training staff on using monitoring data to reduce indoor exposures.[172]

State Inspections

Inspecting school facilities is another way that states oversee and assist schools in achieving compliance with ventilation requirements. Many state laws and regulations require state agencies (or delegated local agencies) to conduct school inspections, though the policies vary widely.[173]

An initial consideration for policymakers is ensuring that the responsible agency has sufficient qualified staff to conduct the inspections. State occupational safety and health programs that have federally approved plans must have the necessary "qualified personnel" and must devote "adequate funds" for administering and enforcing workplace standards. 29 U.S.C. §667(c). In the public health realm, states could leverage resources by building on existing, related state inspection programs. For example, where states fund local health departments to inspect and advise schools on environmental health matters, ventilation and related IAQ issues could be designated as priority issues for use of the funding.

The state of *West Virginia* is unusual in having an education law that provides for the state education agency to hire HVAC technicians to conduct state inspections and assist schools with HVAC matters. The law and rules go further by requiring the agency to provide "continuing professional learning opportunities" for those HVAC technicians in order to "develop and maintain proficiency in existing and emerging HVAC technology."

Other important aspects of a school inspection program include establishing the frequency and scope of inspections, incorporating specific ventilation items into the inspection, using a common inspection checklist, and providing a state inspection report that identifies follow-up actions to address deficiencies.

[169] Ariz. School Facilities Oversight Bd., Inspection Reports (last updated Oct. 31, 2013), https://tinyurl.com/2p9ar3jw.
[170] Mass. Dept. of Public Health, Indoor Air Quality Reports, https://www.mass.gov/report/indoor-air-quality-reports.
[171] Boston Public Schools, Indoor Air Quality (IAQ) Sensor Dashboard, https://www.bostonpublicschools.org/Page/8810 and BPS Indoor Air Quality Monitoring and Response Action Plan (rev. Oct. 2022), https://tinyurl.com/bdhm6ej8.
[172] See Efficiency Vermont, School Indoor Air Quality Grant Program, https://www.efficiencyvermont.com/schools.
[173] Agencies could also use more general statutory authorities to develop a school inspection program. This is the case in Massachusetts, where the Department of Public Health has broad authority to "advise the government concerning the… sanitary condition of any public institution." Ma. Gen. Laws ch. 111 §5.

Area of Authority and Scope of the Inspection. More than half of the states have established some type of facility inspection requirement that applies to schools through their labor, health, or education authorities. Ventilation and IAQ issues can be incorporated into the inspection framework, though current policies vary in this respect.

At least 27 states with federally approved occupational safety and health programs already have policies requiring state inspections of public workplaces, including schools. These state laws and rules must include inspection provisions that are at least as stringent as the comparable federal provisions. The federal Occupational Safety and Health Act broadly authorizes inspectors to "enter, inspect, and investigate any OSHA-regulated workplace…" 29 U.S.C. §657. The Act allows any employee who believes that an OSHA violation exists in their workplace to request an inspection by making a complaint in writing. With limited exception, the agency must conduct an inspection as soon as is practicable after the complaint is received. 29 C.F.R. §1903.11. OSHA may also carry out "programmed" inspections, which are scheduled according to neutral criteria reflecting agency priorities and generally focus on high-hazard workplaces.[174] As noted earlier, while state occupational safety and health rules provide for inspections, only a small number of state rules (e.g., *New Jersey, California, Minnesota*) include ventilation requirements relevant to general school operations.

Several states have adopted public health laws that require the state health department (or delegated local health agencies) to inspect schools to ensure compliance with health, sanitation, and/or safety criteria. Most of these public health policies address ventilation only in general terms, with *Indiana*'s school IAQ inspection program a notable exception. State policies requiring the education agency to inspect school facilities are likely to be connected to the state's capital funding program and focused on ensuring that HVAC and other building systems are maintained in good repair.

Frequency of Inspections*.* State laws should specify the minimum frequency of inspections. Existing policies differ on this question, reflecting in part the area of state authority responsible for the program.

One approach is to require an inspection *following a complaint* about ventilation or IAQ at a school. Occupational safety and health programs have fairly broad inspection authority and focus heavily on conducting inspections upon complaint by an employee. At least one state, *Indiana*, has enacted a law requiring the health department to inspect schools (and state buildings) following an IAQ complaint, and the department has promulgated regulations and guidance for the program. Indiana's policy also authorizes the health agency to conduct an inspection on its own initiative, for "any condition that it reasonably believes is contributing or could contribute to poor IAQ regardless of whether a complaint has been filed." Schools must provide a written response "explaining how the school…is correcting any deficiencies noted in the inspection report." Indiana's law does not expressly authorize the health department to take action if a school fails to address a problem noted in the state's inspection report; rather, the policy emphasizes making the school and community aware of deficiencies and providing technical assistance to correct the problems. The health

[174] U.S. OSHA, Field Operations Manual, Directive No. CPL 02-00-164 at 2-4 (Apr. 2020), https://tinyurl.com/3tznv739; OSHA Fact Sheet: OSHA Inspections (2016), https://tinyurl.com/2bsn4nnm.

department also facilitates compliance by providing training videos that include department staff presentations on the school IAQ rule.[175]

While a complaint-based program is important for responding to suspected problems, requiring a state agency to inspect schools at *specified intervals*, whether or not a complaint has been filed, can facilitate broader oversight of school conditions if the inspections occur often enough. *North Carolina* is an example of a state that requires its health agency to inspect schools annually, while *Nevada* requires the state health agency to inspect schools twice each year, and *Ohio* requires semi-annual inspections to be carried out by its local health departments. These state policies, however, do not include detailed ventilation criteria. *West Virginia*'s education agency conducts annual inspections of schools built with state funds, with a strong focus on HVAC systems.

In some cases, state public health laws require local health departments to conduct health and safety inspections but do not specify a frequency. This is likely to result in wide variation in school inspection practices across the state – including some local jurisdictions that do not have a regular inspection program – depending on the resources available to and priorities of the local jurisdiction. *Washington*'s revised school health and safety rule (not currently being implemented) would address this by changing the local health department inspection frequency from "periodically" to annually.

Annual state/local inspections of school facilities can facilitate ongoing oversight of state standards and requirements. Where state or local agencies conduct inspections less often than once per year, policymakers could require the school district to conduct comparable inspections in intervening years. A key to this type of hybrid approach is to incorporate state oversight of the inspections conducted by school staff – e.g., by requiring state-approved inspection forms, reviewing submitted forms, working with schools to correct identified deficiencies, and retaining state authority to inspect as needed.

In *Colorado*, public health rules allow for schools to inspect and self-certify in lieu of a state/local inspection. In such cases, the health agency reviews the school district submission and conducts an audit of selected schools to verify inspection results. A school's failure to submit the Self-Certification Checklist may result in the issuance of a compliance advisory.[176] *Washington*'s revised rules (not currently implemented) would apply a similar hybrid approach: "The local health officer may allow a school official or qualified designee to conduct a required inspection under a program approved by the local health officer not more than two out of every three years" if conditions stated in the rules are met.

Inspection Protocols. Uniform protocols for conducting and documenting state inspections help ensure effective and consistent inspections across the state and create information that can be readily shared with the school community.

An inspection form/checklist might incorporate: a visual review of items such as whether the system is operating during required hours and obvious defects like obstructed vents; interviews with facility personnel; and a review of maintenance logs and ventilation assessment reports. The inspecting agency could develop guidance on technical elements of the inspection (e.g., CO_2 monitoring) and on completing the inspection report. *New Jersey* has developed an inspection sheet for its public employer IAQ rule to help ensure that all

[175] Indiana Dept. of Health, Indoor Air Quality, https://www.in.gov/health/eph/indoor-air-quality/.
[176] Envtl. Law Inst. Communication with Colorado Dept. of Public Health & Envt. (Apr. 2022).

aspects of the rule are included during an inspection. The program has also developed a brief guidance document with additional information on conducting the inspection.[177] Federal OSHA inspection guidance in conjunction with the COVID-19 Emergency Temporary Standard for healthcare facilities described how inspectors were to evaluate compliance with the ventilation requirements of the standard.[178]

Inspection Reports. Policies that require state inspections upon complaint or at stated intervals typically direct the inspecting agency to prepare a report documenting the conditions found during the school visit. *Colorado*'s school health rules require the inspector's findings, including any violations, to be recorded in an inspection report. *Indiana* health rules direct state inspectors to prepare a report with several specified items, including inspection findings, conditions that could contribute to poor IAQ, and guidance on steps to address any issues; schools must send a written reply to the state within 60 days, explaining how the school is correcting any identified deficiencies.

Enforcement

State agencies that oversee school ventilation requirements typically emphasize a cooperative approach to working with schools to address facility problems, rather than a reliance on traditional enforcement tools. While such a cooperative approach is important, adequate enforcement authority is also an important component of a state policy that establishes school ventilation requirements. Some state laws and regulations include an inspection requirement combined with enforcement measures that are available in cases of ongoing noncompliance. These measures include citations/compliance orders and civil penalties/fines. Agencies can supplement statutory and regulatory provisions and promote consistency by issuing guidance on how enforcement authorities will be applied.

The most detailed corrective action and penalty provisions related to school facility conditions are found in state occupational safety and health rules. States that have federally approved occupational safety and health programs governing schools and other public workplaces (currently 27 states) must have enforcement authorities and programs consistent with the federal OSHA requirements, and they may establish more stringent or additional enforcement tools. 29 U.S.C. §667. The federal OSHA regulations state that when an inspector finds "violations of OSHA standards or serious hazards," the agency may issue either a citation or a "notice of de minimis violations which have no direct or immediate relationship to safety or health." Citations must set a reasonable deadline for correcting hazards. The OSHA regulations establish maximum fines based on the violation type, with the amount of the penalty based on factors including the size of the business, the gravity of the violation, the good faith of the employer, and the history of previous violations. 29 C.F.R. §1903.14-15.

Some state health policies include an explicit requirement for schools to correct identified deficiencies within a time frame specified in the policy or determined by the inspecting agency. In *North Carolina*, for example, schools must "immediately take action to correct conditions that do not satisfy the [state's] sanitation rules." In *Nevada,* deficiencies identified by state inspectors "must be corrected within 30 days after the inspection" unless the inspection report indicates otherwise. *Washington*'s revised school health and safety rules (not

[177] N.J. Dept. of Health, PEOSH Indoor Air Quality Standard Inspection Checklist (June 2008), https://tinyurl.com/53pwejsb and Indoor Air Quality Inspection Guidance document, https://tinyurl.com/6vnpdk8x.
[178] U.S. OSHA, Inspection Procedures for the COVID-19 Emergency Temporary Standard (June 2021), https://www.osha.gov/sites/default/files/enforcement/directives/DIR_2021-02_CPL_02.pdf.

currently implemented) would require schools generally to "[i]dentify, assess, and mitigate or correct environmental health and safety hazards in their school facilities," and would direct health inspectors to develop a correction schedule if necessary, and to "[c]onfirm that corrections are accomplished."

Colorado's health rules are more detailed. Violations cited during a state or local inspection must be corrected "as soon as possible, but in any event by the date specified by the Department." The health agency is authorized to issue a compliance advisory requiring the school to take corrective action, which may include capital improvements necessary to "eliminate any public health hazard." The school must then prepare and submit for approval by the health agency, a "Plan of Action detailing the corrective measures and timeframe required to rectify critical violations or other significant deficiencies noted during an inspection." The rules also incorporate a community oversight measure, authorizing the health department to order "public notification of unresolved critical violations and noncompliance with these rules and regulations." Prior to initiating an enforcement action, the health agency is authorized to schedule a meeting with school officials to discuss the violations and noncompliance "and to agree on an appropriate and viable Plan of Action to achieve regulatory compliance."

Even where health or education rules do not establish enforcement measures tied specifically to school ventilation/IAQ requirements, state health or education laws may provide general enforcement authorities that can be used to address serious noncompliance.[179]

School Community Involvement

Along with state agencies, members of the school community – parents, staff, unions, advocacy organizations, and others – are key partners in addressing ventilation and IAQ conditions in schools. In addition to requiring public reporting of school facility information, state policies include community involvement strategies such as requiring schools to implement a facilities complaint process and to designate a school point of contact for IAQ and ventilation matters.

School IAQ Complaint Resolution Process. At least a few states have adopted health or education regulations that expressly require schools to establish a process for addressing IAQ-related complaints. Important elements of such a process include investigating/resolving complaints within a specified time frame and correcting conditions identified by the school's investigation. A state policy should also expressly prohibit retaliation against anyone making a complaint.

West Virginia's education rules prescribe specific components of a required school complaint process, including deadlines for the school to respond and to develop a corrective action plan. Under *New York's* school facility rules, boards of education must have a process to monitor the condition of public school buildings that includes, among other things: "procedures for investigation and disposition of complaints related to health and safety." The procedures must include a written response (made publicly available) that describes how the complaint was verified (or why it was not investigated) and the actions taken, if any, to solve the problem. *New Jersey's* IAQ rule for public workplaces requires public employers to: "Promptly investigat[e] all employee complaints of signs or symptoms that may be associated with building-related

[179] For example, North Carolina's public health law authorizes the health agency to "enforce the State health laws and the rules of the Commission." N.C. Stat. §130A-5. Washington law requires state and local officials to "enforce all rules adopted by the state board of health." Rev. Code Wa. §43.20.050. In Maine, the Commissioner of Education is responsible for "[e]nforcing applicable regulatory requirements for school administrative units." 20-A Maine Stat. §251-A.

illness or sick building syndrome." The rule requires schools to send a response to the complaint to the state within 15 working days. A 2022 *Delaware* health law requires school districts to establish procedures for addressing IAQ complaints by May 2025, including identifying a responsible school official to receive complaints, establishing a web-based complaint form, and investigating complaints.

Another approach taken by a few states is to require that schools implement an IAQ management plan, which may in turn include complaint response procedures. As noted earlier, *Minnesota* law requires schools to annually update and submit a health and safety program that complies with best practices for IAQ management, in order to qualify for long-term facilities maintenance revenue; the health department's model IAQ management plan includes provisions for investigating complaints and designating an IAQ coordinator. *Wisconsin* law requires public school districts and certain private schools to develop a plan for maintaining indoor environmental quality in their schools, and the education agency's model plan includes a complaint resolution process, among other things. Widely referenced models, including EPA's IAQ Tools for Schools Action Kit, recommend practices for investigating IAQ complaints.[180]

Designated Ventilation/IAQ Point of Contact. Another measure that can facilitate participation by the school community, as well as oversight by the state, is the designation of a school point of contact on ventilation/IAQ matters. State policies can require that the name and contact information of the current designated official be provided to the appropriate state agency (which could post that information on its website) and also be made available via the school website and other school publications.

At least a handful of states have laws or regulations including this type of requirement. *Indiana's* school IAQ inspection rule is notable for directing schools to provide the designated IAQ coordinator's contact information to all students, parents, employees, visitors, and to the state inspector and to publish that information on the school's website and in the school's handbook. The state health department's Indoor Air Quality in Schools Best Practices Manual, which assists schools in implementing the state school inspection rule, adds: "The IAQ Coordinator can be appointed at the school or corporate level but for bigger corporations having both is an advantage. It is not expected that this individual be an expert on indoor air quality. When an issue is brought to their attention, they should know who to notify to see that the issue is addressed. If the school has an IAQ committee, they would be an active participant in the committee. The coordinator position should not require a large time commitment. For the individual to be effective they must have ready access to the School Nurse, Head of Maintenance, Principal, and Superintendent."

