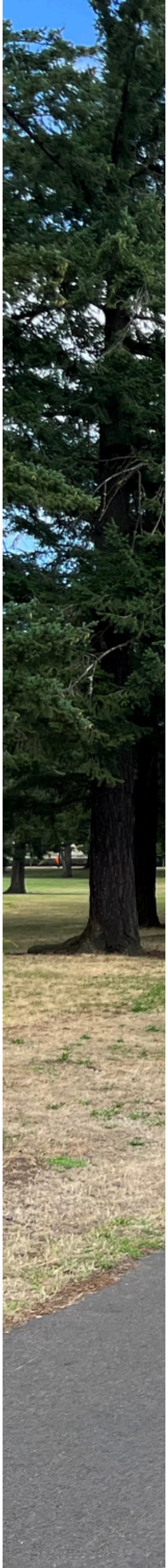
SAFE INDOOR AIR FOR OREGON SCHOOLS

MCDANIEL HIGH SCHOOL

AIR QUALITY REPORT

PPS buildings do not meet health-based goals for ventilation, air filtration, and clean indoor air.

Using McDaniel High School and its feeder schools as a case study, this report highlights systemic needs in PPS's air quality reporting, analyses, policies, practices, and conditions — even at fully modernized schools.



McDaniel High School: A new building that illustrates air quality challenges in Portland Public Schools

This report on poor ventilation rates at PPS's remodel of Leodis V. McDaniel High School, with examples from feeder schools as well, serves several groups: families and staff at McDaniel, the PPS community as a whole, and the broader Portland public. Parents, students, and staff at McDaniel will learn about indoor air quality challenges within their own building, while families, staff, and community members from across Portland will gain insights on systemic issues affecting indoor air quality throughout the district.

However, this report does not just describe problems and challenges. We also call attention to simple, cost-effective solutions PPS has on hand to address insufficient clean air in McDaniel, its feeder schools, and schools throughout the district.

School communities and district staff in the McDaniel cluster can take simple steps to move their buildings from poor ventilation rates to excellent levels of clean airflow. So can schools in other clusters.

Most feeder schools in the McDaniel cluster have aging HVAC systems. They illustrate how older buildings miss the mark on health-based air quality targets. But the data from McDaniel, as well as feeder school Faubion and other new buildings outside the cluster, show poor airflows at fully renovated schools, revealing deeper issues in PPS air quality policies and practices. These findings underscore the urgent need for the district to implement new, transparent, science-based air quality measures in the design of the buildings and remodels they have asked Portlanders to fund.

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MCDANIEL HIGH SCHOOL'S AIR QUALITY FAILS TO MAKE THE GRADE

Health risks for students, staff, families, and community members

In 2021, COVID-19 brought new awareness to the role that poor ventilation plays in not only transmission of respiratory viruses, but also in a wide variety of health and wellness concerns, ranging from asthma[1] to lung cancer[2] to students' ability to concentrate in class.[3] In the same year, Portland Public Schools completed construction at McDaniel High School — a $240-million investment that serves nearly 1700 students and 200 staff. However, like the vast majority of buildings in public school systems across the nation,[4] this beautiful modernized campus has a largely invisible problem: poor ventilation.

Despite the best of intentions and a demonstrated commitment to improving indoor air quality, PPS built our city yet another school with too little clean air.

Based on district data, McDaniel has 75 classrooms, and 31 of them do not even get 3 changes of air per hour from the building's new HVAC system.* Another 33 classrooms fall between 3 and 6 air changes per hour — all less than the 6 to 12 air changes recognized for decades as a practical, reliable, and authoritative benchmark for clean air and infection control indoors.[5]

The regular McDaniel classroom with the lowest airflow is Room 247, with only 1.9 changes of air per hour from the HVAC system. At 1.9 air changes per hour, it takes the HVAC system 1 hour and 9 minutes to clear out 90% of students' respiratory aerosols and other indoor air pollutants. Under this kind of low airflow, sneezes, coughs, and other bioaerosols emitted as students breathe, talk, and sing linger and fill the room for over an hour.

To make poor airflows in McDaniel visible, this report reviews the district's airflow (p. 12) and air quality (p. 32) reports and expands McDaniel's data into detailed Room-by-Room Air Quality Profiles (p. 48). Together, these profiles show that this fully remodeled building — intended to serve PPS students for decades — falls far short of health-based recommendations for fresh, clean air. Only 40 of 179 total rooms in McDaniel's airflow report reach 6 air changes per hour from the HVAC system, meaning that only 40 rooms are clearing 90% of respiratory aerosols out in 23 minutes or less.

Poor airflow spreads illness because it lets infectious aerosols accumulate. It lets other air pollutants accumulate, too. These other pollutants pose their own health risks and adversely affect learning as well. For example, indoor air pollutants directly trigger asthma symptoms and attacks,[6] and exposure to pollutants can lead to new cases of asthma as well.[7,8] Poor ventilation also affects asthma indirectly by increasing spread of respiratory viruses which commonly transform into severe asthma episodes.[9,10]

**Throughout the report, we use air changes per hour to refer to effective air changes per hour. See pp. 22-24 for more on air changes and terminology.*

May 2022 Oregonian article and analysis

"… even new construction doesn't guarantee good, built-in ventilation. The new McDaniel High School in Northeast Portland reopened last fall after more than $200 million in updates. Even so, more than half its officially designated classrooms have fewer than three air changes per hour without purifiers operating …."

OREGONLIVE The Oregonian

Ventilation in schools

These Portland classrooms don't meet bare minimum targets for indoor airflow

Look up results for your child's school and classroom.

Updated: Feb. 11, 2023, 12:13 p.m. Published: May. 15, 2022, 6:00 a.m.

Carolyn Hickman with her children Michael Parrish Jr. (left) and Lyric Parrish (center), and nephew Ayden Garland-Mitchell (right). Hickman said all three children are still wearing masks inside Rosa Parks Elementary in North Portland because she doesn't want to risk them catching COVID-19 again. Sean Meagher/The Oregonian

By Aimee Green | The Oregonian/OregonLive

tinyurl.com/oregonian-bare-minimum

Lack of ventilation and air filtration in schools also results in student and staff exposure to cancer-causing substances. A common carcinogen[11] in classroom air is fine particulate matter. Volatile organic compounds (VOCs), such as formaldehyde and benzene, are also a concern, and carcinogens found in smoke penetrate into classrooms during wildfires and inversion days with woodsmoke. These pollutants are small enough to penetrate deep into the lungs and enter the bloodstream.[12] Over years of teaching in a classroom, these particles can cause lung cancer,[13] and they also cause or exacerbate conditions such as heart disease,[14] stroke,[15] and chronic obstructive pulmonary disease.[16,17] Air pollutants are especially harmful to kids, too — their developing lungs and bodies are more vulnerable to long-term damage.[18]

Inadequate ventilation and airflow also cause cognitive impacts such as poor concentration and inability to focus, which then affects test scores and ability to perform academically. Both staff and student performance suffer when learning conditions include exposure to high levels of carbon dioxide (a marker of poor ventilation), bioaerosols, fine particulates, and other air pollutants.[19,20,21]

These risks and impacts on learning do not have to be the norm at McDaniel, or at any PPS school. PPS has the ability to provide clean air at the level of excellence that PPS students, staff, and leaders strive for in our public schools. Important steps for safe, clean indoor air highlighted in this report include: smart use of district data (p. 20), better airflow goals (p. 23,132), improvements in bond project planning (p. 131), advances in district operations (p. 36), simple changes in daily classroom practices (p. 28-31), and crucially, deployment of thousands of additional air purifiers in storage to deliver more clean air (p. 37-45). With these kinds of steps, excellent ventilation and airflow rates can be the new norm across Portland.

How did we get modernized buildings with poor airflows in a district committed to environmental justice?

PPS invested wisely in numerous forward-thinking and essential indoor air quality efforts upon our return to in-person learning. These investments made this report possible. However, the district's work on indoor air continues to face challenges, many of which stem from a need for indoor air quality education at all levels of society, and all levels of the district. SIAFOS hopes this report helps fill key gaps in understanding.

Benefits of Clean Indoor Air

Ventilation & air filtration improve student performance

Increasing ventilation and clean airflow improves attention, concentration, and cognitive performance,[3,22] and decreases errors among students and staff.[23] Kids and teens in schools and classrooms that have more air filtration and better ventilation get better test scores and higher grades.[24-26] Air quality addresses everyday factors underlying learning loss students and teachers are still facing.

U.S. Environmental Protection Agency

Indoor Air Quality in Schools

epa.gov/iaq-schools/evidence-scientific-literature-about-improved-academic-performance

> "Children in classrooms with higher outdoor air ventilation rates tend to achieve higher scores on standardized tests in math and reading than children in poorly ventilated classrooms."

Clean air provided by air purifiers that use standard mechanical filtration has produced results similar to increased ventilation. One study,[26] profiled in Vox,[25] found that "air filters raised mathematics and English scores by 0.2 [standard deviations]." This positive impact on student achievement is similar to the student performance results in studies of smaller class sizes.[25]

Clean indoor air reduces absences & educator sick days

Meeting health-based clean airflow targets reduces kids' absences,[27-29] cuts down on visits to the school nurse for respiratory issues,[30] and results in fewer teachers and staff needing to take sick leave.[31]

With better air quality, kids and teachers enjoy improved respiratory health,[32] including fewer respiratory viruses;[33,34] less wheezing, dry cough, and rhinitis;[35,36] decreased allergy symptoms;[37] fewer asthma attacks;[38] lower asthma rates;[7,37] and fewer headaches and fatigue.[39] When these health-related disruptions are minimized, students stay in class, and teachers require less time away. This translates to more consistent attendance for students and reduced reliance on substitute teachers.

School air quality is a driver of health — for students, staff, and the surrounding community

Clean indoor air has numerous health benefits — for kids and teens whose lungs are still developing, for staff who have a range of respiratory and cardiovascular baselines, and for the communities schools are embedded in.

Clean classroom air protects against airborne viruses

Clean classroom air prevents colds, flu, RSV, and covid transmission,[40] reduces the infectious dose of these airborne viruses, and helps prevent complications.[41,42] Fewer and less severe infections mean fewer bad colds needing doctor's visits for breathing treatments. Less flu means less risk of secondary pneumonia, hospital stays, and deaths — 370 Oregonians died from flu in 2022, and over the 2024 winter break, two Portland-area children died from flu.[43]

Vaccine-preventable diseases like measles and whooping cough are also airborne. Because vaccine exemption rates are high in PPS,[44] adding a layer of protection against transmission and severity of vaccine-preventable illnesses is a key benefit of appropriately cleaning classroom air.

> "Influenza transmission is common in schools and contributes to school absenteeism and parental absenteeism from work."
>
> **U.S. Centers for Disease Control**
> cdc.gov/mmwr/volumes/66/rr/rr6601a1.htm

Benefits of preventing respiratory illness in PPS schools do not only accrue to PPS students and staff. PPS parents who can't afford to take time off work, vulnerable family members of staff and students, and the community at large all benefit when schools stop being centers of virus transmission. In a Journal of the American Medical Association study of 850,000 U.S. homes, 70% of household spread of covid started with a child, and rates drop during school breaks.[45] Cleaning classroom air means students bring less illness home to family and neighbors.

Clean classroom air prevents asthma and asthma attacks

Asthma is a leading chronic disease affecting students and educators.[46] Cleaning classroom air reduces exposure to both well-known triggers such as dust[47] and traffic-related air pollution[48] and less well-known asthma triggers like respiratory infections.[10] School closures and other measures for covid caused big drops in respiratory viruses.[49] School closures also caused dramatic drops in asthma attacks and ER visits for those attacks.[50] Now, doctors are increasingly recognizing the role of virus prevention in asthma control and how much children are exposed to both types of asthma triggers (irritants and illnesses) in school.[51]

Asthma & Allergy Foundation of America

community.aafa.org/blog/indoor-air-quality-and-its-impact-on-school-children-with-asthma

"... most public schools in the U.S. have polluted indoor air, exposing children and staff to asthma triggers."

Cleaning infectious aerosols from classroom air helps prevent infections from escalating into asthma episodes.[52] Improving ventilation and using high-quality air filtration can also prevent asthma from developing in the first place. By reducing exposure to pollutants like fine particulate matter, filtration of indoor air creates a healthier environment for students' developing lungs — protecting them against particles that cause new cases of asthma.[7,8]

Clean classroom air clears out cancer-causing pollutants

Filtering classroom air and improving ventilation removes cancer-causing pollutants from the air that students, teachers, and volunteers breathe in classrooms and other learning spaces.

Filtration is especially effective at capturing fine particulates ($PM_{2.5}$), which are particles less than 2.5 micrometers in diameter and are known to cause lung cancer[11,53] at levels measured in PPS classrooms,[54,55] and are implicated in other cancers as well, such as breast cancer.[56] Strong systems for cleaning the air in our schools are invaluable for limiting student and staff exposure to carcinogens in wildfire smoke, which not only cause lung cancer but are also associated with lower survival rates for people in recovery from lung cancer.[57] Focusing on clean air in schools also reduces exposure to VOCs and radon, both of which are linked to increased cancer risk.[58,59]

Clean classroom air protects hearts, lungs, and lives

Clean classroom air supports the health of students and staff by promoting healthy hearts, healthy lungs, and overall well-being. By reducing exposure to fine particulate matter ($PM_{2.5}$) and other harmful pollutants, effective ventilation and air filtration help prevent conditions such as heart disease, stroke, COPD, and chronic respiratory issues, as well as deaths from these conditions.[54] Clean classroom air means teacher lives saved over the decades they work in Portland schools.

Scrubbing air of fine particles offers more than just long-term health benefits, such as fewer heart attacks and reduced lung disease over a student or teacher's lifetime. Air filtration and ventilation also reduce student and staff exposure to short-term spikes in air pollutants, fine particulates especially, which cause spikes in serious health events like hospitalizations for chest pain, heart attacks, stroke, and death.[54] Even teenagers are impacted.[60] A 2022 study in the *Journal of the American Heart Association* found that healthy adolescents experienced irregular heart rhythms following short-term exposure to fine particles.[61] Effects were observed at concentrations of fine particulate matter that have been measured in numerous PPS classrooms.[55]

Airflow fosters inclusion in classrooms & equity in our city

Indoor air quality is an equity and inclusion issue. Ensuring that classrooms have an abundance of fresh and well-filtered air contributes to schools being equitable and inclusive learning environments. Communities of color and low-income communities face higher exposures to pollution, compounding health risks for students and staff already made vulnerable by inequities.[62,63] Clean classroom air is particularly important for reducing student and staff of color exposure to pollutants. It is critical to students and staff with disabilities and medical vulnerabilities, too.[64] Infections and pollution can trigger severe health complications or limit the ability to safely participate in classroom activities. For example, a child with a neuromuscular disability affecting lung function may be unable to clear respiratory infections, putting them at risk for pneumonia or other complications.[65] Pregnant staff, students and staff of color, and HIV-positive staff face higher risks of complications from flu.[66] Students with asthma or compromised immune systems may face frequent absences or difficulty focusing when air quality is poor, while clean air allows them to attend regularly and thrive alongside their peers.[1,64] Clean air helps ensure that all students, regardless of health status, can fully participate.