[180] See U.S. EPA, Coordinators Guide to Indoor Air Quality: Section 3, https://www.epa.gov/iaq-schools/coordinators-guide-indoor-air-quality-section-3. See also, e.g., CHPS, Best Practices Manual Vol. IV: Maintenance and Operations of High Performance Schools, https://chps.net/best-practices-manual.

Policies for Enhanced Ventilation/Filtration During Infectious Disease Emergencies

Prior to the COVID-19 pandemic, few (if any) state policies directly addressed enhanced ventilation in schools during infectious disease outbreaks. The onset of the pandemic led to an unprecedented number of state laws, regulations, and guidance addressing school ventilation practices to reduce indoor transmission of the virus. The first part of this section describes those policies. The second part notes considerations for developing policies that incorporate planning for future airborne infectious disease emergencies.

State Policies Adopted for the COVID-19 Pandemic

Executive orders were a central policymaking tool during the first two years of the COVID-19 pandemic.[181] The health-related measures in these orders dealt largely with vaccinations, masking, and social distancing, rather than ventilation. However, many executive orders also affirmed the broad authority of state health, education, or labor agencies to establish requirements for protecting public health. For example, Connecticut Executive Order 9, issued on September 4, 2020, stated that "the Commissioner of Education…in consultation with the Commissioner of Public Health, may issue binding guidance, rules, or orders for operation of schools…[that it] deems necessary to respond to the COVID-19 pandemic or its effects."

State agencies addressed school ventilation during the pandemic mostly in the form of guidance documents rather than through rulemaking, though some agency guidance specified ventilation measures that schools were expected to take in connection with school reopening. A few states adopted significant COVID-19 regulations governing workplaces. Prior to promulgating its emergency COVID-19 rule, Oregon's occupational safety and health agency explained that the "rulemaking, even on an emergency basis, will allow many Oregon workplaces to move beyond the necessary but inevitably unstable measures adopted through Executive Orders and public health guidance…"[182]

This section highlights notable examples of how states established ventilation requirements and expectations for reducing risk during the COVID-19 pandemic, through workplace rules and as part of health and education agency guidance.

State COVID-19 Workplace Rules: California, Oregon, and Virginia

Background: Federal OSHA Rules*.* The federal Occupational Safety and Health Act's general duty clause – and state equivalent provisions – could potentially be used to ensure that schools and other public workplaces address conditions that do not provide adequate protection against COVID-19, in the absence of a more specific regulation addressing the hazard.[183] The clause states: "Every employer shall furnish… employment and a place of employment which are safe as well as free from recognized hazards." 29 U.S.C. §654. OSHA provides detailed considerations for and limitations on using the general duty clause, noting that the clause "shall normally not be used to impose a stricter requirement than that imposed by the OSHA

[181] For a comprehensive listing of state COVID-19 Executive Orders from 2020 to 2021, see Council of State Governments, 2020-21 Executive Orders, https://web.csg.org/covid19/executive-orders/.
[182] Oregon OSHA, Initial Issue Paper on Oregon OSHA Infectious Disease Rulemaking for the General Workplace (July 2020), https://tinyurl.com/4bzs6s6d.
[183] See generally OSHA, Field Operations Manual at ch. 4 (Apr. 2020), https://tinyurl.com/3tznv739.

standard" and that it "shall normally not be used to require additional abatement methods not set forth in an existing standard."[184]

After determining that "specific requirements aimed at controlling COVID-19 hazards in the healthcare industry, i.e., beyond the general duty clause, would improve worker protections," OSHA adopted a COVID-19 Emergency Temporary Standard (ETS) in June 2021, and subsequently withdrew the non-recordkeeping portions of the rule in December 2021.[185] The OSHA ETS applied to healthcare facilities as described in the rule, including portions of non-healthcare facilities that provide health care services. 29 C.F.R. §1910.502(a)(3)(i). Thus, the rule was potentially applicable to those portions of school facilities that provide health services and were not exempted by the rule.[186] The federal ETS applied only to private workplaces; however, states with approved plans that cover public workplaces were required to adopt a measure that was the same or as effective as the federal ETS. 29 C.F.R. §1953.5(b).

Although the ETS did not apply broadly to school facilities, it is notable for including a number of ventilation requirements, such as increasing outside air as appropriate, using MERV 13 filters or higher if feasible, and maintaining filters. 29 C.F.R. §1910.502(k). The ETS required covered employers to develop and implement a COVID-19 plan for each workplace and to conduct a workplace-specific COVID-19 hazard assessment. 29 C.F.R. §1910.502(c). OSHA developed a model plan that incorporated the ventilation and other requirements of the ETS**.**[187]

COVID-19 Workplace Rules – California, Oregon, and Virginia*.* A small number of states adopted COVID-19 rules for workplaces, rather than relying on the general duty clause and agency guidance*. California, Oregon*, and *Virginia* promulgated rules that addressed ventilation and filtration, along with issues ranging from cleaning and personal protective equipment to COVID-19 outbreak response.[188] As background for adopting its rule, Oregon OSHA stated:

> "In most situations, Oregon OSHA has previously relied upon the application of general guidance in tandem with the employer's general obligations to provide a safe and healthy workplace. However, as the pandemic has progressed and, in many respects, become more severe, it has become clear that relying upon such general guidance does not provide sufficient protection to workers or sufficient predictability for their employers. A failure to adopt rules immediately would subject workers throughout the state to a heightened risk of serious illness – and even death – due to COVID-19."[189]

Status of the Rules. Each of the three states adopted its workplace COVID-19 rules on an emergency/temporary basis in 2020 and readopted and amended the rules on multiple occasions.[190] In each

[184] Id. at ch. 4, §IIID.
[185] U.S. OSHA, Statement on the Status of the OSHA COVID-19 Healthcare ETS (Dec. 27, 2021), https://tinyurl.com/muzku8em.
[186] Settings could be exempted if, e.g., they qualify as "ambulatory care settings where all non-employees are screened prior to entry and people with suspected or confirmed COVID-19 are not permitted to enter." 29 C.F.R. §1910.502(a)(2).
[187] U.S. OSHA, COVID-19 Plan Template, available at: https://www.osha.gov/coronavirus/ets.
[188] Other states may have adopted broad COVID-19 workplace rules that did not address ventilation. See, e.g., Mich. Occup. Safety & Health Admin., Emergency Rules – Coronavirus Disease 2019 (10/14/20), https://tinyurl.com/5477cwxb.
[189] Oregon OSHA, Rules Addressing the COVID-19 Public Health Emergency in All Oregon Workplaces at 1 (Nov. 6, 2020), https://osha.oregon.gov/OSHARules/adopted/2020/ao3-2020-filing-temporary-rules-covid19.pdf.
[190] Requirements relating to the adoption of emergency/temporary rules vary by state. States may limit the length of time an emergency rule may be in effect before it must be readopted and may also limit the number of readoptions.

state, early versions of the rule differed significantly from the current (or most recent) versions of the rule, with respect to ventilation measures applicable to schools.

- California's rule applies to workplaces not covered by the state's Aerosol Transmissible Diseases Standard (8 Ca. Code Regs. §5199). After adopting and extending an emergency rule, the state approved the rule on a *non-emergency* basis in December 2022, to become effective for two years following approval by the state Office of Administrative Law (expected in early 2023). The non-emergency rule revises the ventilation requirements that had been included in previous versions of the rule.
- Oregon's rule was adopted on an emergency basis and then as a permanent rule in 2021, with the expectation that "the rule will be repealed when it is no longer needed."[191] The rule is currently in effect but was revised significantly in March 2022. Many of the provisions that were previously required for all workplaces are now only required for "exceptional-risk" workplaces as defined in the rule; for other workplaces, the measures are now recommendations.
- The Virginia rule was repealed in March 2022. The rule had been amended in 2021 to scale back the ventilation requirements that applied to schools in the original rule.

Ventilation Measures. All three of the COVID-19 workplace rules at some point during the pandemic required most employers covered by the rules to ensure adequate ventilation. Reflecting a common recommendation articulated in pandemic guidance, these provisions variously required employers to "optimize," "maximize," or "increase" outside air, to the extent feasible. California and Oregon provided exceptions for when outdoor ambient conditions such as pollution levels or temperature could pose a hazard.

None of the rules established a requirement or goal for workplaces to achieve a specific ventilation rate or standard, such as the current state building code standard or the 4-6 ACH recommended by some experts during the pandemic.[192] Oregon's rule included a note that HVAC systems meeting ASHRAE 62.1 satisfy the requirement to "optimize" ventilation, though the rule has not required compliance with that standard.

California's non-emergency rule, adopted in late 2022, changed the ventilation requirements that had been included in previous versions of the rule. The rule no longer requires employers to "maximize the quantity of outside air provided to the extent feasible." Instead, the rule shifts toward a strategy of reducing transmission risks through outdoor air ventilation and/or filtration. Employers must "develop, implement, and maintain effective methods to prevent transmission of COVID-19" that include *one or more* of three actions listed in the rule: (1) maximizing the supply of outside air to the extent feasible, (2) using MERV 13 filters or the highest compatible with the system, or (3) using HEPA filtration units where ventilation is otherwise inadequate. If there is a COVID-19 outbreak at a workplace, the employer must review COVID-19 policies and controls (including the adequacy of outside air supply and air filtration) every 30 days and implement changes as needed to prevent further spread of the disease.

[191] Oregon OSHA, Revision and Extension of Oregon COVID-19 Workplace Rules at 4 (May 2021), https://tinyurl.com/f2c8b9ud (providing history of and background on the rulemaking).

[192] As described earlier in this chapter, California passed an education law in September 2022 requiring schools to comply with current state building code ventilation requirements if feasible.

California's rule continues to require employers to review state health and Cal/OSHA guidance, specifically the health department's Interim Guidance for Ventilation, Filtration, and Air Quality in Indoor Environments. A new provision in the rule notes that employers remain responsible for complying with other Cal/OSHA ventilation requirements for continuous ventilation and for HVAC system inspections.

Filtration Measures. The California, Oregon, and Virginia rules have addressed filtration in different ways. As noted above, California's permanent rule requires employers to implement ventilation or filtration methods to prevent transmission. When there is a COVID-19 outbreak at a workplace, HVAC systems must use MERV 13 "or higher efficiency filters if compatible with the ventilation system;" if MERV 13 filters are not compatible, they must use the highest efficiency filter that is compatible. The rule requires the use of HEPA filters "in indoor areas occupied by employees for extended periods, where ventilation is inadequate to reduce the risk of COVID-19 transmission."

Oregon's current rule requires exceptional-risk workplaces to ensure on a quarterly basis that filters are maintained and replaced as necessary to ensure the proper function of the ventilation system (previously, this was required of schools and other workplaces as well). The Virginia rule, no longer in effect, included a requirement to improve central air filtration to MERV 13 if the system could accommodate the adjustment and to ensure proper filter fit.

Requirements for a COVID-19 Plan. The California, Oregon, and Virginia workplace rules have each included requirements for employers to implement a COVID-19 plan or program.

California's emergency COVID-19 rule required a written COVID-19 Prevention Program. The permanent rule requires employers to include COVID-19 procedures within their existing written Injury and Illness Prevention Program (required under Cal/OSHA rules) or maintain the procedures as a separate document. During an outbreak, employers must review every 30 days relevant COVID-19 policies, procedures, and controls.[193]

Oregon's current rule requires exceptional-risk workplaces to assess exposure risks (including ventilation) and implement an infection control plan based on the identified risks, including a "list and description of the specific hazard control measures" implemented. Oregon OSHA developed a sample infection control plan in 2020, which asks employers to describe engineering controls that have been "installed, implemented, or developed," and includes a sample answer: "The building ventilation system was assessed on November 24, by XYZ Heating and Air, and set to optimize the amount of fresh outside air circulated through the system."[194]

Although California, Oregon, and Virginia were the only states to adopt broad COVID-19 workplace rules addressing ventilation and filtration, other states may have enacted policies requiring employers to adopt some type of plan that addressed COVID-19. One example is *Minnesota*, where Executive Order 2020-74 required employers to establish and implement a COVID-19 Preparedness Plan that includes "ventilation protocols" and is consistent with state OSHA Standards and health department guidance. Minnesota OSHA developed a template stating "[t]he maximum amount of fresh air is being brought into the workplace, air recirculation is being limited, and ventilation systems are being properly used and maintained" and including

[193] Cal/OSHA provided a model plan under the emergency rule and is currently developing a new model plan under the permanent rule. See Cal/OSHA Model COVID-19 Prevention Program (rev. May 2022), https://tinyurl.com/mryz53cs; Cal/OSHA, COVID-19 Prevention Non-Emergency Regulations, https://tinyurl.com/2kktdntk.

[194] Oregon OSHA, COVID-19 Infection Control Plan at 2 (Nov. 2020), https://osha.oregon.gov/OSHAPubs/pubform/infection-control-plan-example.pdf.

questions about how the employer was addressing ventilation protocols and what steps were being taken to "introduce fresh air, to improve air circulation, and to properly use and maintain ventilations systems."[195] The Executive Order was rescinded in November 2020, though Minnesota OSHA continues to encourage employers to implement COVID-19 prevention programs in order to meet federal and state regulatory requirements: "To meet [their] obligations under OSHA laws, employers should continue to implement COVID-19 prevention programs in the workplace."[196]

State Public Health and Education Agency COVID-19 Guidance

Many state health and education agencies produced guidance to assist schools in safely reopening and operating during the pandemic. Many referenced or summarized CDC's guidance for schools, while some offered more detailed discussions of recommended engineering controls and highlighted state information resources.

Most health and education agency guidance documents were framed in terms of recommendations for schools to consider. Some, including the examples below, established expected minimum practices or requirements – either through the language of the guidance itself or in connection with executive orders that directed schools to follow agency guidance. In most cases, the requirements established early in the pandemic were later removed or modified as pandemic conditions evolved.

- The *Connecticut* Department of Public Health (DPH) issued a reopening plan for the 2020-2021 school year that included both requirements and guidance and instructed local education agencies to "consult with all relevant stakeholders to determine the best way to proceed consistent with the requirements." On ventilation, the plan required schools to comply with a DPH ventilation guidance document that set out a number of actions, including a detailed description of commissioning building mechanical systems for full occupancy prior to the start of operations. The DPH updated this plan for the 2021-2022 school year, noting that: "Decisions regarding how fully to implement any particular strategy in a school, and to what extent compliance will be mandated and enforced, are complicated and multi-factorial. School administrators should work with their local health departments on a continuous basis to discuss the mitigation strategies that work best in light of local conditions." The 2021-2022 plan's short section on ventilation stated that schools should work with a qualified HVAC contractor "to inspect and ensure that central mechanical HVAC system components are operating in such a way as to maximize the introduction of fresh outdoor dilution air into occupied spaces, to provide adequate filtration of recirculated air, to operate continuously while the school is occupied, and to ensure thermal comfort to the extent possible."[197] Executive Orders issued by Governor Lamont affirmed that these DPH plans were to be considered "binding guidance, rules or orders as authorized by this order." Ct. Exec. Order Nos. 9, 13 (9/4/20, 9/30/21).

- Pursuant to its statutory authority to protect public health, the *Illinois* Department of Public Health issued guidelines in March 2021 that provided "public health requirements for schools and

[195] Minn. Dept. of Labor & Ind., COVID-19 Preparedness Plan Template and Instructions (rev. July 2020) (on file with ELI).
[196] Minn. Dept. of Labor & Ind., Updates Related to COVID-19, https://tinyurl.com/5yumtbsw (last viewed: Jan. 10, 2023).
[197] Conn. Dept. of Public Health, Guidance for School Systems for the Operation of Central and non-Central Ventilation Systems during the COVID-19 Pandemic (June 2020), https://tinyurl.com/mr3yw8pu and Adapt, Advance, Achieve: Connecticut's Plan to Learn and Grow Together (Aug. 2021), https://tinyurl.com/4nt4t559.

associated guidance." The guidelines, issued jointly with the Illinois State Board of Education, required schools in Illinois to "follow…[five] essential, layered mitigation strategies" and directed schools to "improve ventilation to the extent possible" using some or all of the steps listed in the guidance. In June 2022, the agencies issued a brief statement superseding the prior guidance and adopting CDC's guidance for K-12 schools. With respect to ventilation, the statement notes that ventilation improvements and other strategies "remain important" and states: "The following strategies should be in place at all Community Levels…Optimize ventilation systems…"[198]

- *New Jersey* Governor Murphy issued Executive Order 175 in August 2020 to address school reopening. Among other things, the order required school districts to meet health and safety standards delineated in the Department of Education's school guidance, including a "plan to ensure that indoor facilities have adequate ventilation." The Department guidelines referenced in the order incorporated "Anticipated Minimum Standards...so that every district can work from a set of established statewide standards and ensure that our State's educational health does not come at the expense of our public health." These minimum standards are "items that school districts should incorporate into their reopening plans as definite components…and are "consistent with a school district's general obligation to ensure the health and safety of its students and staff" pursuant to state law. The state education and health agencies later issued joint guidance for the 2021-2022 school year that "contains recommendations for public schools rather than mandatory standards," including improving outdoor airflow by bringing in "as much outdoor air as possible" and opening windows and doors when it is safe to do so.[199]

- The *New Mexico* Public Education Department (NMPED) issued a COVID-19 Response Toolkit for the 2021-2022 school year, which emphasized enhanced filtration as a central strategy: "To address issues and concerns surrounding air quality, NMPED will work with each district and school to ensure installation of high quality air filters. The NMPED will be deploying the [ASHRAE] recommendation, which states the target level for filtration in schools is minimum efficiency reporting value (MERV) 13 or higher." Toward this end, the toolkit stated that the agency would work with schools to identify the highest quality compatible filters and consider portable HEPA fan/ filtration systems. Schools that were "unable to immediately install MERV 13 or its equivalent must work with their operations staff to take" actions noted in the toolkit. In addition, the toolkit document required each district to have an "established and written protocol on inspecting, repairing and providing maintenance on ventilation systems within all school facilities."[200]

- *Washington* Governor Inslee issued an order in July 2021 (Emergency Proclamation 20-09.4, K-12 Schools) prohibiting in-person instruction unless schools follow guidance issued by health and education agencies. The Department of Health guidance for the 2020-2021 school year, which

[198] Il. State Bd. Of Educ. & Dept. of Public Health, Revised Public Health Guidance for Schools: Part 4 – Transition Joint Guidance (March 2021), https://www.isbe.net/Documents/revised-public-health-guidance-for-schools.pdf.
[199] N.J. Dept. of Educ., The Road Back: Restart and Recovery Plan for Education (June 2020), https://tinyurl.com/39f3fzxd; N.J. Dept. Of Education and N.J. Dept. of Health, The Road Forward: Health and Safety Guidance for the 2021-2022 School Year, https://tinyurl.com/44es2mzm.
[200] N.M. Public Educ. Dept., Covid-19 Response Toolkit for New Mexico's Public Schools for School Year 2021/2022 (rev. Nov. 2021), https://tinyurl.com/ycy57peu.

included ventilation and filtration measures, was "based on existing science, expert public health guidance, current policies, stakeholder input" and CDC guidance. The guidance also recommended that schools consult a professional engineer or HVAC specialist to determine the best way to maximize the system's ventilation and air filtration capabilities. In March 2022, the Department of Health revised its guidance for schools to provide a few recommended ventilation best practices but no requirements. In December 2022, the agency published a two-page fact sheet, Ventilation and Air Quality for Reducing Transmission of Airborne Illnesses.[201]

Even where state guidance documents are framed as recommendations, state agencies might implement them in a way that creates stronger expectations for schools to comply with the recommendations. It is beyond the scope of this report to review broadly how states implemented their school reopening guidance during the pandemic, but two notable examples are California and Rhode Island.

- In February 2021, the *California* Department of Public Health (DPH) published its Interim Guidance for Ventilation, Filtration, and Air Quality in Indoor Environments. The guidance, intended for schools and other non-healthcare facilities, "supplements the Cal/OSHA ETS by recommending practical steps building operators can take to promote better ventilation, filtration, and air quality in indoor environments for the purpose of reducing the spread of COVID-19." The DPH guidance defines technical terms and provides detailed recommendations for improving natural and mechanical ventilation and filtration and for considering the use of portable air cleaners. Although the guidance is not binding, the Cal/OSHA COVID-19 rule described earlier in this section expressly requires employers to review the guidance. The health department also produced more detailed technical guidance providing school facility personnel and consultants "a road map, with simple flow charts, focused on the practical steps that schools can take to assess and improve classroom ventilation and air filtration."[202]

- The *Rhode Island* Department of Education issued reopening guidance for the 2020-2021 school year that described a wide range of detailed ventilation and filtration practices for schools to consider. The guidance stated that schools with: "4-6 Air Changes per Hour…no less than 15 cubic feet of ventilation air per minute (cfm) per person…MERV13 filters, and outside air would require no changes for use at standard classroom densities. HVAC systems with lower filtration ability will require an increase in the use of outside air or supplemental air filtration." The guidance also stated: "Indoor spaces without windows, adequate HVAC, filtered air, or other mitigation strategies to ensure adequate air circulation should not be used for instruction programs, and should only be used as may be appropriate for storage or similar uses." According to agency officials, school districts were required to follow the guidance, and an interagency committee established by the governor visited schools at the start of the school year to review the school reopening plans and make sure the

[201] Wash. Dept. of Health, K-12 COVID-19 Requirements for Summer 2021 and the 2021-2022 School Year; Guidance to Prevent and Respond to COVID-19 in K-12 Schools and Child Cares (rev. Dec. 2022), https://tinyurl.com/2prz9xej; and Ventilation and Air Quality for Reducing Transmission of Airborne Illnesses (Jan. 2022), https://tinyurl.com/5532hx47.
[202] Calif. Dept. of Public Health, Interim Guidance for Ventilation, Filtration, and Air Quality in Indoor Environments (Feb. 2021, rev. July 2022), https://tinyurl.com/3zhvf3dx; Ventilation and Filtration to Reduce Long-Range Airborne Transmission of COVID-19 and Other Respiratory Infections: Considerations for Reopened Schools (July 2021, rev. 2022), https://tinyurl.com/28wvm8ha.

guidance was being implemented. Later in the year, the state made portable air cleaners available to assist schools in meeting the guidelines.[203]

Planning for Future Airborne Infectious Disease Emergencies

A clear lesson from the past three years of the COVID-19 pandemic is the need to plan for future airborne infectious disease emergencies and to incorporate ventilation measures into that planning.

One policy strategy for states to consider is to require that schools have in place a written plan that would be activated during a future designated emergency or outbreak. A state policy setting forth the components of such a plan would help ensure consistency among school districts and facilitate oversight by the state. As noted earlier, some state labor agencies did require schools and other employers to develop and implement a written plan for reducing COVID-19 transmission risks. In 2021, *New York* enacted a new labor law that established a planning requirement applicable to airborne infectious disease emergencies more broadly.[204]

New York's "Hero Act" applies to non-healthcare workplaces in the private sector (including private schools).[205] Although the law and its implementing rules could be strengthened by more explicit ventilation provisions, they are notable for creating a mandatory planning framework aimed at protecting employees during a future airborne infectious disease outbreak.

- Covered employers must establish a written airborne infectious disease exposure prevention plan "designed to eliminate or minimize employee exposure to airborne infectious disease in the event of an outbreak." The plans are to be implemented for airborne infectious diseases that are "designated by the commissioner of health as a highly contagious communicable disease that presents a serious risk of harm to the public health."

- When the commissioner makes such a designation, the employer must immediately and regularly review the plan and update it if necessary to ensure that the plan incorporates current information, guidance, and mandatory requirements related to the designated disease. The employer must promptly activate the plan, post it "in a visible and prominent location," and make it available in the employee handbook. On September 6, 2021, the state designated COVID-19 as an airborne infectious disease that presents a serious risk of harm to public health under the HERO Act, triggering a

[203] R.I. Dept. of Educ., Back to School RI: COVID-19 Facilities and Physical Plant Guidance to Reopen Rhode Island's Elementary and Secondary Schools (Aug. 2020), https://tinyurl.com/294kk35m; Envtl. Law Inst. Communication with R.I. Dept. of Educ. (Apr. 2022).

[204] At the federal level, OSHA is "examining regulatory alternatives for control measures to protect employees from infectious disease exposures" in healthcare and other high-risk occupational settings and currently expects to issue a notice of proposed rulemaking in September 2023. U.S. Office of Info. and Reg. Affairs, Regulatory Agenda (RIN: 1218-AC46) (Fall 2022), https://tinyurl.com/493k5jwd.

[205] In 2020, New York enacted a separate labor law that requires public employers to develop a "plan for the continuation of operations in the event that the governor declares a public health emergency involving a communicable disease." While the law exempts public schools, a separate education law was adopted directing public schools to include in their (already required) school safety plan "protocols for responding to a declared state disaster emergency involving a communicable disease that are substantially consistent with" the labor law requirements for other public employers. Neither these laws nor their implementing policies currently address ventilation or filtration expressly. N.Y. Labor Law §27-c; N.Y Educ. Law §2801-a.

requirement for covered employers to implement the plans; the designation ended on March 17, 2022.[206]

- The law also requires the state labor agency to develop a model "airborne infectious disease exposure prevention standard" which "shall establish minimum requirements for preventing exposure to airborne infectious diseases in the workplace...[including] compliance with applicable engineering controls such as proper air flow or exhaust ventilation." The current labor rule establishing this standard requires employers to include several controls in their plans – e.g., health screening, face coverings, hand hygiene, cleaning/disinfection, physical distance – but lacks an express requirement for the plans to include ventilation as a control measure.

- The agency created a model plan template for private schools that includes a short section on ventilation, recommending that schools determine whether certain ventilation/filtration best practices are necessary as advanced controls during an outbreak "where the Minimum Controls [which do not address ventilation] alone will not provide sufficient protection for employees." The template lists a few natural and mechanical ventilation practices for schools to consider (e.g., increasing outside air, avoiding air recirculation, using MERV 13 filters or as high as feasible, and using air cleaners). The plan states that it "is subject to any additional or greater requirements arising from a declaration of a state of emergency due to an airborne infectious disease, as well as any applicable federal standards."

States can build on New York's example by requiring all schools to develop, regularly update, and implement a written airborne infectious disease plan that incorporates ventilation measures. The requirement could be enacted through new legislation or by regulation, depending on existing authorities under workplace, public health, education, or other statutes. The plan could be a stand-alone document, or it could be incorporated into a set of plans already maintained by schools. Model plans and checklists developed by state agencies could assist schools and help ensure consistency across the state.

An airborne infectious disease plan might include both ongoing ventilation and filtration measures and enhanced measures that would be activated at times of higher risk – e.g., during an emergency designated by the responsible agency or during an outbreak. State policy could specify key ventilation-related elements of the plan, such as:

- Periodic assessment and inspection – routine maintenance inspections of HVAC systems, as well as more comprehensive, periodic assessments to: document that the system is operating properly to meet current state requirements and system specifications for ventilation and filtration; identify opportunities for optimizing ventilation and filtration; and indicate the steps that would be needed to provide enhanced ventilation and filtration during periods of heightened risk.

[206] See N.Y. State Dept. of Labor, Health & Safety Precautions for Worksites – NYS HERO Act, https://dol.ny.gov/ny-hero-act; N.Y. State Dept. of Health, NYS HERO Act, https://tinyurl.com/4xwmkx46; N.Y. State, Governor Kathy Hochul Press Release (Sept. 6, 2021), https://tinyurl.com/yc6y6vpb.

- Enhanced ventilation during a designated airborne infectious disease emergency or outbreak – implementation of additional ventilation measures needed to further reduce transmission risk (increasing outside air supply, increasing filtration efficiency, and/or using supplemental air filtration/cleaning) in accordance with state law, rules, or guidance.

  States could establish more detailed requirements for enhanced ventilation that would apply during a designated emergency or during an outbreak – e.g., MERV 13 filtration efficiency as feasible, or an equivalent air changes per hour standard. How such enhanced requirements are framed depends in part on the ventilation and filtration standards schools are otherwise required to follow under state law. As noted earlier, ASHRAE expects to develop a new IAQ pathogen mitigation standard in 2023.

- Documenting and communicating the ventilation measures that schools considered and implemented – submitting initial and updated plans to state agencies and making copies of the plans easily accessible to the school community.

Policymakers could also develop similar planning requirements for addressing ventilation in other public health emergencies that pose indoor air risks, such as wildfire smoke episodes.

Financial and Technical Assistance for Improving Ventilation in Existing Schools

While research demonstrates the cost-effectiveness of improving ventilation and IAQ on a broad scale, some school districts face considerable financial challenges in assessing and improving ventilation and filtration. Policies that increase ventilation and related facility requirements should also identify resources available for schools that need financial or technical assistance in order to comply with the new state standards.[207] Funding and technical assistance are especially critical for realizing improved facility conditions in low-wealth, rural, and other historically underserved communities.

This section describes state grant programs that provide funding for school ventilation. Grant programs are only one part of a comprehensive approach to school finance that sustains progress in building, operating, and maintaining school facilities. However, they can play a strategic role in helping schools improve IAQ and meet the types of ventilation standards and requirements discussed in this report. The discussion that follows highlights selected state policies and programs that fund ventilation measures by:

- *Prioritizing* ventilation among other allowable uses in existing grant programs, or
- Establishing grant programs *dedicated to* school ventilation.

The discussion also highlights state policy and program approaches to providing schools with technical assistance for improving ventilation and filtration.

[207] State laws include various requirements for how these costs are to be considered as part of the legislative and regulatory process. California's recently enacted school ventilation law (A.B. 2232) states: "If the Commission on State Mandates determines that this act contains costs mandated by the state, reimbursement to local agencies and school districts for those costs shall be made pursuant to" state law governing the reimbursement of such costs. In 2022, Maine's legislature considered whether proposed revisions to state education rules addressing school ventilation imposed an unfunded mandate, and the availability of pandemic relief funds and state renovation funds was a consideration in the adoption of the revised rules. Envtl. Law Inst. Communication with Maine Dept. of Educ. (May 2022).

Background: The Need for Increased and Equitable School Facility Funding

In the U.S., local school districts have primary responsibility for constructing, renovating, maintaining, and operating their facilities, including mechanical systems. This responsibility involves both "determining what level of their operating budgets will go to maintenance and operations [and] raising revenue to build and modernize their facilities."[208]

According to the *2021 State of Our Schools* report, public school districts reported spending a combined annual average of $110 billion of their operating and capital budgets on facilities from fiscal year 2017 to 2019, but still fell $85 billion short of benchmark funding levels for good stewardship.[209] To help offset these costs, most states provide some form of financial assistance to local school districts for facility construction and improvement.[210] Nevertheless, the *2021 State of Our Schools* report found that local school districts paid 77 percent of PK-12 capital school construction costs during Fiscal Years 2009-2019. Only eight states contributed more than 50 percent of district school construction capital outlay, while 11 states provided no such funding. In terms of general operating expenditures, states and local districts each contributed approximately 45 percent, while the federal government contributed around 10 percent.[211]

Federal pandemic funding legislation in 2020 and 2021 represents a historic investment in schools. The programs are notable for including facility improvements as eligible expenses, and federal and state agencies issued guidance on the opportunities for using the funds to improve ventilation and filtration. Some states have used their own share of pandemic relief funding to support school ventilation and filtration improvements. And many school districts have allocated at least a portion of their pandemic-related funding for this purpose. But schools were not required to use the funds for facility improvements, and the funds were available to address a wide array of competing needs (e.g., testing for students and staff, purchasing masks, acquiring computers and building technological capacity, hiring new teachers, developing online curricula, and incurring additional costs for providing meals).