Stopping virus transmission in the classroom also stops chains of transmission to vulnerable family members at home.[67,68] Many students and staff live with family members who are elderly or have chronic health conditions like asthma, diabetes, or heart disease.[69] Effective classroom air filtration provides a critical layer of protection for entire households. The benefit is especially important in multi-generational homes and for families with limited access to healthcare.

Filtering classroom air is critical climate crisis mitigation

Having in-room air cleaners and effective HVAC filters operating year-round has numerous benefits for reducing the indoor air pollutants students and staff are exposed to throughout the school year: mold spores in old buildings, vehicle pollution and diesel emissions, woodsmoke from home heating in winter, infectious aerosols during flu season, and pollen in spring.[70,71,72]

But year-round air filtration is more than these daily health benefits — it is also a proactive response to the challenges posed by the climate crisis. Rising temperatures, wildfires, and extreme weather events are contributing to worsening air quality, with higher levels of fine particulates and other harmful pollutants infiltrating indoor spaces.[73] Better air filters in the HVAC system, rated at MERV 13 or higher, are important to use year-round. This is a step PPS has already taken to help filter wildfire smoke and other particulates from outdoor air brought into the building, and to filter recirculated air in classrooms that have recirculation.

Particle filtration right in the classroom, using multiple air purifiers, is a critical year-round strategy as well. We can't meet our climate crisis response policy goals by moving all the air that needs cleaning through the whole HVAC system.[74] Air purifiers in the classroom are the most energy-efficient way to get effective particle filtration.

A Vision and Mission for Healthy Indoor Air

"... for many people, this may seem like a narrow topic, indoor air quality. But ... this is neither narrow nor a side issue. It is absolutely critical **if we're going to think about public health in America, improving public health in the world, indoor air quality has got to be at the top of that agenda**.[75]"

Dr. Ashish Jha
White House Summit on Indoor Air Quality

A century ago, communities across our country started saving lives because advocates pushed for new, smart, and simple engineering methods for making drinking water safe, clean, and free of disease. Today, we have an opportunity to do the same with the air in our schools.

But making this advancement for clean classroom air needs school communities — like those at McDaniel, its feeder schools, and across the district — to learn and make some simple changes in everyday practices.

"…we spend 90% of our time indoors. I'm going to ask you to think about it another way. Take your age and multiply it by 0.9. That's how many years you've lived indoors. Your indoor age. I'm 47. I've spent 42 years of my life indoors in homes, apartments, schools, airplanes, trains, buses. Thinking of it this way, it becomes obvious and intuitive that **the indoor environment has an outsized impact on our health … the person who manages your building has a greater impact on your health than your doctor**." [75]

Dr. Joseph Allen, Harvard's Healthy Buildings Program

Safe Indoor Air for Oregon Schools (SIAFOS) brings scientists, parents, educators, and community members together to research, advocate, and organize for clean, healthy air in Oregon schools. Our mission is clear: improving air quality in classrooms and learning spaces, like those at McDaniel High School, isn't just about meeting minimum standards — it's about setting a new standard for public health, student success, and healthy environments.

At McDaniel High School, its feeder schools, and schools across PPS, SIAFOS members see both the challenges and the tremendous opportunity to lead the way in improving air quality in schools. If the McDaniel community and other PPS communities implement much-needed change in healthy air practices, we're not just addressing air quality in those buildings; we're stepping up to meet one of the most pressing and ignored public health challenges of our time and setting a powerful example for the entire district and beyond.

District Airflow Measurements

About PPS's Airflow Testing Reports

Each report has a complete map of the school.

For example, this is the first floor map in McDaniel's report.

PPS contracted with Ameresco for these reports.

Ameresco, in turn, contracted with Neudorfer Engineers.

AMERESCO

Airflow Testing Report

Prepared for

Portland Public Schools

August 2021

Neudorfer did the actual measurements and calculations.

Neudorfer Engineers. Inc.
Consulting Engineers Seattle Portland

Project: Portland Public Schools Airflow Testing
Location: McDaniel HS; 2735 NE 82nd Ave., Portland, OR 97220
Filter Status: Upgraded

Room	Equipment Info		Room Dimensions					Airflow Measurements			Calculated ACH				
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Ef… Change… (ACH_e… Porta…
Level 0															
Office 031D	FC-E-08	FCU	Note #1	Note #1	93	10.0	930	65	12	18%	4.2	0.8	1	64.4	
Office 031E	FC-E-08	FCU	Note #1	Note #1	98	10.0	980	65	12	18%	4.0	0.7	1	61.1	
Conf Rm 029	FC-E-06	FCU	Note #1	Note #1	236	8.8	2,084	245	76	31%	7.1	2.2	1	32.6	
Rm 027	FC-E-06	FCU	Note #1	Note #1	206	8.8	1,819	225	70	31%	7.4	2.3	1	36.9	
Rm 015	FC-E-02	FCU	Note #1	Note #1	646	10.0	6,460	370	303	82%	3.4	2.8	1	11.5	
Rm 013A	FC-E-01	FCU	Note #1	Note #1	979	10.0	9,790	950	460	48%	5.8	2.8	1	10.2	
Rm 013B	FC-E-03	FCU	Note #1	Note #1	978	10.0	9,780	925	450	49%	5.7	2.8	1	10.1	
Level 1															
Health 161	FC-A-03	FCU	Note #1	Note #1	153	10.0	1,530	255	26	10%	4.8	0.5	1	21.3	
Reception 161K	-	-	Note #1	Note #1	167	10.0	1,670	-	-	-					
Office 161A	FC-A-03	FCU	Note #1	Note #1	120	10.0	1,200	255	26	10%	12.8	1.3	1	56.8	
Office 161B	FC-A-03	FCU	Note #1	Note #1	161	10.0	1,610	250	25	10%	9.3	0.9	1	42.2	
Office 161C	FC-A-03	FCU	Note #1	Note #1	121	10.0	1,210	230	23	10%	11.4	1.1	1	55.4	
Conf Rm 161D	FC-A-01	FCU	Note #1	Note #1	167	10.0	1,670	495	50	10%	17.8	1.8	1	47.1	
Lab 161E	FC-A-02	FCU	Note #1	Note #1	152	10.0	1,520	460	55	12%	18.2	2.2	1	50.7	
Exam 161G	FC-A-04	FCU	Note #1	Note #1	110	10.0	1,100	165	38	23%	9.0	2.1	1	58.5	
Exam 161H	FC-A-04	FCU	Note #1	Note #1	110	10.0	1,100	155	36	23%	8.5	1.9	1	58.1	
Exam 161J	FC-A-04	FCU	Note #1	Note #1	130	10.0	1,300	155	36	23%	7.2	1.6	1	49.1	
Choir 163	FC-A-05	FCU	Note #1	Note #1	1,534	14.0	21,476	1,460	642	44%	4.1	1.8	1	5.7	
Office 163A	FC-A-05	FCU	Note #1	Note #1	160	10.0	1,600	90	40	44%	3.4	1.5	1	38.2	2.5
Practice 165E	FC-A-06	FCU	Note #1	Note #1	99	10.0	990	80	29	36%	4.8	1.7	1	61.2	3.6
Practice 163B	FC-A-06	FCU	Note #1	Note #1	92	10.0	920	85	31	36%	5.5	2.0	1	66.1	4.1
Practice 165D	FC-A-06	FCU	Note #1	Note #1	91	10.0	910	85	31	36%	5.6	2.0	1	66.8	4.2
Practice 165C	FC-A-06	FCU	Note #1	Note #1	91	10.0	910	85	31	36%	5.6	2.0	1	66.8	4.2

Date: 9/14/2021 Readings By: Jason Coutu

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Measurements were generally done in summer 2021, before the return to in-person learning.

Neudorfer's test engineer signed off on McDaniel's final table of data in September 2021.

HVAC-only airflows were measured using certified standard procedures

Ameresco contracted with Neudorfer Engineers, another professional engineering firm that conducts HVAC airflow measurements using Test-Adjust-Balance methods.

Neudorfer is certified by the National Environmental Balancing Bureau (NEBB) to perform accurate HVAC airflow measurements. The firm used calibrated equipment, current testing standards and procedures from NEBB's Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems,[76] and a standardized report stamped with their certifications.

Calibrated equipment:
AirData Meter with flow hood and velocity grid
(Model: Shortridge ADM 870)

Submitted and certified by:
Neudorfer Engineers, Inc.
(Certification No: 3414)

Signed and sealed by:
Mike Vawter, P.E. and Eric Stotts
Certification seal:
Air and Hydronic Testing

Room	Equipment Info		Room Dimensions					Airflow Measurements				
	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)
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Office 031D	FC-E-08	FCU	Note #1	Note #1	93	10.0	930	65	12	18%	4.2	0.8
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Rm 027	FC-E-06	FCU	Note #1	Note #1	206	8.8	1,819	225	70	31%	7.4	2.3
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Rm 013B	FC-E-03	FCU	Note #1	Note #1	978	10.0	9,780	925	450	49%	5.7	2.8

Airflow was measured in nearly every room

Airflows were measured in classrooms and other learning spaces across the district. Most rooms that staff and students spend time in were measured. However, many schools had no measurements in key spaces, and unoccupied rooms, such as storage closets, were often mischaracterized, leading to errors in district analyses.

Some key spaces at McDaniel were missed, including the commons, the locker rooms, the breastfeeding room, the black box theater, the kiln and glaze rooms, and several science prep rooms. In addition, no ventilation rates were obtained for any restrooms or hallways at any schools, including McDaniel.

Types of rooms included:

- Classrooms
- Main offices
- Principal & assistant principal offices
- Nurse's offices
- Counseling & speech pathologist offices
- Libraries & media centers
- Gyms & auditoriums
- Cafeterias & kitchens
- Band, theater & performance rooms

Testing was done but adjusting and balancing were not

Neudorfer only conducted the testing portion of a Test-Adjust-Balance or TAB report. That means we know where things stand, but the airflows were not fixed to ensure a balance between different rooms. For example, if Mr. Smith's language arts class was getting 113% of the outdoor air required for the room, and Ms. Jones' math class was only getting 89% of the outdoor air required, nothing was done to correct issues in the HVAC ducts to deliver more fresh air to Ms. Jones and her students.

The airflow reports have gaps but the underlying data is good

Although PPS's airflow reports contain mistakes that need correction and include gaps, such as rooms that were missed, the errors in the reports can be fixed, and the reports provide invaluable data for each room that was measured. The data tables provide accurate information on:

✓ **The type of HVAC equipment serving the room, its identifier, and notes about the system**

Details about HVAC equipment provide context, such as the range of equipment used within each school and across the district, the role of equipment in driving poor ventilation rates, and in many buildings, these details help identify rooms that lack mechanical ventilation entirely. At McDaniel, the report shows that all rooms included are served by fan coil units and air handling units.

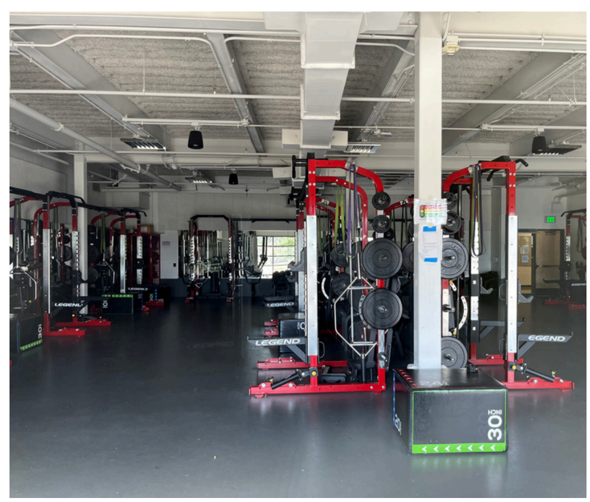
✓ **Room dimensions**

Room volume is used to calculate clean airflow from both the HVAC system and from air purifiers. The reports also provide room lengths, widths, heights, and areas. In other schools, these details have helped us correct cases where incorrect room dimensions caused serious errors in a room's airflow calculation. We have not identified any cases of errors in McDaniel's room dimensions.

✓ **Total amount of air supplied to the room by the HVAC system + how much of the total is from outside air**

The total air supply from the HVAC system was measured and reported in cubic feet of air flowing into the room each minute. Cubic feet per minute of outdoor air flowing to the room from the HVAC system was likewise included in the table, as was the percent of the total supply that comes from outside. This data also allows us to calculate how much of the airflow is recirculated air.

A problem in some schools in PPS is that the HVAC system is turned off in warm weather, meaning those schools do not actually get the measured ventilation rates during the fall and spring. At McDaniel, we believe the system remains on, providing the measured ventilation rates year-round.



179 rooms were detailed in McDaniel's ~$10,000 airflow report. Most of the building's occupied rooms, including the Flexible Learning Room FX 105 (left) and Weight Room G122 (right) had HVAC equipment identified, room dimensions provided, and total and outdoor airflow measured. Another ~5,500 rooms across 85 active PPS buildings have these detailed and valuable data as well.

How air to each room was measured: flow hoods & velocity grids

With the ventilation system on, the engineers used a special device called a flow hood to measure the volume of air entering the room through the room's supply vents. The flow hood captures the air coming out of the vents, in order to determine the number of cubic feet of air flowing into the room each minute. This measurement is reported as "Total CFM supply" where CFM is cubic feet per minute.