Thus, while federal funding has been an important resource for schools to address facility conditions during the pandemic, it is only part of the solution.[212] According to a CDC survey on ventilation improvements in public schools during the pandemic, the most frequently reported ventilation measures were lower-cost strategies such as "inspecting and validating" existing HVAC systems or opening windows, while a smaller proportion reported more resource-intensive strategies such as replacing or upgrading HVAC systems or using HEPA filtration systems in classrooms or eating areas.[213] Another report found that while a majority of the hundreds of superintendents surveyed "planned" to use a portion of their 2021 federal relief money for HVAC and capital improvements, many school districts are experiencing or perceiving obstacles to

[208] See 2021 State of Our Schools report, supra, at 43.
[209] Id. at 29.
[210] Amer. Society of Civil Engineers, How Your State Funds School Construction (July 24, 2014), https://tinyurl.com/3e5tbyct.
[211] See 2021 State of Our Schools report, supra, at 43-45.
[212] Federal legislation has been introduced that would give tax credits for assessing air quality in buildings and for qualified HVAC or air filter upgrades or repairs. H.R. 7671 - 117th Congress (2021-2022).
[213] S. Pampati, et al., "Ventilation Improvement Strategies Among K–12 Public Schools – The National School COVID-19 Prevention Study, United States, February 14–March 27, 2022," MMWR Morb. Mortal Wkly. Rep. 71:770–775 (2022), https://www.cdc.gov/mmwr/volumes/71/wr/mm7123e2.htm [hereinafter "Pampati, et al."].

implementing projects before a federal spending deadline in 2024.[214] These findings suggest that advancing equitable implementation of school ventilation improvements requires ongoing efforts to increase schools' awareness and understanding of funding opportunities, provide technical assistance on ventilation improvement strategies, and otherwise provide support to districts that were unable to move quickly to implement HVAC improvements in response to the pandemic.[215]

Prioritizing Ventilation in School Facilities Funding Programs

In many states, policies and programs that predate the COVID-19 pandemic provide grants, loans, or other financing for school facility improvements. States can ensure that these programs expressly include HVAC repair and replacement or establish HVAC work as a priority for awarding funds. (The citations for policies described below are included here rather than in the Appendix.)

For example, a *Minnesota* law governing school districts' use of long-term facilities maintenance revenue provides expressly that the revenue may be used for health and safety capital projects, which may include IAQ inspections, investigations, and testing and upgrading/replacement of mechanical ventilation systems to meet ASHRAE standards and the state mechanical code. Mn. Stat. §123B.595. In *Maine*, the law establishing the School Revolving Renovation Fund (SRRF), which funds school repairs and renovation, provides priority status to health and safety projects, including IAQ improvements. The SRRF, which is funded through bonds and appropriations, makes funding awards as part zero-interest loan and part grant; the percentage of grant funding ranges from 30 to 70 percent, depending on the financial resources of the school district.[216] In *California*, a 2018 law specifically authorized use of school modernization funds "to limit pupil exposure to harmful air pollutants by updating air filtration systems," among other eligible uses. Ca. Educ. Code §17074.25.

States can also prioritize ventilation and IAQ improvements in programs that fund school energy retrofits.[217] It is widely recognized that energy efficiency upgrades can provide cost-effective opportunities to enhance IAQ in school buildings. At the same time, if IAQ is *not* considered, energy-saving measures can inadvertently diminish indoor environmental quality during and after construction, with potential adverse consequences for student and staff health.[218] The EPA Guide, Energy Savings Plus Health: Indoor Air Quality Guidelines for School Building Upgrades, provides detailed information on a variety of best practices for school retrofits,

[214] The School Superintendents Assoc., School District Spending of American Rescue Plan Funding (Jan. 2022), https://aasa.org/uploadedFiles/ARP-Survey-Findings-Part2.pdf.
[215] Id. (noting generally that "the school districts that were able to move quickest to improve their air ventilation and filtration…were those that already had money available to upgrade their facilities, and in many cases, they'd already assessed their buildings and knew which ones needed work"); Pampati, et al., supra.
[216] 30-A Maine Rev. Stat. §6006-F; Maine Dept. of Educ., State Revolving Renovation Fund, https://tinyurl.com/59m2pwdj.
[217] See Envtl. Law Inst., Addressing Indoor Air Quality in School Energy Efficiency Upgrades (2016), https://tinyurl.com/mr4c7m58.
[218] See generally U.S. DOE, Advanced Energy Retrofit Guide: K-12 Schools (2019), https://tinyurl.com/mva6xm2x; Institute of Medicine, Climate Change, the Indoor Environment, and Health (2011), https://tinyurl.com/yk246csr; A. Persily and S. Emmerich, Natl. Inst. of Standards and Tech., Indoor Air Quality in Sustainable, Energy Efficiency Buildings (2010), https://tinyurl.com/2p9dejxd.

including integrating IAQ protections into the design and renovation process and ensuring adequate outdoor air ventilation.[219]

Some states have taken steps to incorporate IAQ goals into their school energy funding programs. Using funds from the state's Clean Energy Fund, the *New York* State Energy Research and Development Authority recently established the Clean Green Schools Initiative to help public schools that historically "lack resources to invest in infrastructure improvements become healthier, more productive learning environments" by reducing energy loads, decarbonizing buildings, and improving IAQ. A Track I grant can be used to fund planning activities including HVAC assessments and other IAQ evaluations.[220] In *California*, the law authorizing the Clean Energy Jobs Act (Proposition 39) program – which has allocated more than $1.7 billion to schools to plan and install energy efficiency upgrades and clean energy generation projects – explicitly authorized expenditures for "related improvements and repairs that contribute to reduced operating costs and improved health and safety conditions." Ca. Public Res. Code §26205.

This is an especially important time for states to adopt policies integrating IAQ and energy efficiency: in addition to pandemic relief funds, the 2021 Infrastructure Investment and Jobs Act (IIJA) allocates $500 million over five years for the U.S. Department of Energy (DOE) to award competitive grants to improve energy efficiency and install renewable energy in public schools. The funds can be used for "energy improvements," defined to include HVAC improvements that reduce school energy costs, as well as "any improvement, repair, or renovation to, or installation in, a school that...leads to an improvement in teacher and student health, including indoor air quality [and] achieves energy savings." A portion of a grant can be used for investigation and analysis (e.g., building commissioning), and up to five percent of the grant can go to "operation and maintenance training…such as maintenance staff and teacher training, education, and preventative maintenance training." Pub. L. 117–58 §40541. In October 2022, the agency announced that the first round of these "Renew America's Schools" grants will provide around $80 million to be used for "high-impact" school energy efficiency improvements that "lead to improvements in teacher and student health, including indoor air quality" and/or innovative energy technology projects.[221]

School districts may also benefit from $550 million appropriated in the IIJA for Energy Efficiency and Conservation Block Grants. Pub. L. 117–58, §40552. In an extension of a program first established in 2007, formula grants will be awarded to states, tribes, and localities for a broad range of allowable uses, including but not limited to improving energy efficiency in the building sector through audits and retrofits.[222] In late 2022, the Department of Energy released a notice of intent to open the application period and published draft allocations for states, tribes, and local governments.[223]

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[219] See U.S. EPA, Energy Savings Plus Health: Indoor Air Quality Guidelines for School Building Upgrades (2014), https://tinyurl.com/238ku4jp.

[220] N.Y. State Energy Research and Devt. Authority, P-12 Clean Green Schools Initiative, https://tinyurl.com/3yr2ecev.

[221] U.S. DOE, Notice of Intent to Issue Funding Opportunity Announcement No. DE-FOA-0002756 (rev. Dec. 22, 2022), https://tinyurl.com/ypcu7edb; see also U.S. DOE, Biden Administration Announces $84.5 Million to Make Clean Energy Improvements and Lower Energy Costs for K-12 Schools (Oct. 26, 2022), https://tinyurl.com/2zsf3xss; U.S. DOE, Grants for Energy Improvements at Public School Facilities, https://tinyurl.com/ye2y5ayc.

[222] See id.; U.S. DOE, Bipartisan Infrastructure Law: Energy Efficiency and Conservation Block Grant Program, https://www.energy.gov/bil/energy-efficiency-and-conservation-block-grant-program.

[223] U.S. DOE, Notice of Intent Announcement No. DE-FOA-0002882 (Nov. 22, 2022), https://tinyurl.com/ytedt9vf. Around $8 million will be awarded to local governments and tribes not otherwise eligible for formula grants. See U.S. DOE, Request for Information No. DE-FOA-0002883 (Dec. 14, 2022), https://tinyurl.com/5389kn9h.

Establishing Funding Policies and Programs Specifically for School Ventilation

During the COVID-19 pandemic, some states established or augmented programs that provide grants focused on school ventilation and filtration. This section describes some of the key provisions for states to consider in establishing a targeted ventilation and IAQ funding program, drawing on the examples of 10 state policies established from 2020-2022:

- California – created CalSHAPE, a new utility-funded grant program for school HVAC assessment, maintenance, and in some cases repair or replacement, including detailed technical requirements for funded projects.
- Colorado – utilized an existing school capital construction grant program (BEST) to provide targeted emergency grants for ventilation and filtration improvements, along with a separate legislative appropriation for portable air cleaners.
- Connecticut – established a new grant program for reimbursing costs associated with HVAC installation, replacement, or upgrades or other improvements to IAQ in school buildings.
- Maryland – extended and expanded a preexisting funding program to provide competitive grants for public school capital projects that improve the health of school facilities, including HVAC and IAQ projects.
- Massachusetts – established a state reserve fund for grants to public school districts to address inequitable school facilities' needs and repairs for improved ventilation and IAQ.
- Michigan – utilized state funds to pay licensed professionals to perform school HVAC assessments, at no cost to the schools.
- Nevada – established technical requirements that apply *if* a school utilizes state or federal funding for ventilation projects.
- New Jersey – created a new grant program for school HVAC assessment, maintenance, repair or replacement, including detailed technical requirements for funded projects.
- Vermont – created a new School and Indoor Air Quality Grant Program to provide technical assistance and financial support for ventilation improvements in schools.
- Virginia – appropriated funds for direct formula grants to counties for improving ventilation systems in public school facilities.

Many of these programs were funded using federal pandemic response and economic relief money, though a few have used non-federal funding sources. For example, California's program is funded by the state's large electric and gas investor-owned utilities as part of their energy efficiency portfolios, while in Colorado, school facilities grants are funded annually through a portion of the state's public school lands income, the state excise tax on marijuana, and other state funding sources.

For a more detailed review of these policies, see ELI's companion paper, State Funding for School Ventilation: A Review of Selected Policies, 2020-2022.[224]

Agency Administering the Program. In some states, ventilation funding programs are administered through the education agency, while in others an energy-related agency is responsible for implementation. In a few cases, states have determined that a new or expanded school ventilation funding program can be

[224] The report is available at https://www.eli.org/buildings/ventilation-schools.

administered most efficiently with help from contractors outside the state government. For example, New Jersey's program is being administered on behalf of the Board of Public Utilities by an engineering and construction consulting company with a history of implementing energy efficiency programs in the state.[225] In Vermont, the legislature directed the state education agency to work with Efficiency Vermont – an efficiency utility operated by the nonprofit Vermont Energy Investment Corporation to promote energy savings – in providing grants to schools.

Technical Assistance to Applicants. Some state funding programs have provided direct assistance to school districts in developing grant applications. In Vermont, for example, Efficiency Vermont's professional engineers provide individualized technical input and recommendations to schools applying for targeted ventilation improvement funding.[226] In Colorado, the BEST program "offers technical assistance during all phases of a project," including (but not limited to) pre-award assistance on project identification, grant application information, and RFQ development. The program also offers post-grant assistance, such as "[h]elpful information with maintenance, project management, construction review, warranty, O&M manuals, etc."[227] In California, the law authorizes a small percentage of program funds to be used for administrative expenses, including "providing technical support to program participants." According to the California Energy Commission, program staff have worked with CalSHAPE ventilation grant applicants to correct deficiencies in initial applications and also may help schools with technical research – e.g., research on existing facilities and equipment to help establish baseline conditions and demonstrate the need for program-funded HVAC activities.[228]

Scope of Eligible Activities*.* In authorizing and developing funding programs, states have made different choices about the specific types of activities eligible for funding.

Some programs have prioritized ventilation assessments and maintenance activities. *Michigan's* Environment, Great Lakes and Energy (EGLE) agency established a K-12 HVAC Assistance Program during the pandemic, spending around $260,000 to pay pre-approved contractors to conduct HVAC assessments in school buildings.[229] In California, the CalSHAPE Ventilation program's primary purpose is funding HVAC assessments and maintenance, including general maintenance, adjustment of ventilation rates, and installation of filters and CO_2 monitors (though each grant award also includes an additional 20 percent in "contingency funds" that can be used for "repairs, upgrades, or replacements necessary to make the system functional or more energy efficient"). New Jersey's policy, which is modeled in part on California's law and includes some similar language – allows school ventilation grants to be used to reimburse "reasonable costs of an HVAC assessment, assessment report, deferred general maintenance, adjustment of ventilation rates, filter replacement, system replacement, and CO_2 monitor installation."

Massachusetts has defined the scope of eligible activities expansively. While the law authorizing the state's new school ventilation grant program generally provides that funds may be used for "inspections, maintenance, installation, repairs or upgrades," the state education agency has developed a wide-ranging list

[225] See TRC, TRC Acquires New Jersey's Clean Energy Program Contract and Assumes Program Administrator Role" (Jan. 2017), https://tinyurl.com/3nsmv9a4.
[226] Envtl. Law Inst. Communication with Efficiency Vermont (July 2022).
[227] See Colorado Dept. of Educ., BEST Grant FAQ, https://www.cde.state.co.us/capitalconstruction/best-faq.
[228] Envtl. Law Inst. Communication with Calif. Energy Comm. (May 2022).
[229] See Mich. Dept. of Envt, Great Lakes and Energy, Grants and Loans Dashboard—Fiscal Years 2019-2021, https://tinyurl.com/94x6nr5j.

of eligible activities. According to the agency's request for applications, funds can be used not only for HVAC assessments and HVAC upgrade/replacement projects, but also for activities such as needs assessments, long-term IAQ improvement planning, securing outsourced services or in-house HVAC maintenance positions, and providing professional development for facilities directors to service and maintain HVAC systems.[230]

This report did not review state programs established to fund the purchase of portable air cleaners in schools, but one example is the state of Colorado, where the legislature appropriated $10 million in 2021 specifically for portable air cleaners. 2021 Co. Senate Bill 21-202.

Technical Specifications and Requirements. Most of the state policies reviewed here do not include strict technical requirements for funded projects, apart from compliance with applicable state laws and rules. A few of the states, however, have included detailed technical standards for funded projects to help ensure that the projects achieve significant improvements in ventilation and filtration.