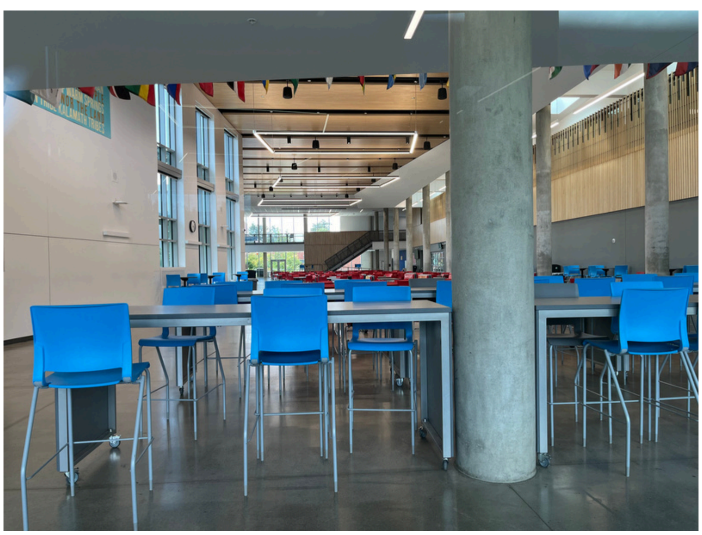
The amount of outside air coming in to the system was also measured with a flow hood at the louvres (slats on the outside of the building for intake of air from outdoors), where possible, but were recorded with a velocity grid if necessary. Cubic feet of outdoor air entering the room was then calculated by accounting for shape and size of the ducts, using measures of the open unobstructed area that air actually flows through. These areas were from AK factors (areas provided by the manufacturer) or were determined using the free area method (total area minus area of obstructions). Outdoor air is reported as "OA CFM Supply." The difference between total cubic feet per minute and cubic feet per minute of outdoor air then provides recirculated airflow.

Conducting such detailed measurements in each school could give the district a truly comprehensive view of ventilation problems and opportunities, if the data were analyzed and used correctly. The airflow data is incredibly valuable for identifying which rooms are falling short and by how much, providing an opportunity to add what the room needs to meet healthy airflow targets.

Room	Served By	Equipment Type	Room Length	Room Width	Room Area	Room Height	Room Volume	Total CFM Supply	OA CFM Supply	OA %	Air Changes per Hour (supply)	Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	Notes
Level 0																

Original McDaniel airflow report available at: safeairoregon.org/mcdaniel-airflow

Important gap: some spaces were overlooked for measurements



Some rooms that should have been included in airflow measurements were not. At McDaniel, rooms that got overlooked included the commons (pictured left), as well as the locker rooms, the breastfeeding room, the black box theater, the kiln and glaze rooms, and several science prep rooms. Most airflow reports did not have key rooms missed, but a number of other schools had issues with missed rooms similar to McDaniel. Across all airflow reports, bathrooms and hallways (including this McDaniel hallway, pictured right) were intentionally not measured.

The reports have serious errors but most can be corrected easily

Errors and issues in the airflow data tables include:

⚠ Calculation of air changes per hour provided by the HVAC system

In rooms that have mechanical ventilation, the best measure of clean air coming to the room from the vents is the sum of outdoor air and the 75 to 90% of recirculated air that gets cleaned when that air passes through a MERV 13 furnace filter, the type the district installed in all schools. This total is then multiplied by a correction factor to account for how well vs poorly HVAC systems distribute the air throughout a room. The airflow reports use a generous and questionable estimate of how much of the recirculated air is cleaned by the MERV 13 filter (90%).

At some schools that were not yet upgraded to MERV 13 filters, calculations used the percentage of cleaning that the old MERV 8 filters accomplish (57%). Those schools' air changes per hour from the HVAC are not correct in rooms with recirculation, and need to be recalculated to reflect the higher efficiency provided by the MERV 13 filters the district installed. In McDaniel's airflow report, calculations of air changes per hour correctly used the MERV 13 value.

A grossly incorrect calculation of total air changes per hour in high schools

Total air changes per hour provided by the HVAC system and the original air purifier purchased by PPS for the room are wrong in every single high school room. The district's high school reports mix cubic feet with cubic meters in these calculations. This across-the-board error is easily fixed by doing calculations correctly at a fan speed setting that is realistic for the room. We have done this fix in our calculations for McDaniel and for all other high schools that still have valid airflow reports.

Another problem with the high school reports is that many rooms in PPS high schools received Intellipure air purifiers, which provide far less clean airflow than do the Medify air purifiers the district bought for most high school rooms. However, the reports fail to identify which high school rooms got Intellipures instead of Medifys. In some high schools, we have been able to identify the type of air purifier in most rooms, in order to calculate correct airflow values. But for McDaniel, we have had to assume that Medifys were placed in all rooms.

A misleading, sometimes incorrect calculation of total air changes per hour in other schools

Total air changes per hour (provided by the HVAC system and the original air purifier PPS bought for the room) are misleading because they are calculated at noisy fan speeds that only cafeterias can handle. Air changes per hour that classrooms can realistically achieve are easily calculated by using the air purifier's clean air delivery rate at fan speeds teachers can actually use. In addition, total air changes per hour are incorrect in schools where HVAC-only measurements were done with MERV 8 filters instead of MERV 13, but as described above, these values can be recalculated easily.

PPS needs help fixing errors in McDaniel's airflow report

The district has made decisions about staff and students' air quality based on false data and faulty analyses. These errors need correction. Indoor air quality is a science that needs to be based on accurate calculations. SIAFOS and partners have analyses done and can assist with capacity challenges the district faces for air purifier inventories, getting corrected estimates, and using appropriate approaches with airflow data.

Examples from McDaniel of the error in every high school room

Air changes per hour with the portable filter is supposed to report the room's clean airflow if the air purifier is running at full speed, but is calculated incorrectly →

← Air changes per hour without portable filter = HVAC-only airflow

Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter
64.4	3.1
61.1	2.9
32.6	5.3
36.9	5.5
11.5	2.7
10.2	4.4
10.1	4.3

Calculated ACH			
Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter
0.8	1	64.4	3.1
0.7	1	61.1	2.9
2.2	[illegible]	32.6	5.3
[illegible]	[illegible]	36.9	5.5
[illegible]	[illegible]	11.5	2.7
[illegible]	1	10.2	4.4
[illegible]	1	10.1	4.3

FALSE

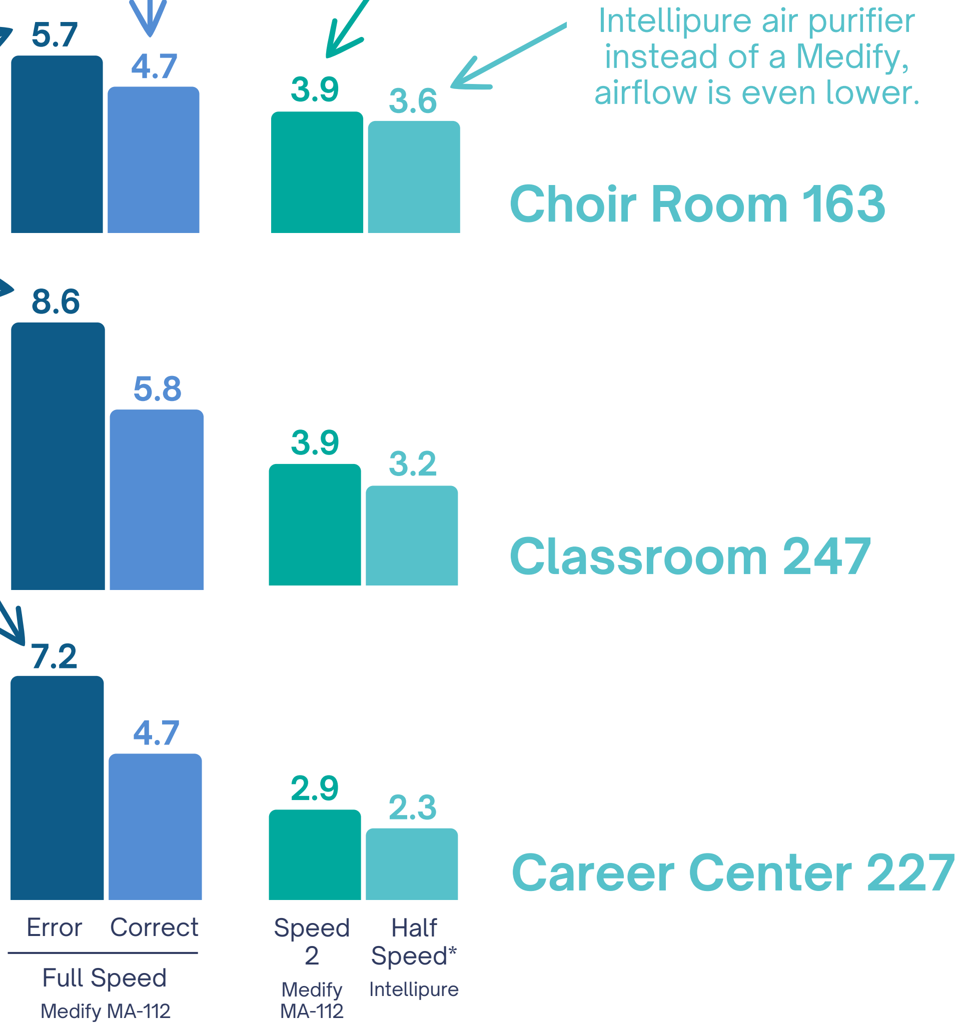
Air changes per hour with the air purifier running is wrong in every single room in the high school reports. This error makes air changes per hour look far higher in high schools than they actually are.

① District report calculated air changes per hour with the air purifier at full speed incorrectly.

② Actual air changes per hour at full speed are not as high as what PPS reported.

③ Air changes are even lower at the fan speed with a noise level that works for classrooms

④ If the room has an Intellipure air purifier instead of a Medify, airflow is even lower.



What was the error? Mixed units! Cubic meters and cubic feet are mixed in the calculations.

*Clean airflow rates with Intellipures at half speed may be lower than this estimate; see p. 41

Error Breakdown

	Incorrect	*Correct**
Airflow from HVAC system	Total Effective Air Changes per Hour (ACH_e) without Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter
	+	+
	Airflow from the Medify MA-112 air purifier at full speed	
Clean air delivery rate at full speed	**950 cubic meters/hour**	**559 cubic feet/minute**
	x	x
Minutes in an hour	60	60
	÷	÷
Size of room	**room volume in cubic feet**	**room volume in cubic feet**
	≠	=
Total airflow	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) with Portable Filter

*Correct but impossible

Using the full speed setting of the original Medify MA-112 air purifier that was assigned to most (but not all) rooms in McDaniel and other high schools is not feasible. A regular Medify MA-112 would add 57 decibels of noise to each room, if teachers and other school staff used the full speed setting that would deliver the 559 cubic feet of clean air per minute this unit provides at its highest setting. This is an impossible noise level to run these units at daily, especially given the Center for Green Schools' guidance to limit air purifier noise to 35 to 45 / 50 decibels and wide recommendations based on EPA guidance that classrooms need air purifiers at 45 decibels or lower.

Classroom-Appropriate Calculations

If Medify was placed

Total Effective Air Changes per Hour (ACH_e) without Portable Filter

+

Airflow from a Medify MA-112 at speed 2

281 cubic feet/minute

x

60

÷

room volume in cubic feet

=

Realistic Total Effective Air Changes per Hour (ACH_e) with Portable Filter

If Intellipure was placed

Total Effective Air Changes per Hour (ACH_e) without Portable Filter

+

*Airflow from Intellipure at half speed**

182 cubic feet/minute

x

60

÷

room volume in cubic feet

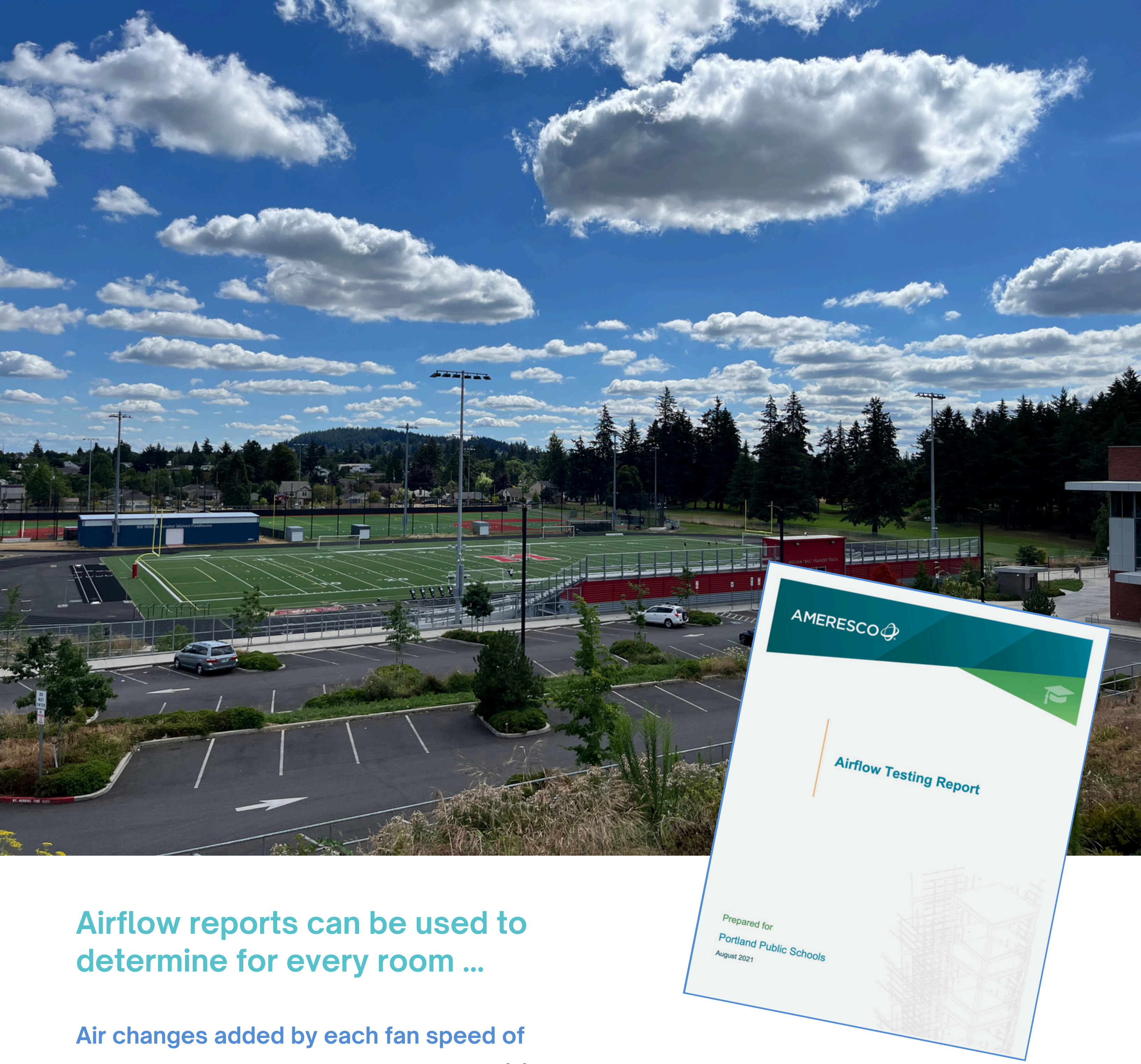
=

True & realistic Total Effective Air Changes per Hour (ACH_e) with Portable Filter

Recalculating for reality: getting it right and not too noisy

At speed 2, a regular Medify MA-112 is only 41 decibels. But speed 2 provides just 281 cubic feet of clean air per minute. This 281 value is the realistic amount of clean air that can be added to classrooms and is the clean air delivery rate that should be used for regular MA-112's. PPS's airflow reports also assume placement of MA-112's in all high school rooms, but many high school rooms got Intellipure units for their first air purifier instead of Medifys. Intellipures deliver less clean air than Medify MA-112's do and have a similar noise issue, where the unit must be run at a lower setting. The speed setting on the Intellipure that works best for classrooms is half speed, which is only ~39 decibels and delivers only 182 cubic feet of clean air per minute, according to information provided by the manufacturer to SIAFOS members.

**Clean airflow rates with Intellipures at half speed may be lower than this estimate; see p. 41 for details*



Airflow reports can be used to determine for every room ...

Air changes added by each fan speed of
- * the currently assigned air purifier(s)
- * air purifiers in district storage
- * any alternative model of air purifier

Impact of MERV 13 furnace filters
- * whether they improved airflow at all
- * how much they improved airflow

Time to clear out aerosols/pollutants

Expected carbon dioxide levels
- * screen for rooms where high levels are expected

Compliance with outdoor air standards

Airflows compared to targets for airflow
- * target air changes per hour
- * target per-person airflow rates

PPS is not using this comprehensive data set fully or correctly

After $940,000 in spending to conduct such valuable measurements in each school, this detailed airflow data could give the district a truly comprehensive view of ventilation problems and opportunities across the 85 buildings in the district where the airflow reports remain relevant and actionable.

With appropriate QA of the data, and analyzing and using the data correctly, or by working collaboratively with our organization and partners to make use of the corrected analyses we have already conducted and continue to refine, this resource could make a significant difference by improving indoor air quality for students and staff, and the health and learning outcomes air quality affects. The airflow data has incredible value for identifying which rooms are falling short and by how much, providing an opportunity to add what the room needs to meet healthy airflow targets. The airflow data can also be used to calculate expected carbon dioxide levels, and indicate which rooms have carbon dioxide levels that are too high. This use of the data could facilitate the facilities team getting a comprehensive view of which rooms in which schools are likely above their informal goal for an upper carbon dioxide limit, and promote improvements to achieve even lower CO_2 targets recommended by clean air advocates, education organizations, and health agencies.[77,78] Additionally, the data can help evaluate how much MERV 13 filters are improving airflow within the room.

A tremendous amount of time, effort, and money went into collecting these data which have the power to guide simple, effective policies and actions to appropriately clean indoor air at McDaniel and all PPS schools.

For McDaniel and some cluster schools, this report uses the airflow reports to look at:

Air changes per hour added by the currently assigned air purifiers

Air changes per hour added by the air purifiers in district storage

Impact of MERV 13 furnace filters

Time to clear out aerosols/pollutants

Airflows compared to target air changes per hour

PPS needs help using realistic and quiet air purifier settings to calculate clean airflows

In addition to fixing the units error that led to incorrect airflow values for every high school room, the district must also rely on calculations that use realistic airflow numbers. SIAFOS and partners have calculations of airflow with the air purifier(s) running using clean air delivery rates at fan speeds that meet appropriate classroom noise limits. Airflows need to use speed settings that staff will actually use, because noise levels at full speed compromise students' learning.

Likewise, the calculation of total air changes with the portable filter needs to use the model of air purifier actually in the room. Calculations for the high schools need accurate inventories of which room has which model.

Airflow 101

Air changes per hour
=
How many times in one hour an airflow source delivers a volume of air equal to the size of the room*

Add up the clean air!

Outdoor airflow + 90% of recirculated airflow

x

Multiply by 0.8 to account for weaknesses in the HVAC system's ability to distribute clean air throughout the room

=

Air changes per hour from the HVAC system

Air changes per hour from the HVAC system

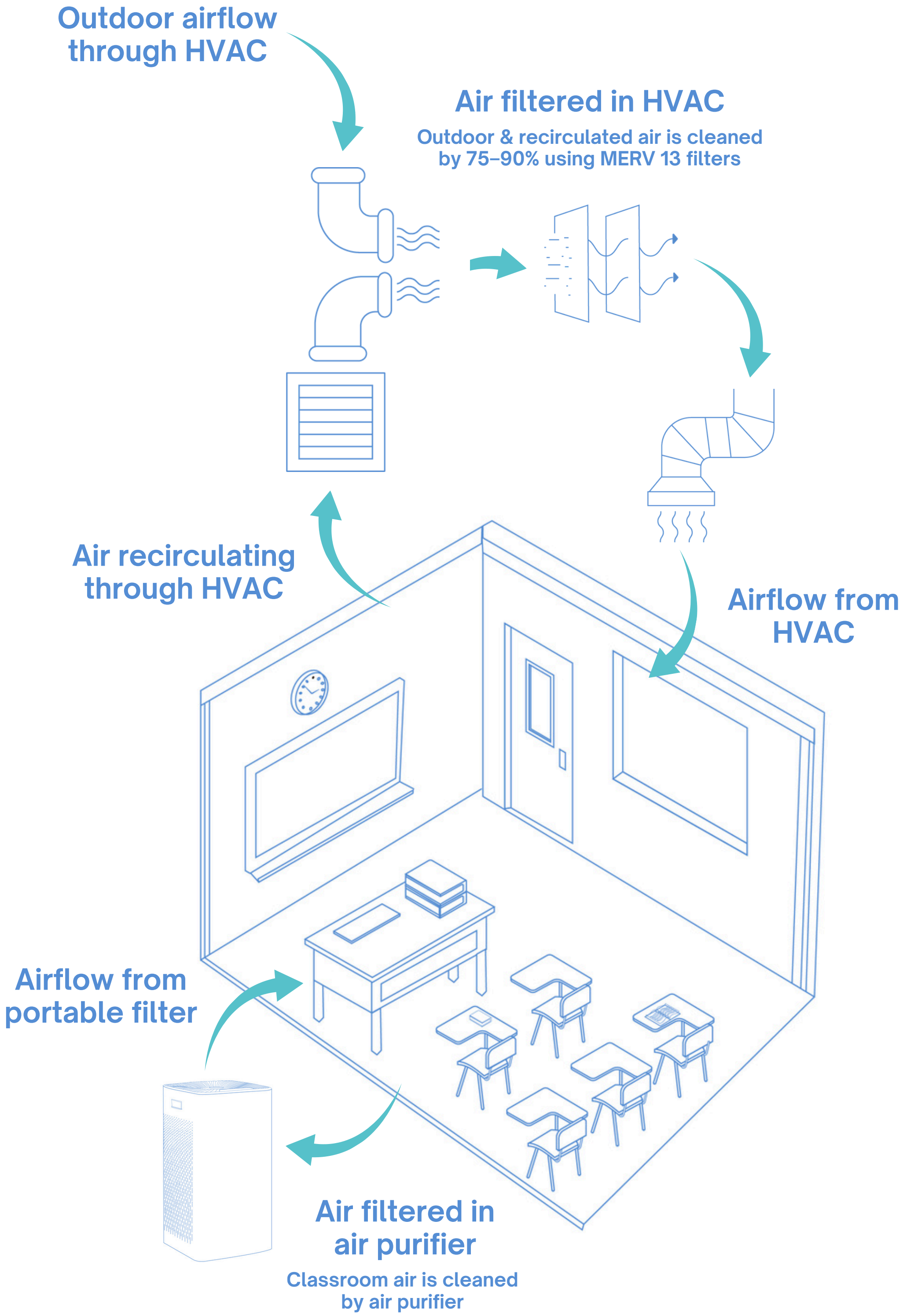
+

Air changes per hour from any air purifiers

=

Total air changes per hour

*Note: We use air changes/hour for effective air changes/hour; see p. 24.



Air changes per hour are not actual full changes of air — an analogy

A good analogy for airflow expressed in air changes per hour is to imagine one bucket of clean water being poured into a bucket of dirty water, in order to clean out the dirty water. In this analogy, one "change" has occurred once a full bucket's worth of clean water has been poured into the bucket full of dirty water. The new clean water will displace a lot of the old dirty water, but not all of it.

Similarly, when a room's worth of clean air pours into a room from the HVAC vents, air purifiers, and other sources of clean air, that new air will displace much, but not all, of the stale, dirty air already in the room. Each air change clears some pollution, but complete replacement requires multiple changes.

Translating air changes to how long sneezes and coughs float around the classroom

Because an air change is not an actual full exchange of air in the room, we need more changes than you might expect to sufficiently clean the room's air and clear indoor air pollutants and aerosols out.

In McDaniel's worst-performing room, the HVAC system provides only 1.9 air changes per hour. At that rate, each cough, sneeze, plume of smoke that penetrated the building, and cloud of dust kicked up by students moving about takes well over an hour to clear out. The Oregon Health Authority's early pandemic guidance of 3 to 6 air changes per hour[79] also leaves classrooms with sneezes and coughs lingering in the air for far too long – 3 air changes per hour takes 46 minutes to clear out 90% of any given sneeze or cough's bioaerosols. At 6 air changes per hour, it only takes 23 minutes to clear out 90% of aerosols and pollutants, and at 12 air changes, that comes down to 12 minutes. PPS is capable of providing this kind of excellent airflow. The superintendent's office and the school board's meeting room each get high air changes per hour from the HVAC system alone — 7.5 air changes in the superintendent office; 13.4 in the school board meeting room. And in the central office airflow report, each of these rooms is designated with 2 air purifiers on top of that already-excellent HVAC airflow.

How long it takes to clear out 90% of respiratory aerosols and other indoor air pollutants

Targets for air changes

The SIAFOS clean air score is based on a room's air changes per hour.

In this report, each room has three grades listed in the Room-by-Room Air Quality Profiles. The first grade given for each room is based on the air changes per hour from the HVAC system only, with no air purifiers running. A second grade is based on air changes if the air purifier that should currently be in the room, according to the McDaniel airflow report, is running at the speed/noise level that typically works for classrooms. A third grade is given for the airflow that the room could achieve if the district had distributed the Medify Pro air purifiers purchased by Oregon Health Authority for McDaniel, and teachers and staff run both air purifiers at their reasonable noise levels. However, the Medify Pro's were stored in the central office for 18+ months. This report reflects what could still be achieved if these units get delivered and used at McDaniel.

12 air changes per hour is an ideal high goal to limit spread of pathogens and infectious aerosols and provide students and staff with exceptionally clean air

Air changes per hour	Grade
3 or less	F
3 to 3.5	D-
3.5 to 4	D
4 to 4.5	D+
4.5 to 5	C-
5 to 5.5	C
5.5 to 6	B-
6 to 6.5	B
6.5 to 7	B+
7 to 8	A
8 to 10	A+
10 and above	A++

Air changes vs. effective air changes

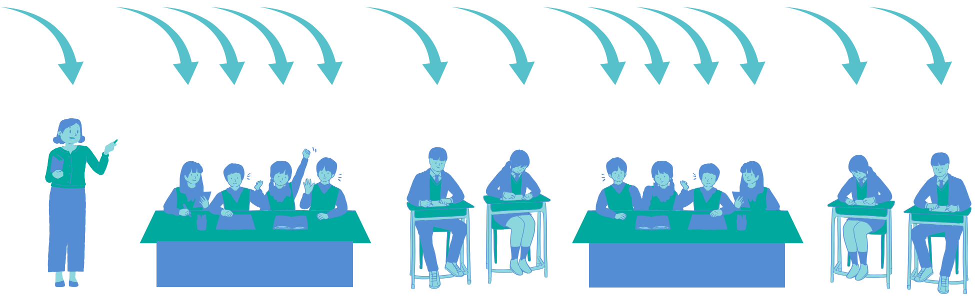
A strict definition of air changes per hour is airflow from outdoor air only, while effective air changes per hour refers to airflow from filtration or a mix of outdoor air and filtration.

For simplicity, we use air changes per hour in this report regardless of whether the airflow source is outdoor air, filtered air, or a mix of both.

Other airflow metrics — total flow, per-person rates, and new standards from ASHRAE

Air changes per hour are not the only way to express airflow, ventilation rates, and clean air benchmarks. The amount of clean air provided to a room can also be given as a total flow rate, in units such as cubic feet per minute or cfm. Likewise, it can be given as a per-person flow rate, in units such as cfm per person. Per-person rates divide the total clean airflow by the room's number of occupants to show how much clean air each person effectively gets. Per-person rates can be a way to check whether a crowded room is getting a clean air supply that keeps pace with the room's occupancy.

Different researchers, organizations, and indoor air quality benchmarks might use any one of these units of clean air. With key information like room volume and occupancy, the various metrics can also be converted between each other.



New standards and references, such as the ASHRAE Standard 241[80] and Guideline 44,[81] introduce additional metrics, approaches, and targets that underscore the need for clean air. ASHRAE Guideline 44 mitigates wildfire smoke infiltration by emphasizing building design and monitoring to achieve lower indoor concentrations of fine particulate matter during wildfire events. ASHRAE Standard 241 provides methods for determining minimum airflow to reduce transmission of respiratory infections and is based on per-person clean airflow rates. ASHRAE 241 defines how to calculate *equivalent clean airflow* from ventilation, filtration, and air cleaning, and includes important new testing protocols for evaluating and verifying air cleaner performance and safety, such as ensuring they do not produce harmful byproducts.

Local and international research shows 6 air changes per hour is a key minimum goal

When a room has low airflow, harmful particles, aerosols, organic chemicals, and gases linger longer and build up to higher levels. But when a room meets or exceeds key minimum rates of air cleaning, particles, viruses, and other pollutants are removed more quickly, and their average concentrations in the air stays much lower. This reduces cumulative exposure for everyone in the room.

Six air changes per hour is a key minimum goal. Classrooms in Italy saw an 80% drop in virus transmission when they achieved this goal.[82] Research on classrooms in Germany reported a similar reduction in exposure to virus-laden aerosols.[83] CDC has established a minimum recommendation of 5 air changes per hour,[84] while the Lancet Task Force on Safe Work, Safe School, and Safe Travel identified 6 air changes as better for reducing aerosols and virus transmission, and going above and beyond 6 as excellent.[85] The benefits of 6 as a *minimum* is supported by other research indicating 8 or 9 air changes per hour as key targets.[86,87]

Additional cubic feet of airflow needed per minute to meet ASHRAE 241 minimum[89]

Additional airflow needed	Number of classrooms
None	296
0-200	354
200-500	731
>500	1294

In a research collaboration between SIAFOS and the Healthy Buildings Research Laboratory at Portland State University,[88] analyses of airflow in PPS classrooms showed 6 air changes per hour is a key target. Minimum airflow goals to mitigate infectious aerosols, as calculated using ASHRAE Standard 241, often corresponded to ~6 air changes. The analysis also showed that during the 2022-2023 school year, over 2000 PPS classrooms needed additional airflow beyond what a single air purifier could provide.[89]

Experts and advocates recommend 6 to 12 air changes

A minimum of 6, and ideally closer to 12, air changes per hour is a long-standing recommendation for clean indoor air. Six or more is recommended as best by the Lancet Task Force for Safe School, Safe Work, Safe Travel, and is the recommendation of numerous other national experts in indoor air quality.