The two programs with the most detailed technical requirements – California and New Jersey – are funded through energy-related agencies. The New Jersey policy is based in part on California's program, and the two laws share some common language. Nevada's law does not allocate funding for ventilation projects but is noted here because the policy takes the unusual approach of setting forth detailed technical requirements that apply *if and when* a school receives state or federal funding for ventilation projects.

The technical specifications in these policies include filtration levels, ventilation rates, and CO_2 monitoring requirements. In California and New Jersey, funded schools must install filtration with a minimum efficiency reporting value (MERV) of 13 or better in the HVAC system "where feasible," replacing and upgrading filters where needed and verifying that filters are correctly installed. In Nevada, covered projects must ensure that filters used have "the best possible minimum efficiency reporting value" without adversely impacting the filtration system. For ventilation rate, New Jersey incorporates the minimum rates from ASHRAE 62.1-2019, while California and Nevada reference the ventilation requirements in an existing statewide mechanical code. California, New Jersey, and Nevada include requirements for school HVAC projects covered by the laws to install CO_2 monitors in classrooms and require notification from the device when levels exceed 1,100 ppm.

Another way to help ensure that school HVAC systems meet industry standards is by mandating that all HVAC services be performed in a timely manner by qualified providers. In addition to any general state requirements governing licensing of contractors, the policies in California, New Jersey, and Nevada explicitly require that funded activities be performed by qualified individuals, whether they are outside contractors or school facilities personnel who meet the laws' qualifications.

In Michigan, the EGLE State Energy Program, which utilized state funds to pay licensed professionals to perform school HVAC assessments at no cost to the schools, worked closely with ASHRAE's regional office to develop a COVID-19 School Building HVAC Checklist. Derived from the technical specifications in the Michigan Mechanical Code, ASHRAE 62.1, and ASHRAE's COVID-19 guidelines, the checklist was used for all funded assessments to create a record of the current status of the school's HVAC systems and provide guidance to schools on "how existing systems may be adjusted and operated during the

[230] Mass. Dept. of Elem. and Secondary Educ., FY2023: Improving Ventilation and Air Quality in Public School Buildings Grant, https://www.doe.mass.edu/grants/2023/209/.

pandemic as well as providing an assessment of additional items and strategies that may be adopted in the future to improve HVAC systems in K-12 schools in the State of Michigan, even after the pandemic is contained."[231]

Prioritizing Equity. In developing policies and programs to fund school ventilation and filtration improvements, there are steps that states can take to prioritize or help ensure equitable distribution of the available funds. Policy language and program implementation strategies can prioritize funding for school districts that have serious ventilation problems and lack the local funding resources to address them without state assistance. States have taken various approaches when addressing two possible program elements related to equitable use of funds: whether to require a local cost share, and whether to include a set-aside for underserved communities.

Requiring a local cost share, or matching funds, may help stretch the state's money across more grant recipients; however, it may also create financial barriers for pursuing eligible activities that are relatively expensive or for participating in the program at all. Three of the states where the legislature established new school ventilation programs during the pandemic (California, Massachusetts, and Vermont) decided not to require a local cost share, and Michigan's agency-driven program did not require schools to contribute to the cost of HVAC assessments. Where states impose a local match requirement, the match formula can account for differences in applicants' resources. In Colorado, for example, the Building Excellent Schools Today (BEST) program uses a cost share formula that accounts for local socioeconomic factors including median household income and percentage of students eligible for free or reduced lunch, resulting in higher cost share percentages for wealthier school districts, and lower percentages for underserved communities.

Another program feature that has been addressed by state legislators is a funding set-aside for underserved school districts. One way to do this is through broader statewide policies requiring a minimum percentage of certain programs' funds to go to underserved communities. In California, for example, state law requires that 35 percent of state climate investments (funded by the sale of cap-and-trade allowances) go to environmental justice and/or economically disadvantaged communities. Ca. Health & Safety Code § 39713.

A similar but distinct approach was taken at the federal level in President Biden's Executive Order 14008, establishing the initiative known as Justice 40. The Order sets a goal that disadvantaged communities receive 40 percent of the "overall benefits" from certain federal investments in climate, energy, and other sectors.[232] Interim White House guidance for implementing Justice 40 offers suggestions for program modifications that can help achieve Justice 40 goals – for example, holding competitive solicitations that prioritize or award extra points to projects that meet the criteria for benefiting disadvantaged communities and include community engagement, and providing technical assistance and capacity building to help potential applicants' access, manage, and report on the results of funded activities.[233]

Several of the school ventilation funding programs reviewed here were authorized with an explicit set-aside for underserved grantees. New Jersey's law includes a requirement that 75 percent of the projects funded

[231] Envtl. Law Inst. Communication with Mich. Dept. of Envt., Great Lakes, and Energy (May 2022); see also Mich. Dept. of Envt., Great Lakes and Energy, COVID-19 School Building HVAC Checklist (2020), https://tinyurl.com/39mx9unj.
[232] The White House, Executive Order on Tackling the Climate Crisis at Home and Abroad (Jan. 2021). See also The White House, Fact Sheet (Jan. 27, 2021), https://tinyurl.com/ycknydfa.
[233] Executive Office of the President, Memorandum: Interim Implementation Guidance for the Justice40 Initiative (July 2021), https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-28.pdf.

by the school ventilation program must be allocated for school districts where at least 75 percent of public-school students are eligible for free or reduced-price meals. In California, the ventilation funding law provides that at least 25 percent of projects funded by the CalSHAPE ventilation program must be located in "underserved communities," as defined by a broader set of criteria.

Where administering agencies do not have authority to establish a set-aside, it may be possible to implement other strategies at the program guidance level. For example, agency policymakers might use prioritization procedures to help ensure or enhance equitable access to financial assistance, whether grants are issued on a rolling basis or competitively. In Vermont, the program is primarily prioritizing applicants based on the percentage of adequate mechanical ventilation currently being provided in the school; however, in cases where applicants' ventilation needs are equal, schools with fewer economic resources generally receive priority.[234] In Massachusetts, the state's Racial Imbalance Advisory Committee provided feedback as the education agency developed procedures to implement its new $100 million grant program; in its initial request for applications, the agency states that priority will be given to schools and districts "in chronically underperforming status," and that $7 million has been set aside for those applicants.[235]

As of January 2023, California's CalSHAPE program has allocated approximately $350 million (around 65 percent of the total available program funds) to underserved schools.[236] In order to ensure equitable allocation for smaller schools, the CEC created separate tiers, based on school district size, and allocated a certain percentage of the available funds to each tier.[237]

Providing Technical Assistance for Improving Ventilation

The pandemic has highlighted the need for ongoing technical assistance and support to schools as they work to improve ventilation in their buildings. This is especially the case for small, rural school districts which, on average, spend less on maintenance and operations and may not have the needed in-house expertise.[238]

At the federal level, the Department of Energy operates the Efficient and Healthy Schools campaign, an interagency effort with EPA to provide technical assistance (and recognition) to school districts implementing "high-impact indoor air quality and efficiency improvements that will reduce energy bills and improve student and teacher health."[239] In October 2022, EPA released a Request for Information in to "support the potential development, improvement, and implementation of technical assistance efforts (e.g., information, tools, training, guidance) and other strategies (e.g., incentives, recognition efforts) to support IAQ related improvements in the nation's building stock, with a particular emphasis on schools and commercial buildings." 87 Fed. Reg. 60396.

State agencies also have an important role to play both in helping individual schools address ventilation problems and in synthesizing best practice guidance on issues relevant to many school districts, such as CO_2

[234] Envtl. Law Inst. Communication with Efficiency Vermont (June 2022).
[235] Mass. Dept. of Elem. and Secondary Educ., FY2023: Improving Ventilation and Air Quality in Public School Buildings Grant, https://www.doe.mass.edu/grants/2023/209/.
[236] Envtl. Law Inst. Communication with California Energy Comm. (Jan. 5, 2023).
[237] California Energy Comm., California Schools Healthy Air, Plumbing, and Efficiency Ventilation Program Guidelines (hereinafter "CalSHAPE Program Guidelines 2nd Ed."), Second Edition at 8 (June 2022), available at: https://tinyurl.com/2bxcpekz; Envtl. Communication with Calif. Energy Comm. (May 2022).
[238] See 2021 State of Our Schools report, supra, at 40-44.
[239] See U.S. DOE, Efficient and Healthy Schools, https://www.energy.gov/eere/buildings/efficient-and-healthy-schools.

monitoring or the selection and use of portable air cleaners. Policymakers could create a program focused specifically on ventilation technical assistance, or they could bolster support of existing programs that work with schools on a range of environmental health issues. (The citations for policies described below are included here rather than in the Appendix.)

Technical Assistance Programs Focused on School Ventilation and IAQ. In some states, agencies may be able to use existing legislative authority and funding to develop a program specifically to provide technical assistance on school ventilation and related measures. In *California*, for example, the education and health agencies used state pandemic funding allocated by the legislature through Assembly Bill 86 to "convene and support a statewide Collaborative across all 58 California counties" through the end of the 2021-2022 school year. The Collaborative funded "local partnerships in each county between county offices of education and local public health departments" for the purpose of providing ongoing technical assistance to schools, with a focus on ventilation, among other COVID-19 risk mitigation measures, and provided a forum to regularly convene local collaborators and state partners for technical assistance and to share lessons learned.[240]

The state of *Delaware* enacted and recently amended an education law that requires the state health and education agencies to "collaborate with local school districts to identify information and technical resources to guide schools in improving the indoor environment" and further establishes that the health agency "shall provide technical expertise and information that are consistent with the requirements of this chapter to support to local school districts in addressing indoor environment concerns via an information portal" on the agency website. 14 De. Stat. §4304.

State legislatures can go further by establishing ongoing, individualized technical assistance programs. *West Virginia* is a notable example of a state education agency that provides individualized technical assistance to all local school systems on HVAC maintenance and operations.[241] In 1999, the state legislature passed a law establishing an HVAC technical assistance program within the Department of Education, directing the agency to develop rules "that address the servicing of public school buildings by…(HVAC) technicians" employed by the department or by local education agencies, using funds allocated by the state. The law also requires the department to provide continuing education for its HVAC technicians and to provide training for school maintenance staff. Department rules require the agency's HVAC technicians to "provide technical assistance and training for county personnel as requested and [to] utilize appropriate equipment and tools to determine necessary actions to operate and maintain HVAC systems in accordance with design specifications." W.V. Stat. §18-9E-4, W.V. Code St. Rules §126-175.

Support for Existing School Health and Safety Programs. In many states, one or more agencies already provide education and technical information to school districts on environmental health issues. Policymakers can provide additional funding to increase the capacity of those programs to assist schools throughout the state in improving ventilation and filtration.

State occupational safety and health programs, for example, already provide voluntary technical assistance through an On-Site Consultation service that helps employers comply with existing rules and take other steps

[240] Calif. Dept. of Educ., California State Plan for the American Rescue Plan Elementary and Secondary School Emergency Relief Fund at 26 (Aug. 2021), https://oese.ed.gov/files/2021/08/California-ARP-ESSER-State-Plan.pdf.
[241] See W.V. Dept. of Educ., School Facilities, https://wvde.us/school-facilities/.

to improve workplace health and safety. The federal government makes funding available to all states to provide these services, which are separate from the OSHA enforcement process and not limited to addressing regulatory requirements or compliance.[242] The free consultation services could be used broadly to help school districts improve ventilation and other indoor environmental conditions. Policymakers could consider publicizing the program and devoting additional resources as needed to ensure that they are available to assist schools with ventilation questions and to work with other state agencies in providing related technical assistance and education.

Many states have public health programs that provide valuable education and technical support on an array of school environmental health issues. One prominent example is the *Washington* Department of Health, which has implemented a School Environmental Health Program for several decades. The program provides "technical assistance on school environmental health and safety issues to local health jurisdictions and school staff" through phone and on-site consultation, presentations, and trainings. The program is a national leader in advancing healthier cleaning and disinfection practices and has also developed materials on topics such as ventilation and IAQ during wildfire smoke episodes, as well as a recent fact sheet on ventilation for reducing transmission of airborne illnesses.[243]

In 2000, *Vermont* enacted legislation directing the state Department of Health to establish a program to provide tools, training, technical assistance, and referrals to schools for improving and sustaining environmental health educational support to schools around ventilation and other IAQ issues. The law sought to "encourage schools, with assistance from the department of health, to develop programs that will enable them to identify and eliminate potentially hazardous materials…and adequately ventilate school buildings to exhaust any pollutants and contaminants." Vt. House Bill 192 (Act 125). To implement the law, the department created the Envision Program, which assists schools in creating and implementing environmental health management plans and has provided resources such as a school walk-through checklist and a model HVAC maintenance procedure.[244]

State health departments have staff with expertise relevant to ventilation and IAQ, but unlike OSHA consultation programs, they do not have a regular source of federal funding. One way that state legislators can provide technical assistance to schools is by establishing and funding school environmental health programs in the state health agency. Additionally, states that fund local health departments can designate ventilation and related IAQ issues as priority uses of that funding.

[242] See U.S. OSHA, On-Site Consultation, https://www.osha.gov/Consultation.
[243] See Wash. Dept. of Health, School Environmental Health Program, https://tinyurl.com/6z9jtcu6 and Ventilation and Air Quality for Reducing Transmission of Airborne Illnesses (Jan. 2022), https://tinyurl.com/5532hx47.
[244] Vt. Dept. of Health, Envision Program: Promoting Healthy School Environments, https://tinyurl.com/3rtsev5h.

APPENDIX

STATE POLICIES REFERENCED IN THE REPORT

The Appendix provides citations to, and short descriptions of, state laws and regulations highlighted in Part Four of the report. As such, it is *not* an exhaustive compilation of state policies addressing school ventilation.

With one exception, the policies included below are either currently in effect or (in the case of polices addressing COVID-19) were in effect during some period of time during the pandemic. Washington revised its school health and safety rules in 2009; those revised rules are described here even though they have not yet been implemented "due to restrictions enacted by the Legislature related to concerns with the financial impact of the new rules."[i]

The Appendix includes four tables, divided into three sections that correspond to the three sections of Part Four of the report:

Policies Addressing Ventilation in General School Operations

- Table 1 includes state policies that establish ventilation and filtration standards, operations and maintenance practices, and compliance oversight mechanisms.

Policies Addressing Ventilation During Infectious Disease Emergencies

- Tables 2 and 3 include state policies established during the pandemic to address COVID-19 or future infectious disease emergencies.

Policies Addressing Funding for School Ventilation: 2020-2022

- Table 4 includes recently enacted policies that establish funding programs for improving school ventilation. Citations to other financial and technical assistance policies discussed in the report are provided in the main text and are not included here.

[i] Wash. State Bd. Of Health, Memorandum to Washington State Board of Health Members (6/8/2022), available at: https://sboh.wa.gov/sites/default/files/2022-06/WSBOH-Packet-Jun2022.pdf (see p. 817).