"... if in one hour, you renew, you change your air 6 times, I think that will provide a quite sensible way of making sure that we are reducing or preventing the spread of the virus indoors...."[90]

Dr. María Neira
Director of the Public Health Environment and Social Determinants of Health Department at the World Health Organization

"... schools should provide at least 6-12 ACH or at least 30 cfm/person, as these are the most widely made, most scientifically backed ... recommendations."[91]

Indoor Air Care Advocates

"... strive for 6-12 ACH as the gold standard for reducing infection risk in settings like classrooms, offices, and homes."[92]

Air Support Project

"... schools [are] where I would prioritize resources ... I would go beyond five air changes per hour .... Let's hit the hospital grade ... 12 air changes per hour or better"[93]

Dr. Linsey Marr, Ph.D., PE.
University Distinguished Professor, Civil and Environmental Engineering, Virginia Tech University

MacArthur Fellow

"I do not believe aiming for 4 or 6 ACH in schools or other indoor spaces is sufficiently aspirational & have written about how a combo of increased outdoor air supply and use of #CorsiRosenthalBox es can get us close to 10 equivalent ACH in classrooms."[94]

Dr. Richard Corsi, Ph.D., PE.
Dean of Engineering at University of California, Davis

Is 12 air changes far higher than we need? Isn't that what hospitals use?

12 air changes per hour as an ideal stretch goal is indeed lofty given that many rooms in PPS start at zero ventilation from an HVAC system. However, we also have many rooms in PPS that achieve 7, 8, 9, even 10 air changes, with just one purifier and sometimes from HVAC alone.

Most importantly, at 12 air changes per hour, we get truly clean air. For far-field exposures in typical rooms, 12 air changes provides the same level of protection that wearing an N95 respirator does.[95] That is actually clean air. We don't expect to only drink actually clean water at the hospital. The hospital should not be the only place we expect to breathe actually clean air. As clean air tools and technologies advance, as SIAFOS brings more solutions to the table (including donated solutions that have already demonstrated Dr. Richard Corsi's aspiration of 10 is achievable in PPS classrooms that start from less than one change of air an hour), let's be ready and willing to reach 12 wherever possible using energy-efficient approaches.

Another way to look at 6 to 12 air changes: reducing exposure through faster clearance

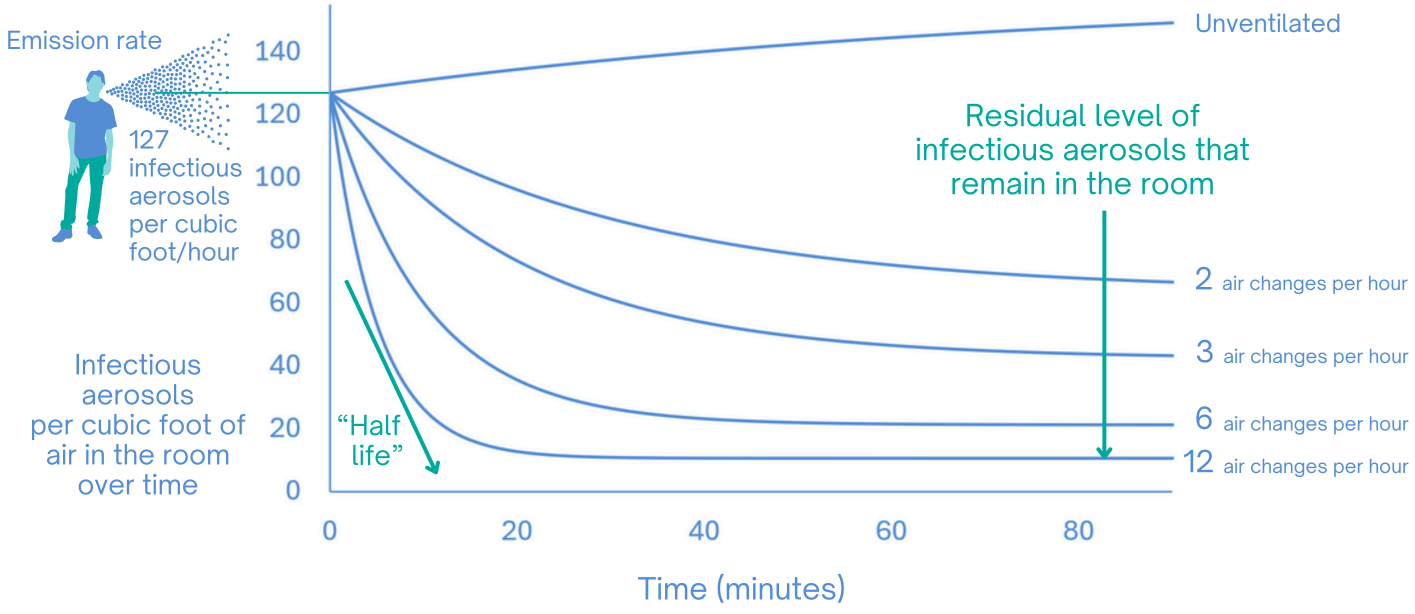
Clean air is not just about how quickly a room clears after someone coughs, leaves, or kicks up a cloud of dust. In reality, respiratory aerosols are emitted continuously — every minute someone is talking, breathing, or present while infectious. Other air pollutants enter building air constantly, too, from outdoors, from building materials, and from everyday school activities. What matters most is how much of that pollution builds up in the room, and how quickly it's removed.

Higher air changes per hour dramatically reduce the amount of airborne particles in a room. Adding clean airflow speeds up how quickly aerosols and pollutants are cleared (shorter "half-life"[95]). More airflow also lowers the steady-state level of aerosols, particles, and other pollutants in the air (the "residual"[95]). The residual is where the room reaches a balance between what's being added and what's being removed.

When there is a wildfire event, smoke keeps seeping in and accumulates indoors. When students gather on rugs for circle time or shuffle in and out between classes and specials, dust and allergens can get stirred up repeatedly. And when someone is sick, their infectious aerosols build up in the air — unless there is enough clean airflow to keep up.

The slower the air turns over, the more virus particles remain in classroom air

This graph shows what happens when one person with a respiratory infection enters a classroom and then continuously emits 127 infectious aerosols per cubic foot of room air over the course of an hour, a realistic emission rate based on studies of respiratory aerosols produced when speaking. Over time, the number of virus-laden aerosols stabilizes at the residual level, the concentration of infectious aerosols that remains in the room while the (perhaps unknowingly) sick student or staff is still present.



With continuous sources of indoor pollutants and aerosols, 2 to 3 air changes per hour is slow to remove these infectious bioaerosol pollutants and their concentrations plateau at high levels. At 6 air changes per hour, removal is faster, and there are far fewer aerosols and particles remaining — 6 air changes cleans the room to just half the level of infectious aerosols that 3 air changes leaves behind. At 12 air changes per hour, pollutants and aerosols are cleared especially quickly and efficiently, and the room reaches a steady state that is twice as clean as it is at 6 air changes.

Graph adapted from Srikrishna[95] with values based on Archer and colleagues[96] and Alsved and colleagues[97]

Multiple air purifiers
=
Additional air changes per hour to achieve airflow targets

Clean More Air

The power of two!

Air changes per hour from the HVAC system

+

Air changes per hour from one air purifier

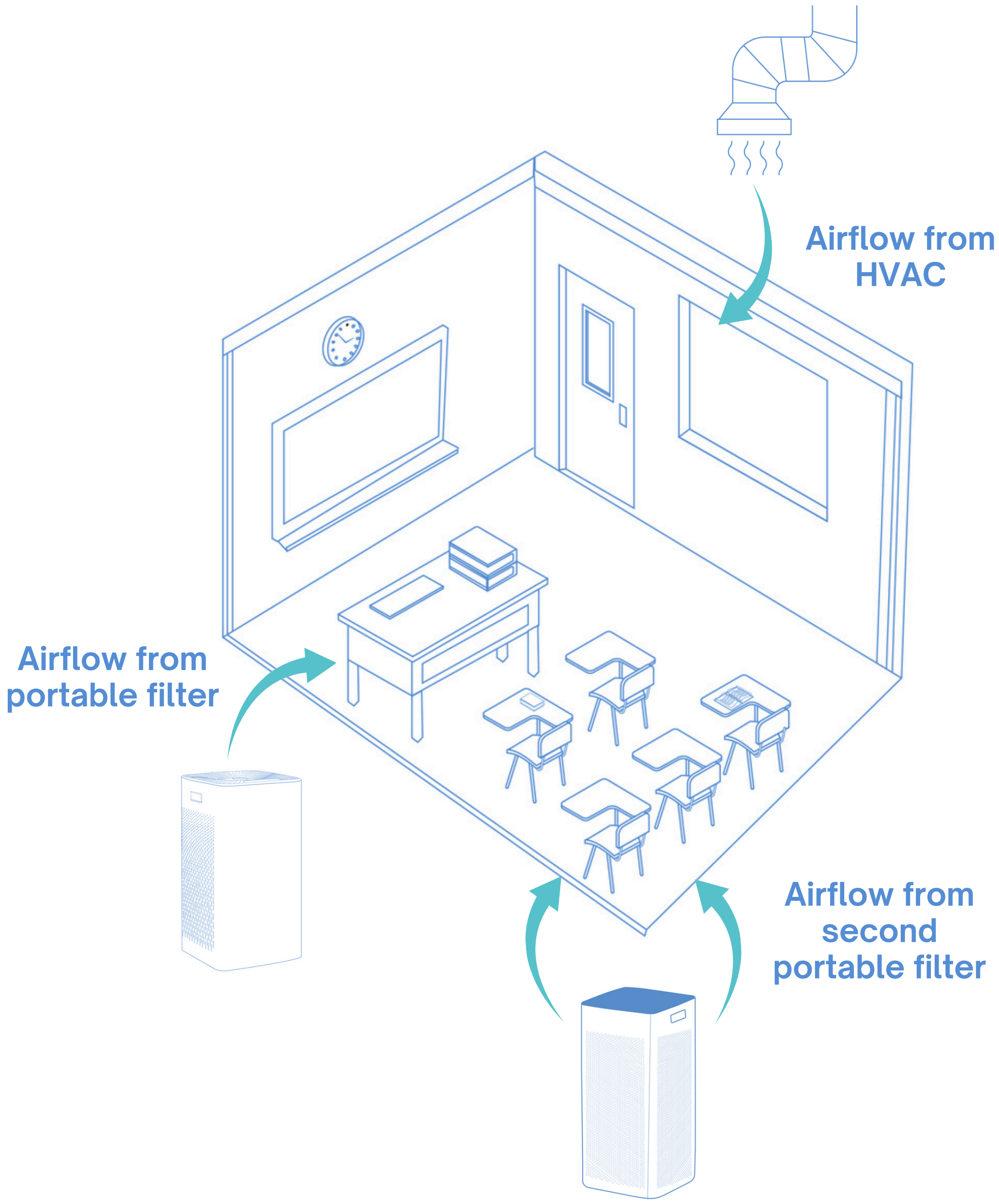
+

Air changes per hour from a second air purifier

=

More total air changes per hour

Large rooms in PPS, like band, choir, dance, and weight rooms, were originally assigned two air purifiers, but generally still need more. Larger spaces need a third unit to get above or closer to clean air targets.



One air purifier set at its highest fan speed is too noisy for classrooms

Two air purifiers set at medium speeds deliver a lot of clean air while being quiet

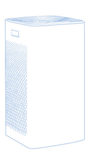
Studies and experts agree: multiple air purifiers are key to quiet clean air

Two or more air purifiers in one room can dramatically improve air quality and reduce harmful exposures, without causing the disruptive noise levels that one unit running at full speed does.[98] Experts consistently recommend using more than one unit in order to achieve effective air cleaning at quiet operation.[98,99] Studies[89,100] and online indoor air quality tools[98] also show that multiple air purifiers can get a room to clean airflow targets and do so while running at quiet settings.

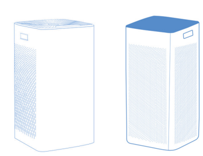
A CDC study found that two HEPA air cleaners positioned strategically in a room were able to reduce aerosol exposure by up to 65%.[100] CDC findings also underscored that multiple air purifiers helps clean the air near people who may be coughing, sneezing, or talking in different parts of the room. Similarly, the Healthy Buildings program at Harvard's T.H. Chan School of Public Health emphasizes that multiple units allow classrooms to meet air change rate goals, while also ensuring more uniform distribution of clean air.[101] Using multiple units helps to distribute filtered air more evenly throughout a room, addressing areas with poor circulation and improving overall filtration efficiency.

The California Department of Public Health,[102] as well as experts from the Corsi-Rosenthal Foundation,[99] Patient Knowhow,[103] Clean Air Stars,[98] and Indoor Air Care Advocates[104] also all recommend using multiple air purifiers in classrooms and other spaces to effectively clean the air while avoiding the noise generated by running a single purifier at full capacity. Multiple units per classroom or other learning space help schools to meet airflow and clean air delivery rate targets without sacrificing quiet — the combination of more airflow and low noise is especially valuable when quieter settings are important.

One vs. two district air purifiers in McDaniel (and most other high school classrooms)



One Medify MA-112 air purifier		Two Medify MA-112's*
Top speed (speed 4)	Mid speed (speed 2)	Mid speed (speed 2)
559 cubic feet of clean air per minute	**281** cubic feet of clean air per minute	**668** cubic feet of clean air per minute
57 decibels	**41** decibels	**44** decibels
✓ Great air cleaning ✗ Too noisy	✗ Insufficient air cleaning ✓ Quiet	✓ Great air cleaning ✓ Quiet



*One regular MA-112 and one MA-112 Pro

Meets EPA & Center for Green Schools noise recommendations

At the top speed that provides a good level of air cleaning, the original air purifier most spaces at McDaniel have from the district is too loud (57 dB) and far above recommendations for decibel levels in classrooms (EPA: 45 dB,[105] Center for Green Schools: 35 to 45 / 50 dB).[106] At mid speed 2, the one air purifier is quiet but provides insufficient clean air for most spaces. Two district air purifiers per room can give McDaniel's classrooms and other spaces quiet clean air.