POLICIES ADDRESSING VENTILATION IN GENERAL SCHOOL OPERATIONS

State Policies Addressing Ventilation in General School Operations	
Authority & Citation	Description
ARIZONA	
EDUCATION Az. Stat. §41-5832	HVAC systems installed *before 8/12/2005* must be "maintained and operated in accordance with the **prevailing maintenance and standards** at the time of the installation or renovation of the HVAC system." HVAC systems installed *on or after 8/12/2005* must be: (1) "maintained and operated in a manner consistent with ventilation standards acceptable to the division [of school facilities]...The division shall consider **ventilation standards in** accordance with standard 62"; (2) "operated continuously during school activity hours except during scheduled maintenance and emergency repairs and except during periods for which school officials can demonstrate to the governing board's satisfaction that the quantity of outdoor air supplied by an air supply system that is not mechanically driven meets the requirements for air changes per hour acceptable to the board."
EDUCATION Az. Admin. Code §R7-6-265	"[B]uilding systems in a school facility [including HVAC systems] shall be in working order and **properly maintained**;" defined as operated as intended and maintained according to manufacturer's instructions. [Language revised in December 2022 rule revision, effective Feb. 2023.]
EDUCATION Az. Admin. Code §R7-6-215	"The **CO_2 level** in each general and specialty classroom shall not exceed 700 PPM above the ambient CO_2 level." [Revised in December 2022; prior standard was 800 ppm above ambient levels.] To determine compliance "Classroom…air quality shall be measured at a work surface in the approximate center of a classroom under normal conditions...Measuring shall be performed for a random sample of 10 percent of the general, science, and art classrooms in each building of the school facility."
EDUCATION Az. Stat. §41-5702(A)(3)	The Division of School Facilities is **required to inspect schools** (or certify school district self-inspections) every five years to ensure compliance with the state's preventive maintenance guidelines and adequacy standards. (The Division requires schools to

	prepare and submit preventive maintenance reports annually, including a detailed HVAC Task Sheet/checklist, which the Division reviews during its inspection.) A copy of the inspection report with any recommendations for building maintenance must be provided to the school facilities oversight board and the school district. The Divisions is also required to report to the legislature and state officials annually on the "summary of the findings and conclusions of the building maintenance inspections conducted…during the previous fiscal year." "Each school district shall develop routine preventive maintenance guidelines" for HVAC and other systems and must "submit them to the division for review and approval." If the division determines during an inspection that the school is not adequately maintained according to its maintenance guidelines, "the school district shall return the building to compliance" with its guidelines." The Division is required to "provide technical support…as requested by school districts in connection with…maintaining existing school facilities" and provide school districts (every 2 years) "information on improving and maintaining the indoor environmental quality in school buildings."
ARKANSAS	
EDUCATION Ar. Stat. §6-21-804	State law requires the education agency to develop a "Public School Facilities Custodial, Maintenance, Repair, and Renovation Manual that contains uniform standards to direct custodial, maintenance, repair, and renovation activities in public school facilities." The Manual requires school districts to develop and implement a **scheduled preventive maintenance and reactive maintenance strategy plan**, requires HVAC training, and sets out HVAC servicing and repair practices, including properly trained personnel, filter maintenance and replacement, and annual ventilation system inspections.
EDUCATION Ar. Stat. §6-21-813	The education agency "shall conduct **random unannounced on-site inspections** of all academic facilities to ensure compliance with the school district's facilities master plan and, if applicable, the school district's facilities improvement plan in order to preserve the integrity of and extend the useful life of public school academic facilities and equipment across the state." "If a…code violation is reported in the course of an inspection or reinspection conducted by a state agency or commission, the [Division of Public School Academic Facilities and Transportation] shall work closely with the school district and the appropriate state agency or commission to ensure the violation is remedied within thirty (30) days of the date the inspection or code violation is reported or as soon as reasonably possible thereafter." (The state's academic facilities distress program (Ar. Stat. 6-21-813) provides more detailed corrective action measures for schools identified by the state as being in "facilities distress.") (Education agency website states that inspectors "document each facility's condition, performance of maintenance and preventative maintenance, custodial plan versus custodial performance, and other facility related issues. [Inspectors] work with public school districts to improve their maintenance and custodial services and refer them to other State agencies…if there are…issues not corrected by the public school district.")

CALIFORNIA	
EDUCATION Ca. Educ. Code §17661(d) (2022 A.B. 2232)	Existing school facilities with HVAC systems must ensure that their "facilities, including, but not limited to, classrooms for students, have HVAC systems that meet the **minimum ventilation rate requirements** set forth in [the *current* state building code]…unless the existing HVAC system is not capable of safely and efficiently providing the minimum ventilation rate." If a school's existing HVAC system is not capable of meeting this standard, then the school must "ensure that its HVAC system meets the minimum ventilation rates in effect at the time the building permit for installation of that HVAC system was issued. In addition, the covered school shall…document the HVAC system's inability to meet the current ventilation standards…in the annual HVAC inspection report required by [the state's OSHA rules – see below], which shall be available to the public upon request." Schools must "install filtration that achieves **MERV levels of 13 or higher to the extent determined to be feasible** and appropriate for the existing HVAC system, as determined by the school." If a school determines that MERV 13 is not feasible, it must "install filtration that achieves the highest MERV level that the school determines is feasible without significantly reducing the lifespan or performance of the existing HVAC system." The state Building Standards Commission and the Division of the State Architect are directed to "research, develop, and propose for adoption mandatory **standards for carbon dioxide monitors in classrooms**…"
EDUCATION Ca. Educ. Code §§17070.75, 1240, 17592.72, 17002(d)	All school districts receiving funding under the state's School Facilities Program or Deferred Maintenance Fund must have a **facilities inspection system** in place to ensure that their schools are in "good repair." Good repair is defined to include: "Mechanical systems, including heating, ventilation, and air-conditioning systems…Are functional and unobstructed [and]…Appear to **supply adequate amount of air** to all classrooms, work spaces, and facilities." County superintendents are required to **inspect** annually a certain number of low-performing schools within their jurisdictions, including review of the good repair standard and any urgent health and safety conditions including "nonfunctioning heating, ventilation, fire sprinklers, or air-conditioning systems."
EDUCATION Ca. Educ. Code §§35256, **33126**	Schools in California must prepare an **annual School Accountability Report Card** which includes brief information about whether the facilities meet the state's "good repair" standard. For mechanical/ HVAC, the report card requires a rating of good, fair, or poor, and an indication of any repairs needed and actions taken/planned. School districts must "publicize [the] reports, and notify parents or guardians of pupils that a hard copy will be provided upon request."
OCCUP. S. & H 8 Ca. Code Regs. §5142	Rules establishing general requirements for employers, including schools, provide: "The HVAC system shall be maintained and operated to provide at least the **quantity of outdoor air** required by the State Building Standards Code...in effect at the time the building permit was issued." "The HVAC system shall be **inspected at least annually**, and problems found during these inspections shall be corrected within a reasonable time. Inspections and maintenance of the HVAC system shall be documented in writing…[including] the specific findings and actions taken." Records must be retained for at least five years and made available upon request to the state and to employees.

	"The **HVAC system shall be operated continuously** during working hours except…during scheduled maintenance and emergency repairs" or "during periods for which the employer can demonstrate that the quantity of outdoor air supplied by nonmechanical means meets the outdoor air supply rate required by [the building code at the time of permitting]. The employer must have available a record of calculations and/or measurements substantiating that the required outdoor air supply rate is satisfied by infiltration and/or by a nonmechanically driven outdoor air supply system."
PUBLIC UTILITIES Ca. Pub. Util. Code §1625 (2020 Ca. A.B. 841)	**Schools receiving a grant** through the state's School Reopening Ventilation and Energy Efficiency Verification and Repair Program (see Fin. Assistance chart, below) **must install CO_2 monitors**; if a classroom CO_2 concentration exceeds 1,100 ppm more than once a week, ventilation rates must be adjusted by qualified personnel.
COLORADO	
HEALTH 6 Co. Code Regs. §1010-6:6	"**Ventilation**, mechanical or natural, shall be installed and **maintained** in accordance with **[**ASHRAE Standard 62.1-2013]…and to minimize health hazards including excessive drafts, extreme temperatures, humidity, and temperature fluctuations." "Ventilation **system filters** shall be cleaned or replaced regularly or according to manufacturer's recommendations to prevent excessive accumulation of dust or debris." The Department of Health "**shall conduct inspections** to determine the condition of schools…All schools with laboratories, and/or engaging in industrial arts or hazardous vocational activities should be inspected a minimum of once per year. All other schools should be inspected a minimum of once per three years." "The completed and signed inspection report is a public document that shall be made available for public disclosure, according to law, to any person who requests it." "The Department may require schools to complete and submit a Self-Certification Checklist**…**[which]…shall be considered equivalent to an on-site inspection performed by the Department." Schools conducting self-certification in lieu of agency inspections submit forms annually. "[T]he Department may issue a **compliance advisory** requiring the school take actions to correct regulatory deficiencies. A compliance advisory may require the school to design, redesign, install, modify, construct, or reconstruct facilities or to take other such corrective action to eliminate any public health hazard." "Any school in receipt of a compliance advisory shall prepare and submit to the Department a Plan of Action detailing the corrective measures and timeframe required to rectify critical violations or other significant deficiencies noted during an inspection," which plan must be approved by the Department. "All violations cited during an inspection shall be corrected as soon as possible, but in any event by the date specified by the Department." A school's failure to respond to a compliance advisory or to rectify critical violations "may result in enforcement action including, but not limited to, public notification of unresolved critical violations and noncompliance with these rules and regulations."
CONNECTICUT	
EDUCATION Ct. Stat. §10-231(e)	Local and regional boards of education must ensure their **HVAC systems are** "**maintained and operated** in accordance with the prevailing maintenance standards, such as Standard 62, at the time of installation or renovation of such system" and…"operated continuously during the hours in which students or school personnel occupy school facilities, except (A) during scheduled maintenance and emergency repairs, and (B) during periods for which school officials can demonstrate to the local or regional board of education's satisfaction that the quantity of outdoor air supplied by an air supply system that is not mechanically

	driven meets the Standard 62 requirements for air changes per hour." Boards of education must maintain HVAC records for at least 5 years.
EDUCATION Ct. Stat. §10–220(a)	Each local and regional board of education shall provide "**proper maintenance of facilities**" and must "adopt and implement an **indoor air quality program** that provides for ongoing maintenance and facility reviews necessary for the maintenance and improvement of the indoor air quality of its facilities." Every five years, a board must report to the state on "the condition of its facilities and the action taken to implement its…indoor air quality program…"
EDUCATION Ct. Stat. §10-220(d)(3) (2022 Ct. H.B. 5506)	Every five years, school boards must "provide for a **uniform inspection and evaluation" of the HVAC system** covering several required items, including: testing for maximum filter efficiency, physical measurements of outside air delivery rate, verification of the condition and operation of ventilation components, measurement of air distribution, verification of unit operation and that required maintenance has been performed in accordance with the most recent ASHRAE indoor ventilation standards, verification of control sequences, verification of CO2 sensors and acceptable carbon dioxide concentrations indoors, and collection of field data for the installation of mechanical ventilation if none exist. The evaluation must be conducted by a certified testing, adjusting and balancing technician, a certified industrial hygienist, or a mechanical engineer. The evaluation must "identify to what extent each school's current ventilation system components…are operating in such a manner as to provide appropriate ventilation to the school building in accordance with most recent indoor ventilation standards promulgated by [ASHRAE]." The written inspection report must include "any corrective actions necessary to be performed…including installation of filters meeting the most optimal level of filtration available...installation of carbon dioxide sensors and additional maintenance, repairs, upgrades or replacement." The report must be made available for review at a regularly scheduled school board meeting and on the web sites of the school and the school board.
EDUCATION Ct. Stat. §10-220(d)(2)	Every three years, for school buildings that were constructed or renovated or replaced after 2003, the "local or regional board of education shall provide for a **uniform inspection and evaluation program of the indoor air quality** within such buildings, such as the Environmental Protection Agency's Indoor Air Quality Tools for Schools Program." The law lists 14 elements that must be covered, including HVAC systems and "provision of indoor air quality maintenance training for building staff." Inspection reports must be made available for public review at a regularly scheduled school board meeting and on the web sites of the school or the school board.
EDUCATION Ct. Stat. §10-291	In order for school building project plans to receive state approval the plans must "provide that the **building maintenance staff** responsible for such facility **are trained** in…or that the applicant plans to provide training in, the appropriate areas of plant operations including, but not limited to [HVAC] systems pursuant to section 10-231e, with specific training relative to indoor air quality…"

DELAWARE	
EDUCATION 14 De. Stat. §2307 (2022 De. S.B. 270)	"On or before January 1, 2024, the Department of Education shall develop the Facilities Evaluation Instrument…to identify areas of a school site that are in need of repair based upon a thorough inspection of the site." The Facilities Evaluation Instrument must include a Standard of Good Repair that provides "a description of a minimum standard of good repair for various facility categories" including mechanical systems. "Each school district shall **annually present the completed inspection findings** and assessments at a public school board meeting." Each year by May 1, the district must "submit a report of facility inspection findings and a board approved repair and maintenance plan" to the state education agency, the controller general, and the legislature.
HEALTH 14 De. Stat. §4302 (2022 De. S.B. 270)	On or before January 1, 2024, the state health agency, in consultation with the education agency and school districts, must establish and publish on its web site "a **routine indoor air quality monitoring program and standards** that includes allowable ranges for temperature and humidity in public schools," taking into account OSHA IAQ recommendations and industry best practices. The program must be developed by individuals with IAQ expertise and industry professionals having detailed experience with ASHRAE Standard 62.1 and in consultation with the state education agency and school districts. On or before January 1, 2024, the health agency must "establish **reporting requirements** for local and regional boards of education" and must "establish a **contractor certification program** for public school indoor air quality services." Once the certification program is established, school districts may only enter into contracts for IAQ remediation with certified contractors.
HEALTH 14 De. Stat. §4303 (2022 De. S.B. 270)	Before May 2025, each school district must identify an individual responsible for receiving IAQ complaints and must **investigate complaints.** Districts must make available on the district's website the procedure for filing an IAQ complaint and provide a report at regular school board meetings of complaints that have been filed.
HEALTH 14 De. Stat. §1055	School boards "shall make all repairs to school property…and provide for adequate heating and **proper ventilation** of the buildings."
FLORIDA	
EDUCATION Fl. Admin. Code §6A-2.0010 (State Requirements For Educational Facilities §§5(16), 4.4, §5(1)(e)(8)(g))	School boards are responsible for **annual inspections of schools**, including relocatables, for compliance with state rules. In public K-12 schools, the "HVAC system shall be inspected to ensure the system is **operating as designed** [and]…shall be re-evaluated if space use changes have occurred or if unusual contaminants or unusually strong sources of specific contaminants were introduced into the space since the most recent inspection." School boards must have **policies and procedures for maintenance** that provide, among other things: "Filters used in conjunction with HVAC equipment shall be kept clean, serviceable and orderly at all times, and shall be sized to prevent unfiltered air from entering the airstream."

INDIANA	
HEALTH In. Stat. §16-41-37.5-2	The state health department must: "Establish an **indoor air quality inspection, evaluation, and parent and employee notification program** to assist schools in improving indoor air quality." The department is required to inspect a school if it receives an IAQ complaint and prepare an inspection report describing its findings and "identifies any conditions that are contributing or could contribute to poor indoor air quality at the school." The agency must "assist the school…in developing a reasonable plan to improve air quality conditions found in the inspection." The department must also develop a best practices manual for managing IAQ in schools and review the manual at least every three years to ensure that it "continues to represent best practices available to schools. Health rules implementing the state IAQ inspection law detail the inspector's authority to inspect schools and investigate complaints and provide: "The state inspector may investigate any condition that it reasonably believes is contributing or could contribute to poor IAQ regardless of whether a complaint has been filed."
HEALTH 410 In. Admin. Code §§33-1 to 33-4, 33-6	The **state inspection report** must identify conditions that could contribute to poor IAQ, including CO_2 levels and provide "guidance on steps the school…may take to address any issues." Schools must post the report "in a conspicuous location: (1) on the school's…website; and (2) at the location of the school…so they are accessible to all students, parents, and employees." The school must provide the state a written reply within 60 days explaining how it "is correcting any deficiencies noted in the inspection report" and must post the reply. The agency may reinspect a school to see that deficiencies noted in the state report have "been corrected as stated in the school…response." Criteria governing state inspections include: "Outdoor air shall be supplied to classrooms when occupied" and "Carbon dioxide **(CO_2) concentrations** in the breathing zone shall never exceed seven hundred (700) ppm over the outdoor CO_2 concentration." Schools must "establish and maintain a **written procedure for routine maintenance of HVAC systems**" including several required items such as a schedule for inspecting and changing filters, and they must keep maintenance logs covering cleaning and filter changes of the HVAC systems for a minimum of three years. Schools must also publish contact information for an IAQ coordinator on the school website and in the school handbook.

MAINE	
EDUCATION 20-A Me. Rev. Stat. §6302	As part of the state's "basic school approval" process, schools with mechanical HVAC systems must ensure they are: "Maintained and operated to provide at least the **quantity of outdoor air** required by the state building standards code in effect at the time the building permit was issued or the ... system was installed, whichever is later." Schools must ensure that their HVAC system is "**operated continuously** during school activity hours except: (1) During scheduled maintenance and emergency repairs; and (2) During periods for which school officials can demonstrate to the [education] commissioner's satisfaction that the quantity of outdoor air supplied by an air supply system that is not mechanically driven and by infiltration meets the outdoor air supply rate required" by the building code at building permitting or system installation. "Each school administrative unit is responsible for: A. **Inspection of the [HVAC] system at least annually** and correction of any problems within a reasonable time; B. Maintaining written records of [HVAC] system inspection and maintenance for at least 5 years. The superintendent shall make these records available for examination upon request." (The basic school approval process requires schools to submit annually a checklist self-certifying compliance with regulatory provisions, including: "Facilities safe, sanitary, healthful; ventilation; code compliant.")
EDUCATION Me. Legis. Document 705 (H.P. 517) (2021)	"[T]he Department of Education shall amend its rules…to require **standards governing air quality and ventilation** for all public schools including school with mechanical and nonmechanical ventilation systems." (See following rule.)
EDUCATION 05-071 Code of Me. Rules Ch. 125, §5.10(D)	Basic school approval rules establish: "Each room used for instructional purposes shall have **sufficient air changes** to produce healthful conditions and to avoid odors or concentrations of toxic substances or dust particles. If [HVAC] systems are mechanically driven, they shall be **maintained and in compliance with HVAC regulations and rules**. *The school administrative unit will utilize the best-available practice national standards of the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) for inspection, maintenance, ventilation and filtration*." (Italicized portion added in 2022 in response to L.D. 705.)
EDUCATION 05-071 Code of Me. Rules Ch. 64, §2	School administrative units must "develop and maintain a **facility maintenance plan** [that] must include, at a minimum, a maintenance and replacement schedule for" HVAC and other major building systems.
EDUCATION 20-A Me. Rev. Stat. §§258-A, 258-B	"The commissioner [of education] shall **periodically review all public schools** and all private schools which receive public funds, to determine their compliance" with state education law. The commissioner is required to inspect, including "an inspection of schools to test air quality" if requested by the district or if petitioned by a certain percentage of voters or parents at the school.

MARYLAND	
EDUCATION Code of Md. Rules §14.39.07.01, .07, .17	**Schools must be assessed** in accordance with the state's Educational Sufficiency Standards at least once every four years. The purpose of the Standards "is to establish acceptable minimum levels for the physical attribute…of existing public PreK-12 school facilities in order to…identify deficiencies." The Standards include a classroom air quality provision: "Each general, science, and fine arts classroom shall have an HVAC system that continually moves air and is capable of maintaining a **CO_2 level** of not more than 1,200 parts per million…The air quality shall be measured at a work surface in the approximate center of the classroom."
MINNESOTA	
OCCUP. S. & H Mn. Admin. Code §5205.0110	"Air shall be provided and distributed in all indoor places of employment as required [by these rules], unless prohibited by process requirements. **Outdoor air shall be provided** to all indoor places of employment at the rate of 15 cubic feet per minute per person."
EDUCATION Mn. Stat. §123B.595(4)	To qualify for long-term facilities maintenance revenue, school districts must annually update and submit a 10-year facility plan that includes "provisions for implementing a **health and safety program** that complies with health, safety, and environmental regulations and best practices, **including indoor air quality management** and remediation of lead hazards. The state Department of Health has published a model IAQ management plan.
MONTANA	
HEALTH Mt. Admin. Code §37.111.826	"**Ventilation systems must undergo annual checks** by the school facility manager, school administrator, or administrator-approved staff to ensure they are operating within manufacturer parameters..." "The school…must complete **annual indoor air quality inspections** using the Walk Through Inspection Checklist from EPA's Indoor Air Quality Tools for Schools or other department-approved inspection form" and must maintain IAQ inspection records for at least three years and make the records available to state and local health agencies upon request." "**Air filters** must have a minimum efficiency reporting value of between 8 and 13 as recommended by the National Air Filtration Association and EPA unless other types of non-MERV rated filters are used. The department recommends that schools with ventilation systems using MERV rated air filters change their filters to MERV 13 or greater during times of poor outdoor air quality."
HEALTH Mt. Admin. Code §37.111.810	"**Annual inspections** must be conducted by a school administrator, facility manager, or other staff member approved by the school administration, as well as having a department or local health authority inspection once a year, or as necessary. The department or local health authority may determine that special circumstances or local conditions warrant inspections with greater or less frequency… Following each inspection, representatives of the department or local health authority must give the school administration a copy of an inspection report which notes any deficiencies and sets a time schedule for compliance. The report must document deficiencies."

NEVADA	
HEALTH Nv. Rev. Stat. §444.335	State health authority "**inspections of schools** and gymnasiums shall be made at least twice each year, once during each semester." An inspection report must be prepared within 20 days; the state may publish reports of school inspections.
HEALTH Nv. Admin. Code §§444.56824, 56826	The state health authority must prepare a **written report of the findings** of an inspection. "Any deficiency indicated in a report…must be corrected within 30 days after the inspection unless otherwise indicated in the report." The school must submit a written report of corrective action taken or planned within 30 days after the inspection, with certain exceptions.
NEW HAMPSHIRE	
EDUCATION N.H. Code Admin. R. Ed. §§321.17, 306.07	"Schools shall be designed, constructed, and maintained to provide...**[c]ode compliant outside air ventilation** and exhaust systems to aid in the maintenance of indoor air quality." Local school boards must require each school to provide, "Exhaust and outdoor air ventilation, proper temperature and humidity conditions in compliance with the state building code."
EDUCATION N.H. Rev. Stat. §200:11-a; N.H. Code Admin. R. Ed. §306.07	"The school principal, or designee shall **annually investigate the air quality** of any schoolhouse or building used for school purposes using a checklist provided by the department of education." The purpose of the review is to "consider physical factors that can influence the air quality" and it "shall require a physical assessment of the facilities, not a measurement of the air quality." The checklist shall allow evaluation of ventilation, moisture control, general cleanliness, and chemical use and storage. "The **completed checklist** shall be filed after the annual inspection with the department of education, the local school board, and the local health officer…Checklists shall be reviewed during the 5 year school approval process and shall be a factor in the approval process for a public school." [Checklists from recent years are currently posted on the education agency website ("IAQ Survey Results").] The education agency is required to ensure that every public school has a copy of EPA's IAQ Tools for Schools resource and to encourage public schools to implement the program.

NEW JERSEY	
OCCUP. S. & H N.J. Admin. Code §12:100–13.1 et seq.	**Indoor Air Quality Standard** issued under authority of state occupational safety and health law "applies to matters relating to indoor air quality in buildings occupied by **public employees** during their regular work hours." Employers must establish and following a **preventive maintenance schedule** that includes checking and/or changing air filters and belts, lubrication of equipment parts, checking the functioning of motors, confirming all equipment is in operating order, and replacing/repairing damaged or inoperable components. Employers must also assure that buildings "without mechanical ventilation are maintained so that windows, doors, vents, stacks and other portals designed or used for natural ventilation are in operable condition…" When "the **carbon dioxide level** exceeds 1,000 [ppm]… the employer shall check to make sure the HVAC system is operating as it should. If it is not, the employer shall take necessary steps" for preventive maintenance as outlined in the rule. Employers must "**identify a designated person**" to assure that HVAC maintenance practices and other actions listed in the rule are implemented and documented and to "[p]romptly investigat[e] all employee complaints of signs or symptoms that may be associated with building-related illness or sick building syndrome." Employers are required to keep **records of maintenance performed**, and to make the records available to the state agency and to employees upon request. In response to an employee complaint to the state agency, the employer must provide specified HVAC documents, if available and if requested by the agency, including as-built construction documents, HVAC system commissioning reports, and HVAC systems testing, adjusting and balancing reports. If the state issues an order to comply, the employer must post it prominently at the place where the violation occurred.
EDUCATION N.J. Admin. Code §§6A:26-20.1, et seq.	School districts must have comprehensive **maintenance plans** documenting prior-year required maintenance activities, including periodic inspection and servicing of building systems, as well as "tests to monitor indoor air quality" and a schedule for 5-year radon testing.
PUBLIC UTILITIES N.J. Stat. §48:3-106.1 (2021 Sen. Bill 3995)	Schools receiving a grant through the state's HVAC grant program (see Fin. Assistance chart, below) must be equipped with **CO_2 monitors** in classrooms; if a classroom CO_2 concentration exceeds 1,100 ppm more than once a week, ventilation rates must be adjusted by qualified personnel.
NEW MEXICO	
EDUCATION N.M. Admin. Code §6.27.30.12	Statewide adequacy standards establishing "acceptable levels for the physical condition" of public school buildings provide that: "All occupiable space within the building(s) shall have an HVAC system that continually moves air and is capable of maintaining a **CO_2 level** of not more than 1,000 parts per million…The air quality shall be measured at a work surface in the approximate center of the classroom."

NEW YORK	
EDUCATION N.Y. Educ. Code §§409-d, e	The state education agency must promulgate a "**uniform code of public school building inspections, safety rating and monitoring**" which may include requiring schools to conduct inspections and to develop a buildings condition survey.
EDUCATION 8 N.Y. Code Rules & Regs. §§155.4(b)--(d).	New York's Uniform Code of Public School Building Inspections, Safety Rating and Monitoring applies to all occupied public school buildings and includes three components: procedures for periodic inspections, a safety rating system and a monitoring system. Schools must provide for 5-year **building condition surveys**, which are eligible for state funding and must be conducted by a team including a licensed architect or engineer. The survey uses a state format and includes inspection of ventilation and other building systems "for evidence of movement, deterioration, structural failure, probable useful life, need for repair and maintenance and need for replacement." The rules have also required schools to conduct **visual inspections** (most recently in 2020 and 2022) using a state form that includes questions on ventilation and filtration. Inspection results must be reported to the state and made available to the public. The education agency may require additional visual inspections as "necessary to maintain the safety of public school buildings and the welfare of the occupants." Schools must also determine the "**safety rating of all occupied school buildings"** based on several listed factors including the need for repair, maintenance, or replacement. If a visual inspection "results in a determination that…the safety rating of the building is unsatisfactory or unsafe/unhealthful…a licensed architect or engineer [must be retained] to perform a detailed inspection and develop a corrective action plan." The required process for schools to monitor the facility conditions includes a **comprehensive maintenance plan**, a health and safety committee, and "**procedures for investigation and disposition of complaints** related to health and safety." The complaint procedure must include a written response that describes how the complaint was verified (or why it was not investigated) and the actions taken, if any to solve the problem.
NORTH CAROLINA	
HEALTH N.C. Stat. §§130A-236, 237	The state health agency is required to adopt school sanitation rules that address the adequacy of ventilation, among other things. The agency must **inspect** schools at least annually to determine compliance with the rules and submit a written inspection report to the state education agency. Schools "shall immediately take action to correct conditions that do not satisfy the sanitation rules."
HEALTH 15A N.C. Admin. Code §18A. 2412	"Lighting and **ventilation shall be provided** and installed as required by the North Carolina State Building Code."
OHIO	
HEALTH Oh. Rev. Code §3707.26	"Semiannually, and more often, if in its judgment necessary, the board of health of a city or general health district **shall inspect** the sanitary condition of all schools and school buildings within its jurisdiction…"

RHODE ISLAND	
EDUCATION R.I. Stat. §16-2-20	"The school committee shall make provision for visitation and inspection of every public school…at regular periods or as often as may be required for proper supervision; provided that at least once during every school year an **examination shall be made of the schoolhouse** and premises…with particular reference to cleanliness, heating, lighting, seating, ventilation, and other sanitary arrangements…Report of the visitation…with recommendations for the improvement of schools, shall be made to the school committee."
VERMONT	
EDUCATION 16 Vt. Stat. §837	Schools must "**designate a person with responsibility for facilities management** for the school district or supervisory union. The designee…shall receive **training and certification pursuant** to" state guidelines that the education agency must develop in consultation with facilities management industry and school operations experts.
WASHINGTON	
HEALTH Wa. Admin. Code §246-366-040 (Current rule)	Local health officers must make **periodic inspections of each existing school…**and forward to the board of education and the administrator of the inspected school a copy of his findings together with any required changes and recommendations."
HEALTH Wa. Admin. Code §§246-366A-095, -020, ***Note: Revised rules - not currently implemented***]	**Revised school health and safety rules** were adopted by the state Board of Health but are **not currently implemented**, due to a legislative hold on implementation of the rules. ***If implemented,*** the rules would establish the following new requirements related to school ventilation. Schools permitted before the rules take effect would be required to provide outdoor air in accordance with the current state building code; schools permitted before that date would be required to conduct "standard operation and maintenance best practices ...[including] setting system controls so that, to the extent possible given the design of the ventilation system, outdoor air is provided consistent with" the current building code. Local health officers would be required to inspect schools at least once each school year, "[c]onsult with school officials…about findings and recommended follow-up actions and, if necessary, develop a correction schedule." The health officer would be required to "[c]onfirm, as needed, that corrections are accomplished." The health officer would be authorized to "allow a school official or qualified designee to conduct a required inspection under a program approved by the local health officer not more than two out of every three years" under conditions specified in the rule. School officials would be required to "[i]dentify, assess, and mitigate or correct environmental health and safety hazards in their school facilities, establish necessary protective procedures, use appropriate controls, and take action to protect or separate those at risk from identified hazards, consistent with the level of risk presented by the specific hazard, until mitigation or correction is complete." Schools would be required to "prepare a report to the public and the school board at least annually about environmental health and safety conditions in the schools," including the dates of environmental health and safety inspections and any deficiencies not corrected.