Airflow add-ons

Open windows & doors
=
An essential way to boost air changes per hour when possible*

Bonus options

Air changes per hour from HVAC and air purifiers

+

Air changes per hour from open windows / exterior doors

=

*More total air changes per hour**

*For some indoor air quality pollutants and risks but not others

Examples

✓ Respiratory aerosols

Open windows and open exterior doors prevent spread of viruses

✗ Wildfire smoke

Windows and exterior doors must be closed during wildfires

✓ Carbon dioxide

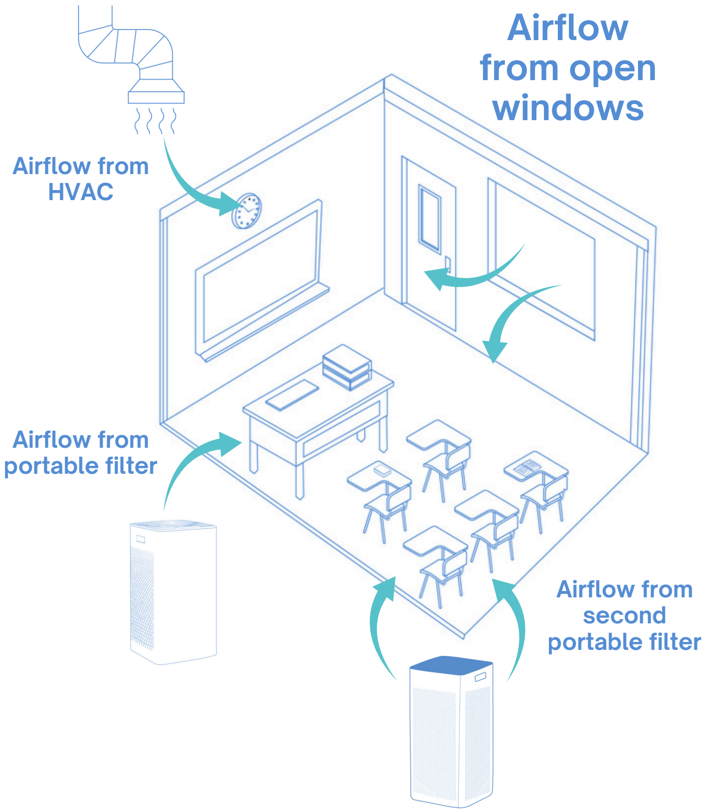
Outdoor air from windows and doors reduces potential cognitive effects of carbon dioxide

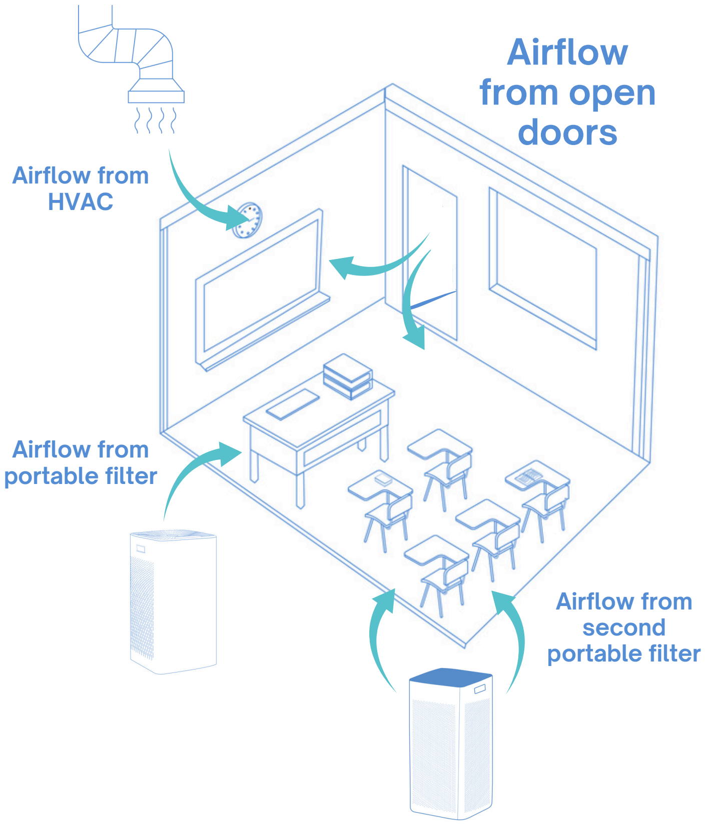
✗ Cold

Windows and outside doors bring in unconditioned cold air in winter

Open interior doors may not add airflow that we add to air change calculations, but they can help clear out viruses, CO_2, and other pollutants. Opening doors - when it is allowed* - can assist with air movement through poorly ventilated rooms.

*Note: Other safety issues generally need doors to be closed (e.g., security, fire safety).





Operable windows are essential

- Staff must be able to open windows for bonus and emergency airflow
- Open windows boost air changes per hour for preventing virus transmission
- Windows can be opened even while air purifiers are running
- Operable windows are critical when HVAC systems break down
- But airflow to a room should not rely on open windows — except during HVAC emergencies

Opening windows has many benefits. Airflow through windows boosts air changes per hour for clearing out respiratory aerosols, viruses, bacteria, carbon dioxide, and other indoor air pollutants that are generated indoors.

Open windows also work alongside air purifiers. For sneezes, coughs, and any viruses hitching a ride on students' breath, outdoor air through windows adds on to the clean air from air purifiers and the HVAC.

HVAC systems break down — especially in PPS, where we face $1 billion dollars in deferred maintenance,[107] and staff have had poor experiences with HVAC issues not being fixed for months to years. Operable windows are like fire escapes: critical pieces of safety infrastructure.

But as important and beneficial as operable windows are, they can't always be open. Wildfire smoke, freeway pollution, noise from outside, and pollen allergies are examples of reasons a teacher may need to close their windows. Students and teachers still need a baseline of at least 6, and ideally closer to 12, air changes per hour even when windows must be closed.

Energy recovery ventilation is an alternative and cost-effective tool

PPS has deviated from the Education Specifications[108] on operable windows, most notably in Lincoln High School — perhaps for good reason. Lincoln sits atop a freeway, and PPS has important energy efficiency goals from its Climate Crisis Response Policy.[109]

Energy recovery ventilation (ERV) systems deserve consideration for both of these reasons. ERVs remove stale indoor air, and bring in fresh outdoor air, without requiring the full level of heating, cooling, and humidity control that outdoor air moving through traditional HVAC systems need.[110] Outdoor air enters the room or building via a heat exchanger, which captures heat and moisture as stale air is exhausted from the building. ERVs save energy and improve ventilation.

PPS needs to build new buildings with windows that can open

Operable windows are critical tools for air quality and airflow. While there may be reasonable design considerations for limiting them in some modernized buildings, schools need the flexibility to bring in additional airflow and address indoor environmental challenges using every tool available. Windows that can open are a key tool and must be part of that strategy.

Learn more about Energy Recovery Ventilation basics: tinyurl.com/Cimbala-ERV

District Indoor Air Quality Tests

Overview of PPS's Methods and Results for IAQ Reports

PPS contracted with PBS Engineering & Environmental for indoor air quality testing.

PBS

April 29, 2021

Joe Crelier, Director–Risk Management
Portland Public Schools
501 N Dixon Street
Portland, Oregon

Via email: jcrelier@pps.net

Regarding: COVID Response Indoor Air Quality Testing Report
Vestal Elementary School
161 NE 82nd Avenue
Portland, Oregon
PBS Project 25000.138

Dear Mr. Crelier:

On April 16, 2021, PBS Engineering and Environmental Inc. (PBS) performed indoor air quality testing in Vestal Elementary School located at the address above. These services were provided to Portland Public Schools (District) to measure air quality parameters before schools and district-owned buildings are opened again for reoccupancy.

As part of these indoor air quality testing services, PBS measured carbon monoxide (CO), carbon dioxide (CO_2), temperature in degrees Fahrenheit (°F), relative humidity (%RH), and airborne particulate (PM2.5 and PM10). Additionally, PBS reviewed and inventoried accessible components of the test rooms' heating, ventilation, and air conditioning (HVAC) systems

Based on PBS' findings, three rooms tested above the recommended range for indoor temperatures. PBS observed rooms with open windows throughout the school which likely led to the increased temperature readings. Additionally, seven rooms in the investigation tested above the recommended ambient airborne particulate concentrations; however, when compared to the ambient outdoor concentrations these results do not present an actionable condition. The results of the testing and assessment indicates that indoor air quality in the building is good and that the building is acceptable for occupancy.

While PBS observed no measurable indoor air quality concerns in any of the rooms that were tested, PBS did not test every occupiable room in each building. This investigation has been performed in concert with a concerted effort on the part of the District to perform regular inspections and repair of all HVAC mechanical systems throughout the District. Additionally, it is the District's policy that rooms without adequate ventilation will not be utilized moving forward.

VENTILATION PARAMETERS AND AIRBORNE PARTICULATE MONITORING

PBS took spot measurements of ventilation parameters in approximately 20% of the classrooms, offices, and common areas in the building (or each building). The readings were compared to recommendations in the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62.1-2016, Ventilation for Acceptable Indoor Air Quality.

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One single reading of each parameter was taken — in only 20% of the school's rooms.

McDaniel was not measured.

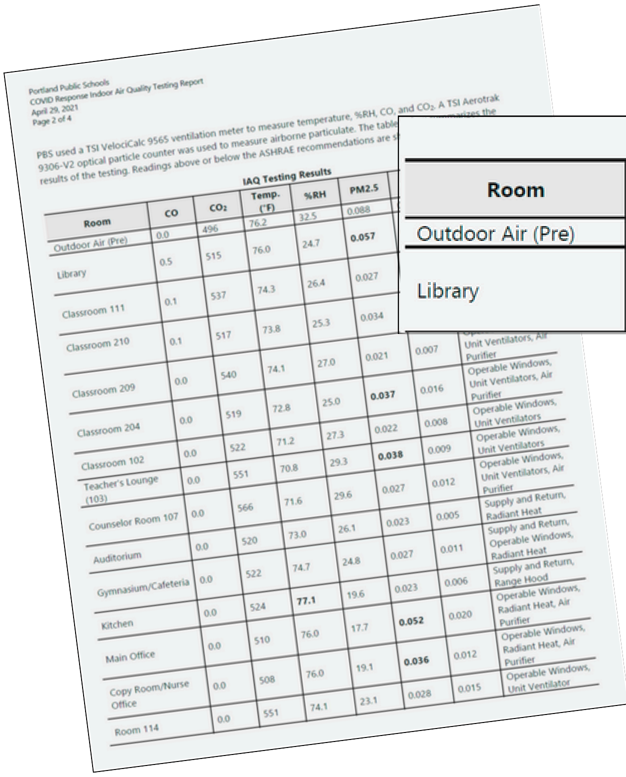
The IAQ readings for McDaniel were taken at the Marshall campus, before the remodeled McDaniel campus opened.

This is the IAQ report for Vestal Elementary, another school on 82nd Avenue.

The reports state that these readings were done before classrooms and other school spaces were occupied.

7 rooms were above the contractor's lenient criteria for flagging carcinogenic fine particulate matter.

Yet the report concluded that there were "no measurable indoor air quality concerns."



Portland Public Schools
COVID Response Indoor Air Quality Testing Report
April 29, 2021
Page 2 of 4

PBS used a TSI VelociCalc 9565 ventilation meter to measure temperature, %RH, CO, and CO_2. A TSI Aerotrak 9306-V2 optical particle counter was used to measure airborne particulate. The table [illegible] summarizes the results of the testing. Readings above or below the ASHRAE recommendations are [illegible]

IAQ Testing Results

Room	CO	CO_2	Temp. (°F)	%RH	PM2.5	PM10	HVAC
Outdoor Air (Pre)	0.0	496	76.2	32.5	0.088	[illegible]	[illegible]
Library	0.5	515	76.0	24.7	**0.057**	[illegible]	[illegible]
Classroom 111	0.1	537	74.3	26.4	0.027	[illegible]	[illegible]
Classroom 210	0.1	517	73.8	25.3	0.034	[illegible]	[illegible]
Classroom 209	0.0	540	74.1	27.0	0.021	0.007	[illegible] Unit Ventilators, Air Purifier
Classroom 204	0.0	519	72.8	25.0	**0.037**	0.016	Operable Windows, Unit Ventilators, Air Purifier
Classroom 102	0.0	522	71.2	27.3	0.022	0.008	Operable Windows, Unit Ventilators
Teacher's Lounge (103)	0.0	551	70.8	29.3	**0.038**	0.009	Operable Windows, Unit Ventilators
Counselor Room 107	0.0	566	71.6	29.6	0.027	0.012	Operable Windows, Unit Ventilators, Air Purifier
Auditorium	0.0	520	73.0	26.1	0.023	0.005	Supply and Return, Radiant Heat
Gymnasium/Cafeteria	0.0	522	74.7	24.8	0.027	0.011	Supply and Return, Operable Windows, Radiant Heat
Kitchen	0.0	524	**77.1**	19.6	0.023	0.006	Supply and Return, Range Hood
Main Office	0.0	510	76.0	17.7	**0.052**	0.020	Operable Windows, Radiant Heat, Air Purifier
Copy Room/Nurse Office	0.0	508	76.0	19.1	**0.036**	0.012	Operable Windows, Radiant Heat, Air Purifier
Room 114	0.0	551	74.1	23.1	0.028	0.015	Operable Windows, Unit Ventilator

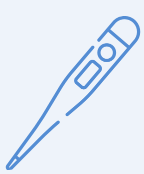
IAQ Testing Results

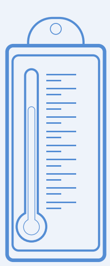
Room	CO	CO_2	Temp. (°F)	%RH	PM2.5	PM10	HVAC
Outdoor Air (Pre)	0.0	496	76.2	32.5	0.088	0.036	N/A
Library	0.5	515	76.0	24.7	**0.057**	0.021	Operable Windows, Unit Ventilators, Air Purifier

Example:

$PM_{2.5}$ was high in the library but hand-waved away as not "actionable" even though air purifiers will filter out such particulate pollutants.

Would you conclude that your temperature is fine today because you had one normal reading on your thermometer four years ago?





That is often how the district uses these nearly useless results — even though a single reading is not a valid way to measure any of the parameters spot-checked in these IAQ tests.

The frequent declarations in memos, internal emails, and media statements that "All PPS schools have healthy air quality" or that "Indoor air quality is good at all PPS schools"[111] are based on these tests.

Yet these tests frequently show unhealthy levels of fine particulate matter, and one single reading can not be used to make conclusions of healthy air in PPS classrooms.

IAQ Testing Results						
Room	**CO**	**CO_2**	**Temp. (°F)**	**%RH**	**PM2.5**	**PM10**
Outdoor Air (Pre)	0.0	496	76.2	32.5	0.088	0.036
Library	0.5	515	76.0	24.7	**0.057**	0.021
Classroom 111	0.1	537	74.3	26.4	0.027	0.011
Classroom 210	0.1	517	73.8	25.3	0.034	0.012
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Counselor Room 107	0.0	566	71.6	29.6	0.027	0.012
Auditorium	0.0	520	73.0	26.1	0.023	0.005
Gymnasium/Cafeteria	0.0	522	74.7	24.8	0.027	0.011
Kitchen	0.0	524	**77.1**	19.6	0.023	0.006
Main Office	0.0	510	76.0	17.7	**0.052**	0.020
Copy Room/Nurse Office	0.0	508	76.0	19.1	**0.036**	0.012
Room 114	0.0	551	74.1	23.1	0.028	0.015
Room 115	0.0	538	73.3	25.2	0.006	0.002
Assistant Principal	0.0	526	73.9	25.0	0.025	0.006
Counseling 208	0.0	546	74.2	24.7	0.028	0.011
Outdoors (Post/Pre)	0.0	486	76.1	17.2	0.114	0.060
East Portable	0.0	508	**77.2**	19.6	**0.044**	0.013
Center Portable (YMCA)	0.0	527	**77.6**	19.7	**0.055**	0.018
West Portable	0.0	500	74.7	21.1	**0.051**	0.019
Outdoors (Post)	0.0	489	79.9	14.7	0.084	0.039

PM readings were reported in milligrams per cubic meter, even though standards and guidelines are in micrograms per cubic meter. Multiply these values by 1000 to get the right values for comparison.

Air pollutants in District IAQ Reports

CO = carbon monoxide

Classrooms should have a carbon monoxide detector, not a fleeting one-time reading

In the subset of rooms that got a reading in the 82nd Avenue school, carbon monoxide was either not detected or was well below any level of concern.

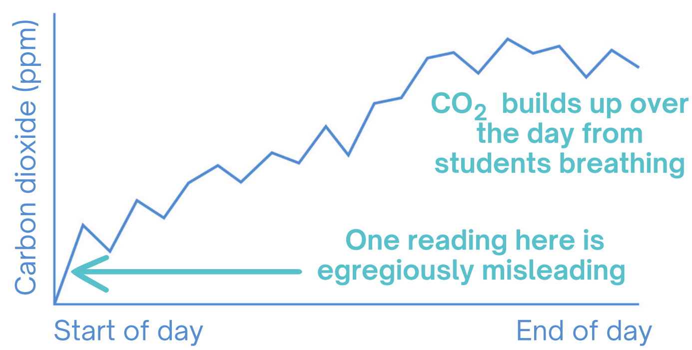
But these single carbon monoxide readings are like installing a smoke alarm and then immediately taking the battery out and leaving it out for years. Best practice is for schools to have carbon monoxide detectors or equivalent continuous monitors, just like in our homes.

Bottom line, these single carbon monoxide values tell us no useful information about air quality in these rooms.

CO_2 = carbon dioxide

One carbon dioxide reading in each room is grossly deficient and misleading.

CO_2 should be measured over multiple full school days in fully occupied classrooms. CO_2 builds up in classrooms over the course of the school day, generally reaching its highest levels at the end of the day. Ideally, CO_2 would be monitored continuously with permanent in-room sensors.



$PM_{2.5}$ = fine particulate matter & PM_{10} = coarse particulate matter

Unhealthy levels of $PM_{2.5}$ were ignored and dismissed

Seven $PM_{2.5}$ readings at the 82nd Avenue school were above the permissive criteria PBS chose to compare to (EPA's short-term limit for outdoor air, 35 micrograms per cubic meter). However, EPA does not provide numeric guidelines or standards for fine particulates in indoor air. The World Health Organization (WHO) does,[54] and 19 out of 20 readings were above WHO's short-term (24-hour) limit of 15 micrograms per cubic meter, while all 20 readings were above WHO's annual limit of 5 micrograms per cubic meter.

Allowing carcinogenic $PM_{2.5}$ to infiltrate and be generated inside PPS buildings, without deploying sufficient air purifiers to filter it out to below the WHO's indoor air quality guidelines is a measurable indoor air quality concern, readily apparent even in these woefully inadequate spot checks.

What did these spot checks honestly show? School closures did not worsen air quality during hybrid, but classroom air needs action

The district's original goal for these IAQ tests was to conduct spot checks before students returned to hybrid learning, after schools were unoccupied for approximately one year during distance learning.

The utility of spot checks for that purpose is highly questionable. However, had these readings been used with the intended goal in clear focus, the data collection and use would have been very different than it has been. First, the majority of the parameters should have been measured before teachers and students returned to hybrid classes, but in most cases, the readings were actually done after hybrid learning started. Second, the data's use should have been strictly limited to providing a tentative indication that no new, immediate, large, unexpected health threats had arisen due to the prolonged building closures. Instead, the district, with the contractor's encouragement, has frequently made claims about "safe" and "healthy"[111,112] air quality that cannot be made based on spot readings. In fact, the spot checks reveal unhealthy levels of fine particulate matter. The $PM_{2.5}$ readings actually indicate that, without additional filtration, students and staff are exposed to high levels of fine particulate matter known to cause health impacts such as asthma, asthma attacks, lung cancer, and cardiovascular and respiratory disease.[54]

Temperature & humidity monitoring has improved, but gaps remain

Thanks to a historic teachers' strike, there is greater awareness of four key air quality issues in PPS: excessive heat, excessive cold, the need to monitor heat index (temperature and humidity), and mold. These are issues teachers see and feel day in and day out. In the years leading up to the strike, teachers consistently identified extreme heat and cold as unsafe, took measurements of these conditions, and brought their findings to board meetings and district leadership. The Portland Association of Teachers' focus on their working conditions being the same as students' (and their galvanizing chant: hot cold rats mold, this is getting really old), also brought visceral understanding to many Portlanders. Teachers won new contract language that holds the district accountable for unsafe temperatures during heat waves and cold winter conditions. Now each building has equipment to sample the heat index during heat waves. This is a great step, but there is still much room for improvement in collecting and managing thermal air quality data. For example, the new HVAC system at McDaniel has the capacity to collect room-by-room temperature and humidity, but the monitors were off during the fall 2024 heat wave and likely remain so as we face continued extreme heat waves.

Room	CO	CO_2	Temp. (°F)	%RH	PM2.5	PM10
Room 115	0.0	538	73.3	25.2	[illegible]	0.002
Assistant Principal	0.0	526	73.9	25.0	[illegible]	0.006
Counseling 208	0.0	546	74.2	24.7	[illegible]	0.011
Outdoors (Post/Pre)	0.0	[illegible]	76.1	17.2	[illegible]	0.060
East Portable	0.0	[illegible]	**77.2**	19.6	[illegible]	0.013
[illegible] (YMCA)	0.0	527	**77.6**	19.7	[illegible]	0.018
West Portable	0.0	500	74.7	21.1	**0.051**	0.019
Outdoors (Post)	0.0	489	[illegible]	14.7	0.084	0.039

Hot cold rats mold, one temperature reading from 4 years ago is really old

PPS needs to leave most of these IAQ test data in the past

The CO, CO_2, temperature, and humidity readings in these reports have no current relevance or utility. The only real value in the IAQ reports is highlighting another major air quality problem: high $PM_{2.5}$ levels that are best addressed with multiple air purifiers per classroom and other spaces where airflow is low. $PM_{2.5}$ readings in these tests are often above the WHO's authoritative limit of 5 micrograms $PM_{2.5}$ per cubic meter. Most PPS classrooms, as well as other spaces, need at least two in-room filters.

PPS's air quality work has cycled between excellent & unacceptable

Examples of air quality excellence from PPS

- ✓ Forward-thinking room-by-room airflow reports
- ✓ Airflow measurements included nearly all staff spaces —from the largest gyms to the smallest school offices
- ✓ A demonstrated commitment to transparency and data sharing: IAQ and airflow reports proactively posted online
- ✓ Quick work to get all rooms outfitted with an air purifier before return to in-person learning
- ✓ Upgrading all buildings to MERV 13 furnace filters
- ✓ PPS takes radon and asbestos work seriously
- ✓ Facilities staff's informal CO_2 goal results in attention and action when high levels are noticed

Examples of deficiencies in air quality work

- ✗ CO_2 monitors generally not calibrated correctly
- ✗ Failures and errors in airflow reports' QA and not recognizing or using the airflow reports' excellent detailed data beyond a "generalized sense" of schools' airflows
- ✗ Not recognizing hidden ionizer defaulting to on
- ✗ *Oregonian* reporting on airflow problems, as well as concerns from scientists and parents, met with denial, disdain, and minimization[113]
- ✗ Misinformation and spin in memos
- ✗ Failure to accurately identify which schools have lower airflows than others
- ✗ Deeply flawed analysis underpinning second air purifier distribution

An important example of unacceptable missteps and inaction following promises to increase filtration capacity

In spring 2023, PPS took an important step toward improving student and staff health. The district ordered 3,500 free air purifiers from an Oregon Health Authority program, funded by the CDC. The program's purpose was advance public health by cleaning classroom air, a critical need highlighted by the White House Summit on Indoor Air Quality[75] for schools across the nation.

This action followed mounting pressure: media coverage of poor airflows, warnings from authoritative local and national experts that PPS was falling short of critical airflow benchmarks, parent advocacy for additional air filtration capacity in PPS schools, and stated commitments from the district to strive to meet recommended air changes per hour. The district obtained enough free units for a second air purifier in all 2,800 classrooms in PPS at the time, with 700 additional units left over for non-classroom spaces needing more air cleaning as well. An email to the entire district, "Our Continuing Commitment to Air Quality," announced that each classroom would have two air purifiers, as well as a five-year supply of replacement filters for both the new and existing units.

From: **Dan Jung, Jonathan Garcia, and Dr. Jon Franco** <ppscomms@pps.net>
Date: Tue, May 2, 2023 at 11:31 AM
Subject: Our Continuing Commitment to Air Quality

PORTLAND
Public Schools

Español | Tiếng Việt | 中文 | Русский | Soomaali

Our Continuing Commitment to Air Quality

May 2, 2023

Dear Portland Public School families,

We strive to ensure that all or your student's learning spaces are inspiring, joyful, and safe. Air quality is one element of school safety, and we provided an update in October about how we maximize the air quality in our schools. This includes:

- Following the consensus advice of public health experts
- Meeting public health authority regulations
- Partnering with PBS Engineering and Environmental, one of the Northwest's top environmental engineering firms
- Continuous review and improvement with PBS, public health experts, and our community

Over the last week, our commitment to continuous review was on display as multiple PPS offices came together to review our systems. Our review aimed to take advantage of an Oregon Health Authority program to grow our inventory of filters and air purifiers at no cost to the district. Our teams took feedback from our schools, central operations, and community members, and placed an order for 3,500 new air purifiers. We also anticipate getting a five-year supply of filters for those 3,500 purifiers – AND nearly all of our existing 5464 purifiers.

As a result, we anticipate each PPS classroom will have two air purifiers sharing the work to cleanse the air and boost the number of air changes per hour. This is a crucial part of our layered-mitigation strategy:

See: safeaioregon.org/may-2023-email

After receiving the 3,500 new air purifiers in summer 2023, a major opportunity to fulfill its public commitment to cleaner classroom air, the district failed to follow through. Instead of delivering the promised second air purifier to every classroom regardless of their air changes per hour, as well as to additional spaces that fall short of the minimum healthy airflow target of 6 air changes per hour, the district kept McDaniel's air purifiers in storage along with the second units intended for seven of its ten cluster schools' as well. Thousands more of the air purifiers intended for schools all over the district were held back instead of being put to use in classrooms.

The plan to store thousands of units, instead of delivering them to all PPS schools as promised, was quietly sent to principals through an emailed summer memo. Despite media coverage and parent advocacy alerting the district to McDaniel's low airflow rates, this 82nd corridor school went without these resources because the district's memo claimed that McDaniel's average airflow in classrooms exceeded 6 air changes per hour. The same was true for 67 more PPS schools: units were not delivered because the memo claimed these schools' classrooms had average air change rates above 6. However, this decision was based on flawed data and analyses detailed in the next several pages.

Misinformation memos with errors in analyses and planning

PORTLAND PUBLIC SCHOOLS
501 North Dixon Street
Portland, OR 97227
(503) 916-2000

Memo – Air Purifier Distribution Plan

To: Principals

Date: August 31, 2023

The District has begun to receive the 3,500 Medify air purifiers and a five-year supply of filter replacements from the Oregon Health Authority (OHA). These Medify air purifiers will be distributed to 28 of our schools with classrooms that are on the lower end of our *air changes per hour* (ACH) measurements. Additional units can be provided upon request to all schools.

All PPS schools already have healthy air quality
Air quality in all PPS schools is safe. We follow consensus advice of public health experts to meet all indoor air quality regulations. PPS also partners with top air quality experts to ensure we meet industry best practices. In 2021, an independent consulting firm, PBS Engineering and Environmental completed air quality assessments at all PPS schools and determined indoor air quality is good at all PPS schools. Copies of these reports can be found on the Environmental Health & Safety website.

Airflow is one component of indoor air quality
One component of indoor air quality is airflow, often measured as **Air Changes per Hour (ACH)**. Airflow changes throughout the day and is based on a number of variables. Please note - there is no common standard for how to measure airflow. To gather airflow information about each PPS school, the district partnered with Ameresco to complete *one point in time testing* during the 2021 and 2022 school year. This information gives us a generalized sense of which schools have generally higher ACH and which ones are lower. These ACH reports can be found on the Environmental Health & Safety website.

The District is providing additional air purifiers to specific school classrooms
While there is no standard for airflow in schools, the Oregon Health Authority recommends 3 to 6 air changes per hour. Currently all PPS classrooms are supplied with one portable air purifier. Our review of the ACH data shows that at 68 schools, classrooms average more than 6 ACH (when the portable air purifier is turned on) while 28 schools' classrooms fall below that average. We are providing one additional unit for each classroom in those 28 schools with the understanding some schools or spaces may also want additional airflow.

safeairoregon.org/flawed-distribution-plan

The summer 2023 memo is one example of misinformation in PPS's air quality memos.

This memo — like others from the district — presents flawed analyses, as well as misleading and misinformed claims. It also reneged on the promise to distribute the new air purifiers to all schools.

The district has made many strides toward improving air quality. But the air purifier distribution memo is a key example of ongoing errors in air quality management. It was quietly sent to principals a few months after promising board members, as well as the entire PPS community, two air purifiers per classroom. The memo breaks that promise, using unacceptable misinformation, poor planning, and inappropriate and inaccurate calculations. These errors highlight areas where learning and improvement at the district level are imperative. With a commitment to learning, accuracy, and collaboration, district staff and SIAFOS supporters can work together to fix these mistakes and build a more effective distribution plan.