EDUCATION Rev. Code Wa. §28A.335.010	School boards must ensure that all school buildings are "**properly** heated, lighted, and **ventilated**."
EDUCATION Wa. Admin. Code §392-347-023	School districts participating in the state's Asset Preservation Program must submit to the state and present at a public school board meeting each year the results of an annual **building condition assessment**, which includes a rating of common building components as excellent, good, fair, poor or unsatisfactory. Every six years, schools must "have a certified evaluator, as approved by the [state], perform a **building condition evaluation** and report the condition to the school district."
WEST VIRGINIA	
HEALTH W.V. Code St. Rules §§64-18-9, 64-18-4	**HVAC systems "shall be in compliance** with the requirements of the State Building Code." "All rooms shall have sufficient ventilation to keep them free of excessive heat, steam, condensation, vapors, obnoxious odors, smoke and fumes" and every indoor space intended to be occupied must provide a minimum of 5 cfm/person outdoor air. Health officers must **inspect schools** at least once every two years.
EDUCATION W.V. Stat. §§18-9D-16(c), (d)	"The State Department of Education shall conduct **on-site inspections,** at least annually, of all facilities which have been funded wholly or in part by [the state] to ensure compliance with the county board's facilities plan and school major improvement plan as related to the facilities; to preserve the physical integrity of the facilities to the extent possible; and to otherwise extend the useful life of the facilities."
EDUCATION W.V. Code St. Rules §§126-174-1—4	Schools must designate an official responsible for addressing IAQ complaints and must **investigate a complaint** according to procedures in the rule. County boards of education must provide a corrective action plan and estimated cost of each valid complaint and must send the state education agency a quarterly report of the number of IAQ complaints and total estimated costs of correction. The rules provide that state HVAC technicians "are available to provide **technical assistance** in resolving IAQ complaints" upon request.
WISCONSIN	
EDUCATION Wi. Stat. §§118.075, 119.23(7)(g)	Public school districts and certain private schools must develop and implement a **plan for maintaining indoor environmental quality** in their schools. The state education agency was required to develop a model management plan and practices for maintaining indoor environmental quality. The agency's IEQ Management Plan template incorporates a variety of elements, including an IEQ coordinator, a complaint resolution process, maintenance/operations procedures, and IEQ policies.

POLICIES ADDRESSING VENTILATION DURING INFECTIOUS DISEASE EMERGENCIES

***Note**: The following two charts include some policies that are no longer in effect and/or that previously included provisions different from those described here.*

State COVID-19 Workplace Rules - Ventilation and Filtration Requirements		
Citation	Status/ History	Description
CALIFORNIA		
8 Ca. Code Regs. §§3205, 3205.1	Rule in effect ***Note*:** Non-emergency rule (Adopted Dec. 2022, scheduled to take effect early 2023; replaces emergency rule.) History	"For indoor workplaces**, employers shall review [state health and labor] guidance** regarding ventilation, including 'Interim Guidance for Ventilation, Filtration, and Air Quality in Indoor Environments.'" "Employers shall **develop, implement, and maintain effective methods to prevent transmission of COVID-19** including one or more of the following actions to improve ventilation: (A) Maximize the supply of outside air to the extent feasible, except when the…(EPA) Air Quality Index is greater than 100 for any pollutant or if opening windows or maximizing outdoor air by other means would cause a hazard to employees…(B) In buildings and structures with mechanical ventilation, filter circulated air through filters at least as protective as…[MERV 13] or the highest level of filtration efficiency compatible with the existing mechanical ventilation system. (C) Use…[HEPA] filtration units in accordance with manufacturers' recommendations in indoor areas occupied by employees for extended periods, where ventilation is inadequate to reduce the risk of COVID-19 transmission." *[Prior versions of the (emergency) rule no longer in effect required:* "For buildings with mechanical or natural ventilation, or both, employers shall maximize the quantity of outside air provided to the extent feasible, except when…"] "Employers subject to section 5142 or 5143 [of Cal/OSHA rules] shall review and comply with those sections, as applicable." [See Table 1] **In the case of a COVID-19 outbreak** at a workplace, the employer must review "potentially relevant COVID-19 policies, procedures, and controls and implement changes as needed to prevent further spread of COVID-19" and repeat the review every 30 days during the outbreak and as necessary. The review must include the supply of outdoor air and the sufficiency of air filtration. Where there is an existing HVAC system the employer "shall filter recirculated air with [MERV 13] or higher efficiency filters if compatible with the ventilation system. If MERV-13 or higher filters are not compatible…employers shall use filters with the highest compatible filtering efficiency. The employer shall use [HEPA] air filtration units in accordance with manufacturers' recommendations in indoor areas occupied by employees for extended periods, where ventilation is inadequate to reduce the risk of COVID-19 transmission."

OREGON		
Or. Admin. Rules §437-001-0744	Rule in effect ***Note:*** These provisions are currently **required in "exceptional risk" work settings only**; previously were required in all workplaces. History	Rule defines "**workplaces at exceptional risk**" to "include any setting (whether a healthcare setting or not) where an employee…performs one or any combination of the following job duties: (A) direct patient care…." Such employers "must **optimize the amount of outside air** circulated through its existing…[HVAC] system(s), to the extent the system(s) can do so when operating as designed and maintaining healthy indoor temperatures, whenever there are employees in the workplace and the outdoor air quality index remains at either 'good' or 'moderate' levels. Note: This does not require installation of new ventilation equipment. Note: While not required, ventilation systems that are installed and maintained in accordance with the provisions of…ASHRAE Standards 62.1…meet this requirement." Such employers "with more than ten employees statewide and an existing HVAC system must **certify in writing** that they are operating that system in accordance with the rule, to the best of their knowledge." The certification must include the name of the individual making the certification and must be maintained as long as the rule is in effect. Such employers must ensure that **on a** quarterly basis: "All **air filters** are maintained and replaced as necessary to ensure the proper function of the ventilation system; and All intake ports that provide outside air to the HVAC system are cleaned, maintained, and cleared of any debris that may affect the function and performance of the ventilation system." Such employers must conduct a **COVID-19 exposure risk assessment,** including whether ventilation measures have been used to minimize COVID-19 exposure.
VIRGINIA		
16 Va. Admin. Code §25-220	Rule no longer in effect. ***Note***: These provisions initially applied broadly to schools and later were limited to higher-risk workplaces. History	"Where feasible and within the design parameters of the system," air handling systems under the employer's control must be maintained in accordance with the manufacturer's instructions utilized to: "Increase **total airflow supply** to occupied spaces provided that a greater hazard is not created….[and] generate clean-to-less-clean air movements by re-evaluating the positioning of supply and exhaust air diffusers and/or dampers and adjusting zone supply and exhaust flow rates to establish measurable pressure differentials…" The rule also required employers to comply with the state building code and applicable referenced ASHRAE standards. For air handling systems under the employer's control, covered employers must, "Where feasible and within the design parameters of the system…Inspect filter housing and racks to ensure appropriate filter fit and check for ways to minimize filter bypass…Increase **air filtration** to as high as possible in a manner that will still enable the system to provide airflow rates as the system design requires...If the system's design can accommodate…improve central air filtration to MERV-13 and seal edges of the filter to limit bypass…and…[c]heck filters to ensure they are within service life and appropriately installed."

State Policies Requiring Workplaces to Have a COVID-19 Plan or an Airborne Infectious Disease Plan		
Citation	Status/ History	Description
CALIFORNIA		
8 Ca. Code Regs. §3205	Rule in effect	"The employer's COVID-19 procedures shall either be addressed in the written Injury and Illness Prevention Program or maintained in a separate document." (Prior emergency rule required a written "COVID-19 Prevention Program" and the agency provided a model program.)
MICHIGAN		
Mi. OSHA Emergency Rules – COVID 2019 (Oct. 2020) (May 2021)	Rule no longer in effect	Employers were required to "develop and implement a written COVID-19 preparedness and response plan." The plan was required to detail the measures the employer will implement to prevent employee exposure, including any…engineering controls…"
MINNESOTA		
Mn. Exec. Order 20-74 (June 2020) Mn. Exec. Order 20-99 (Nov. 2020)	Orders no longer in effect	Employers were required to have a "COVID-19 Preparedness Plan" The plan "at a minimum…must adequately address the following areas…ventilation protocols for areas within the workplace." The requirements were set forth in state guidance. COVID-19 plan is no longer required but is recommended by MNOSHA.
NEVADA		
Nv. Governor's Emergency Directive #044	Directive no longer in effect	All employers "shall abide by all other guidelines promulgated by NV OSHA."
Nv. OSHA Memorandum (Apr. 2021, rev. Jan. 2022)	Guidance no longer in effect	Guidance required employers to develop a COVID-19 Prevention Plan that "will be recognized by and added to the Written Workplace Safety Program…required by [state law and regulations]…for businesses with more than 10 employees. Businesses with 10 or fewer employees are highly encouraged to have a written COVID–19 Prevention Program."
NEW YORK		
N.Y. Labor Law §218-b ("HERO Act") 12 N.Y. Code Rules & Regs. §840.1	Law/rule in effect	Law requires private sector employers to establish an "airborne infectious disease exposure prevention plan" to be implemented for airborne infectious diseases that are "designated by the commissioner of health as a highly contagious communicable disease that presents a serious risk of harm to the public health." The state labor agency is directed to develop a "model airborne infectious disease exposure prevention standard" with minimum requirements including procedures and methods for "compliance with applicable engineering controls such as proper air flow, exhaust ventilation, or other special design

		requirements…" State rules establishing the standard do not expressly include ventilation or other engineering controls. The agency's model plan for private education includes a number of ventilation/filtration best practices as "advanced controls" that schools should consider during an outbreak "where the Minimum Controls alone will not provide sufficient protection for employees."
OREGON		
Or. Admin. Code §437-001-0744	Rule in effect ***Note:*** Provision currently **required in "exceptional risk" work settings only**; previously required in all workplaces.	Covered employers must establish and implement an infection control plan based on risks identified in an exposure risk assessment and implementing controls identified in the assessment, including ventilation. The plan must include a "list and description of the specific hazard control measures that the employer installed, implemented, or developed to minimize employee exposure to COVID-19."
VIRGINIA		
16 Va. Admin. Code §25-220	Rule no longer in effect	Required employers to develop a written Infectious Disease Preparedness and Response Plan that considers and addresses "the engineering, administrative, work practice, and personal protective equipment controls necessary to address employee exposure risks."

POLICIES ADDRESSING FUNDING FOR SCHOOL VENTILATION: 2020-2022

State Policies Addressing Funding for School Ventilation: 2020-2022	
Area of Authority and Citation	Description
CALIFORNIA	
PUBLIC UTILITIES Ca. Pub. Util. Code §1600 et seq. (2020 A.B. 841)	Law establishes the California Schools Healthy Air, Plumbing, and Efficiency (CalSHAPE) program, through which the California Energy Commission will award around $584 million to public school districts and charter schools. The program's initial phase focuses on assessment and maintenance of HVAC systems, with a small portion of the funds available for repairs. The law and program guidelines include detailed technical standards and specifications for projects carried out with program funds, which come from the large electric and gas utilities' energy efficiency budgets. At least 25% of projects must be located in underserved communities and additional priority is given to schools located near certain sources of air pollution.
COLORADO	
EDUCATION Co. Stat. §§22-43.7-101, et seq.; 1 Co. Code Regs. §303-3	The Building Excellent Schools Today (BEST) program, created by law in 2008 and administered by the Public School Capital Construction Assistance Board and the State Board of Education, is a competitive grant program that makes awards from the state's public school capital construction assistance fund (funded by the state's recreational marijuana tax, lottery, and other state sources). BEST grants are for projects that address health concerns at existing public schools, including but not limited to ventilation and filtration improvements. The law authorizes emergency grants, and in 2021 the administering agency provided emergency grants for ventilation and filtration improvements. The same year, the legislature also appropriated $10 million for portable air cleaners and HVAC filters (2021 Co. S.B. 21-202).
CONNECTICUT	
ADMIN. SERVICES Ct. Public Act 22–118, Sec. 367 (2022)	This state grant program was established to reimburse local and regional boards of education for "costs associated with projects for the installation, replacement or upgrading of heating, ventilation and air conditioning systems or other improvements to indoor air quality in school buildings…" Among other eligibility criteria, to receive a grant, a local or regional board of education must comply with the requirement established under a separate law [see ventilation requirements chart, above) to perform a five-year uniform inspection and evaluation of the HVAC system and must provide routine maintenance and training for maintenance staff. The bill allocated $75 million in federal pandemic funds to the grant program, to be administered by the Department of Administrative Services, for FY2023 and also authorized issuance of additional state bond funding.

MARYLAND	
EDUCATION Md. Educ. Code §5-322	The Healthy School Facility Fund, first established by the legislature in 2018, provides competitive grants to public schools for capital projects that will improve the health of school facilities, including but not limited to HVAC and IAQ projects. During the COVID-19 pandemic, the legislature extended the program's duration and increased the mandatory annual appropriation; the fund is currently authorized through at least 2026, with annual appropriations of at least $90 million starting in 2024. A state budget bill passed in 2021 (H.B. 588) allocated additional federal pandemic relief money for FY2022 and FY2023.
MASSACHUSETTS	
EDUCATION Ma. Acts 2021, Chapter 102	A 2021 state appropriations law established a $100 million reserve fund for grants to public school districts to address inequitable school facilities' needs and repairs for improved ventilation and IAQ in districts and schools with high concentrations of economically disadvantaged students. Eligible expenditures include inspections, maintenance, installation, repairs, or upgrades for HVAC. The funds, which were allocated from the state's federal pandemic relief, are being administered by the Department of Elementary and Secondary Education.
MICHIGAN	
ENVIRONMENT Mi. Dept. of Envt., Great Lakes, and Energy State Energy Program, K-12 Public School HVAC Assistance Program	Michigan's K-12 Public School HVAC Assistance Program was established by and within the Department of Environment, Great Lakes, and Energy (EGLE) State Energy Program in 2020, utilizing leftover federal stimulus funds to pay licensed professionals to perform school HVAC assessments, at no cost to the schools. The HVAC inspection checklist was developed by the agency in collaboration with ASHRAE and was used to provide a record of the current status of the school's HVAC conditions and make recommendations for improvements. The program, which ended in 2021, spent over $260,000 on the assessment.
NEVADA	
EDUCATION Nv. Rev. Stat. §§393.390 et seq. Nv. A.B. 257 (2021)	This legislation, in effect until July 2023, did not establish funding for school ventilation, but rather established new statewide standards for public school ventilation and IAQ that apply to any school ventilation or IAQ project carried out with state or federal funding. The requirements incorporate standards for filter efficiency and ventilation rates and address service provider qualifications, CO_2 monitoring, and reporting.
NEW JERSEY	
PUBLIC UTILITIES N.J. Stat. §48:3-106.1 (2021 N.J. S.B. 3995)	This legislation established—and allocated a portion of the state's federal pandemic relief money for—the School and Small Business Ventilation and Energy Efficiency Verification and Repair program, administered by a contractor on behalf of the Board of Public Utilities. Grants may be used to reimburse reasonable costs of an HVAC assessment, assessment report, deferred general maintenance, adjustment of ventilation rates, filter replacement, system replacement, and CO_2 monitor installation. The law requires that 75% of the approximately $100 million available for school ventilation be awarded for projects in underserved communities (though an existing state budget law allows funding to be shifted where necessary based on demand).

VERMONT	
EDUCATION 2020 Vt. Acts and Resolves Nos. 120, 154; 2021 Acts and Resolves No. 9	This 2020 legislation established, and allocated $18 million in federal pandemic assistance for, a new School and Indoor Air Quality Grant Program. Administered by a non-profit efficiency utility, the program provided technical assistance and financial support for ventilation improvements in public and independent schools. In 2021, the legislature appropriated an additional $15 million of the state's federal pandemic response money to implement a second round of the program, which will last through 2024. Priority for funding awards was based on mechanical ventilation needs and economic and geographic equity criteria.
VIRGINIA	
EDUCATION Va. H.B. 7001, 2021 Special Session II of General Assembly	This legislation appropriated $250 million of the state's federal pandemic relief funds for direct formula grants to local education divisions (counties) for improving ventilation systems in public school facilities, in accordance with federal ARP guidelines. The funds were allocated to counties in proportion to their student enrollment counts and were administered by the Virginia Department of Education, which announced in January 2022 that all final grant awards had been made, totaling around $220 million. The grants included a 100 percent local match requirement, and all reimbursable costs must be incurred by the end of 2024.


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