Here is a sampling of what this memo gets wrong and where PPS can learn from mistakes to make positive changes moving forward:

- Claimed to identify 28 schools on the lower end of airflows, but the analysis done used inappropriate methods and was carried out incorrectly. This memo did not actually identify the schools with the lowest average air changes per hour.
- Used an inappropriate averaging method that hides low-airflow rooms. Taking an average of classroom airflows is a fundamentally flawed approach to determining clean air infrastructure distribution. Even if calculated correctly, it would still be unsound, for example, by leaving Ms. Smith and her class with less than 3 air changes just because Mr. Jones enjoys 9 air changes.

Flawed second air purifier delivery plan based on flawed analyses

- Declared "healthy" and "safe" air quality based on IAQ reports that cannot be used to make such conclusions and, in fact, indicate the opposite unhealthy levels of particulate matter in many rooms. (See pages 30-33 for detailed issues with the IAQ reports)
- Made statements that the district meets all indoor air quality regulations without disclosing that few exist — and those that do are completely inadequate to the task of protecting health. For example, there are no regulations from EPA for indoor air, and that includes for carcinogenic and cardiotoxic $PM_{2.5}$. In contrast, WHO seeks for all buildings everywhere to meet a $PM_{2.5}$ limit of 5 microg/cubic meter, based on in-depth review and analyses of health impacts. But WHO's limit is not a regulatory standard and is given no consideration if PPS is simply meeting regulations.
- Downplayed the importance of airflow — a fundamental determinant of indoor air quality — with statements such as "Airflow is one component of indoor air quality," while also making misleading statements about standards for measuring airflow and how variable airflow is or isn't. The airflows were measured using the leading standard approach from the National Environmental Balancing Bureau, and HVAC airflows are not that variable over time relative to their typical values in PPS classrooms, while airflows from air purifiers are known quantities.
- Framed air quality as "good" based on flawed one-point-in time IAQ tests, while dismissing the comprehensive airflow data by describing the airflows as "one point in time testing." Determining airflows once every 5 years is valid industry best practice[114] because HVAC airflows are relatively stable parameters. In contrast, the IAQ tests were also one point in time testing of highly variable parameters, for which one reading is nearly useless and far from best practice for sampling and monitoring. In addition, only 20% of the rooms got one of these flawed IAQ tests to begin with.
- Produced grossly incorrect averages of classroom air changes for at least 63 of 68 buildings, resulting in schools not receiving second air purifiers even by the flawed averaging approach.
- Buried the offer to request the second units deep within a memo full of falsehoods and spin. For the 68 schools that were not delivered their second units by default, the memo downplayed those schools' very real need for additional filtration capacity and cleaner air.
- Signaled a resistance to in-room filtration as key to school modernization and climate goals. Statements that filters might be removed after modernization fails to recognize that in-room particle filtration is the way of the future for energy-efficient clean air. What the district should look at in the coming years, and engage with SIAFOS on, are more convenient and classroom-friendly solutions for aerosol and particle filtration right in the classroom.

PPS needs help fixing its air purifier distribution plan

Regardless of the cause of the inaccuracies, the district needs to fix its mistakes on air quality and airflow, and correct errors and misconceptions promulgated by this plan. SIAFOS and partners are ready to help with a better air purifier distribution strategy that re-commits to two air purifiers per classroom as a core approach to clean air for student and staff heath, safety, performance, and learning.

Example errors from a McDaniel feeder school: Vernon K-8

Classroom 106A:
A particularly egregious and obvious error in district-calculated air changes that inflated the classroom average

FALSE

For Room 106A in Vernon K-8 School, the district airflow report gives a room area of 23 square feet and a room volume of 278 cubic feet. These dimensions are grossly incorrect and do not match the measured room length (28.4 feet) multiplied by width (21.9 feet), which calculates out to 622 square feet in area, not 28 square feet.

Air changes per hour are calculated by multiplying cubic feet per minute of air supplied to a room multiplied by 60 (to convert from minutes to hours), and then dividing by room volume. This gives the number of times per hour a volume of clean air equivalent to the room's volume "pours" into the room. As a result, the large error in room volume led to a large overestimate of air changes per hour.

Classroom	District report air changes with one air purifier has one classroom grossly incorrect	Corrected air changes per hour at full speed (Rm 106A + MERV 13 effects fixed)	Realistic air changes at the fan speed with a reasonable noise level
First floor			
Rm 116	1.8	2.0	1.7
Rm 117	2.4	2.6	1.9
Rm 115	2.7	2.9	2.3
Rm 114	2.0	2.3	1.8
Rm 113	3.0	3.3	2.5
Rm 112	2.7	2.9	2.2
Rm 107	3.0	3.3	2.6
Rm 106A	72.2	3.4	2.6
Rm 106	3.2	3.5	2.7
Rm 109	3.4	3.9	3.1
Rm 108	3.2	3.6	2.9
Rm 103	3.5	3.9	3.3
Rm 102	2.1	2.4	1.9
Rm 101	2.0	2.3	1.7
Rm 301	7.2	9.4	8.7
Rm 302	6.7	8.8	8.1
Rm 303	1.4	1.4	0.9
Rm 304	1.4	1.4	0.9
Second floor			
Rm 215	3.9	4.5	3.9
Rm 213	2.7	3.0	2.3
Rm 214	2.3	2.5	1.9
Rm 212	2.6	2.8	2.1
Rm 209	2.8	3.1	2.4
Rm 207	3.1	3.5	2.8
Rm 206	2.7	3.0	2.4
Rm 208	2.9	3.2	2.6
Rm 203	2.4	2.6	2.0
Rm 202	2.7	3.2	2.6
Rm 201	4.1	5.3	4.7
Average	**5.4**	**3.4**	**2.8**

FALSE

UNREALISTIC

The error in Room 106A contributes to, but does not fully explain, the district's false claim that average classroom airflow at Vernon exceeds 6 air changes per hour

Airflow reports included storage rooms and other small spaces misidentified as having a purifier and that students also do not go in. Based on patterns seen across 49 schools, it appears that the district averaged all airflows in the report, not just classrooms, so the district's average included these other types of inaccurate numbers.

Correct but unrealistic average classroom airflow with one air purifier at full speed is *not* >6

Correct full-speed airflow estimates for Vernon fix the error in Room 106A and account for the upgrade to MERV 13 furnace filters.

Correct and realistic average classroom airflow at Vernon is even lower

Vernon's true average is only 2.8, but the district claimed it was >6 and thus did not deliver its air purifiers until SIAFOS assisted Vernon parents.

Example errors from a McDaniel feeder school: Faubion PK-8

These full speed numbers are unrealistic and impossible to sustain in real classrooms

IMPOSSIBLE

Faubion is another school where the memo's claim that average classroom airflow is >6 is false. It's also another example of how errors in room dimensions can inflate airflows and averages. At Faubion, four non-classroom spaces have errors, such as the staggering 120 air changes per hour claimed for Room 183R, due to the report's erroneous room width of 2 feet. Note that non-classroom 183R is not shown here in our list of classrooms only.

Similar to Vernon, the true average at Faubion indicates the district averaged all airflow values in the reports, not just classrooms. The reports include small rooms that students do not spend time in and that do not actually have the air purifiers the reports claim they do.

Faubion School was also completely re-built in 2016 — with poor ventilation!

31 out of 48 classrooms at Faubion do not even get 3 air changes per hour from the HVAC. The same firm that designed Faubion with such poor airflows is managing the designs of the next round of modernizations as well — making a commitment to 6 air changes per hour for new buildings' HVAC systems all the more urgent.

Watch a full video about the Faubion report errors and next steps for better air quality at Faubion at: safeairoregon.org/faubion-video

*District and SIAFOS full-speed calculations are in good agreement at Faubion. However, to SIAFOS's knowledge, Intellipure has not done gold-standard tests of clean air delivery rate (ANSI/AHAM AC-1), nor have they done any tests at half speed. Our estimates for half speed are based on Intellipure's guidance, but actual CADRs, at half speed, are likely lower.

Classroom	District report air changes at full speed*	Realistic air changes at a reasonable noise level
Rm 188	5.7	4.9
Rm 186	5.3	4.6
Rm 184	5.5	4.7
Rm 181	6.6	6.0
Rm 149	4.7	4.2
Rm 147	4.7	4.0
Rm 145	5.2	4.6
Rm 143	3.7	3.1
Rm 141	2.9	2.3
Rm 115	2.6	2.3
Rm 117	3.1	2.6
Rm 119	2.7	2.2
Rm 122	4.7	4.6
Rm 201	4.2	3.8
Rm 203	3.7	3.4
Rm 205	2.2	1.9
Rm 209	3.3	2.8
Rm 211	3.9	3.4
Rm 213	4.6	4.1
Rm 215	4.5	4.0
Rm 217	4.7	4.2
Rm 219	4.0	3.5
Rm 221	3.5	3.0
Rm 222	3.9	3.3
Rm 223	3.7	3.2
Rm 225	3.7	3.2
Rm 227	3.3	2.8
Rm 229	3.9	3.4
Rm 231	3.6	3.0
Rm 301	3.9	3.7
Rm 303	0.8	0.7
Rm 309	4.5	4.0
Rm 311	5.3	4.8
Rm 313	3.3	2.8
Rm 315	4.2	3.8
Rm 317	2.7	2.3
Rm 319	4.0	3.5
Rm 321	3.4	3.0
Rm 323	3.3	2.8
Rm 325	3.5	3.0
Rm 327	3.8	3.3
Rm 329	3.7	3.3
Rm 331	2.8	2.4
Average	**3.9**	**3.4**

IMPOSSIBLE

The district did not calculate a correct classroom average even at the unrealistic full speed fan setting. The corrected (but still unachievable) full-speed average for Faubion classrooms is only 3.9. Faubion's classrooms do not average >6 as the district claimed in its memo.

Example of errors in classroom averages from McDaniel

The district report calculated air changes per hour with the air purifier at full speed incorrectly (see page 17 for details)

Calculated ACH			
Air Changes per Hour (OA)	# of Portable Filters	Total Effective Air Changes per Hour (ACH_e) with Portable Filter	Total Effective Air Changes per Hour (ACH_e) without Portable Filter
0.8	1	64.4	3.1
0.7	[illegible]	61.1	2.9
[illegible]	[illegible]	32.6	5.3
[illegible]	[illegible]	36.9	5.5
[illegible]	[illegible]	11.5	2.7
[illegible]	1	10.2	4.4
2.8	1	10.1	4.3

FALSE

An accurate and realistic average for rooms that are labelled as classrooms on the McDaniel airflow map is only 5 air changes, not above 6 as claimed in the air purifier distribution memo. Using a more liberal definition of classrooms increases the average slightly but it is still under 6.

This listing of labeled classrooms also illustrates that relying on an average obscures rooms that fall below the minimum benchmark. In addition, an averaging approach fails to recognize the benefits of going above 6 air changes. At 6 air changes, it still takes 23 minutes to clear out 90% of airborne particles from sneezes and coughs. At 12 air changes, they clear out much faster — it's only 12 minutes to clear 90%.

*If the room has a less effective Intellipure air purifier instead of a Medify MA-112, its air changes are even lower than given here.

To SIAFOS's knowledge, there is no inventory of air purifiers at McDaniel to identify which rooms have which models.

Classroom	District report air changes with the air purifier are calculated incorrectly	Actual air changes per hour at full speed are lower than PPS reported	Realistic air changes at the fan speed with a reasonable noise level, if the room has a Medify*
Level 0			
Rm 047	11.2	8.6	6.7
Rm 043	10.3	7.5	5.6
Rm 041	10.4	7.6	5.6
Rm 039	10.4	7.7	5.7
Rm 037	10.8	7.9	5.9
Rm 015	11.5	7.9	5.3
Rm 013A	10.2	7.8	6.1
Rm 013B	10.1	7.7	6
Level 1			
Rm 181	10.1	7.5	5.5
Rm 183	10.3	7.5	5.6
Rm 185	10.3	7.6	5.7
Rm 187	10.3	7.6	5.7
Rm 189	10.3	7.6	5.6
Rm 122	9.4	6.8	5.1
Rm 120	10.0	7.4	5.5
Rm 117	9.9	7.5	5.8
Rm 115	10.2	7.8	6.0
Rm 113	8.5	6.5	5.0
Level 2			
Rm 281	9.6	6.7	4.6
Rm 283	9.9	6.9	4.7
Rm 284	8.4	5.8	4.0
Rm 285	9.9	6.9	4.8
Rm 286	8.9	6.2	4.3
Rm 287	9.8	6.8	4.7
Rm 289	10.0	7.0	4.8
Rm 290	9.2	6.4	4.4
Rm 292	9.3	6.4	4.7
Rm 247	8.6	5.8	3.9
Rm 242	8.3	5.7	3.9
Rm 243	9.6	6.7	4.7
Rm 240	8.4	5.8	4.0
Rm 241	9.6	6.7	4.7
Rm 238	8.4	5.9	4.0
Rm 239	9.6	6.7	4.7
Rm 236	9.3	6.6	4.7
Rm 234	9.6	6.7	4.6
Rm 231	9.7	6.7	4.6
Rm 220	8.6	6.0	4.2
Rm 218	8.7	6.0	4.1
Rm 217	8.7	6.2	4.4
Rm 2[illegible]	8.5	5.9	4.1
Average	**9.6**	**6.9**	**5.0**

FALSE

IMPOSSIBLE

FALSE

UNREALISTIC

Check some of our numbers yourself!

- Download district reports from the PPS website at tinyurl.com/airflowreports
- Match the numbers in our first column colored in **navy blue** against the numbers in the district report under the column "Total Effective Air Changes per Hour (ACH_e) without Portable Filter"
- Check which rooms are classrooms vs. non-classrooms, using the maps at the end of each report
- Look for errors we identified such as Room 106A at Vernon falsely claiming 72.2 air changes per hour
- Calculate air changes using equations from pages 18, 19 and 22 (also see page 3 of the district reports)

Getting ventilation, air filtration, and air quality right is critical

Addressing ventilation and air quality in our schools is critical to providing a healthy learning environment to students and a healthy working environment to staff. While there have been unfortunate errors in the handling of air quality data and air purifier deployment, these issues can be corrected. With continued collaboration and a commitment to clear, science-based strategies, the district can make the improvements necessary to meeting clean airflow targets.

Many of the district's errors stemmed from understandable concerns: juggling many priorities, managing complex data sets, and navigating challenges raised by media coverage. However, there is a clear path forward to remedy these missteps and put a proactive plan in place, to truly address the clean air needs of students and staff, both in the McDaniel cluster and across the whole district.

McDaniel needs its second air purifiers out of storage and into classrooms and other learning spaces — so do many other schools

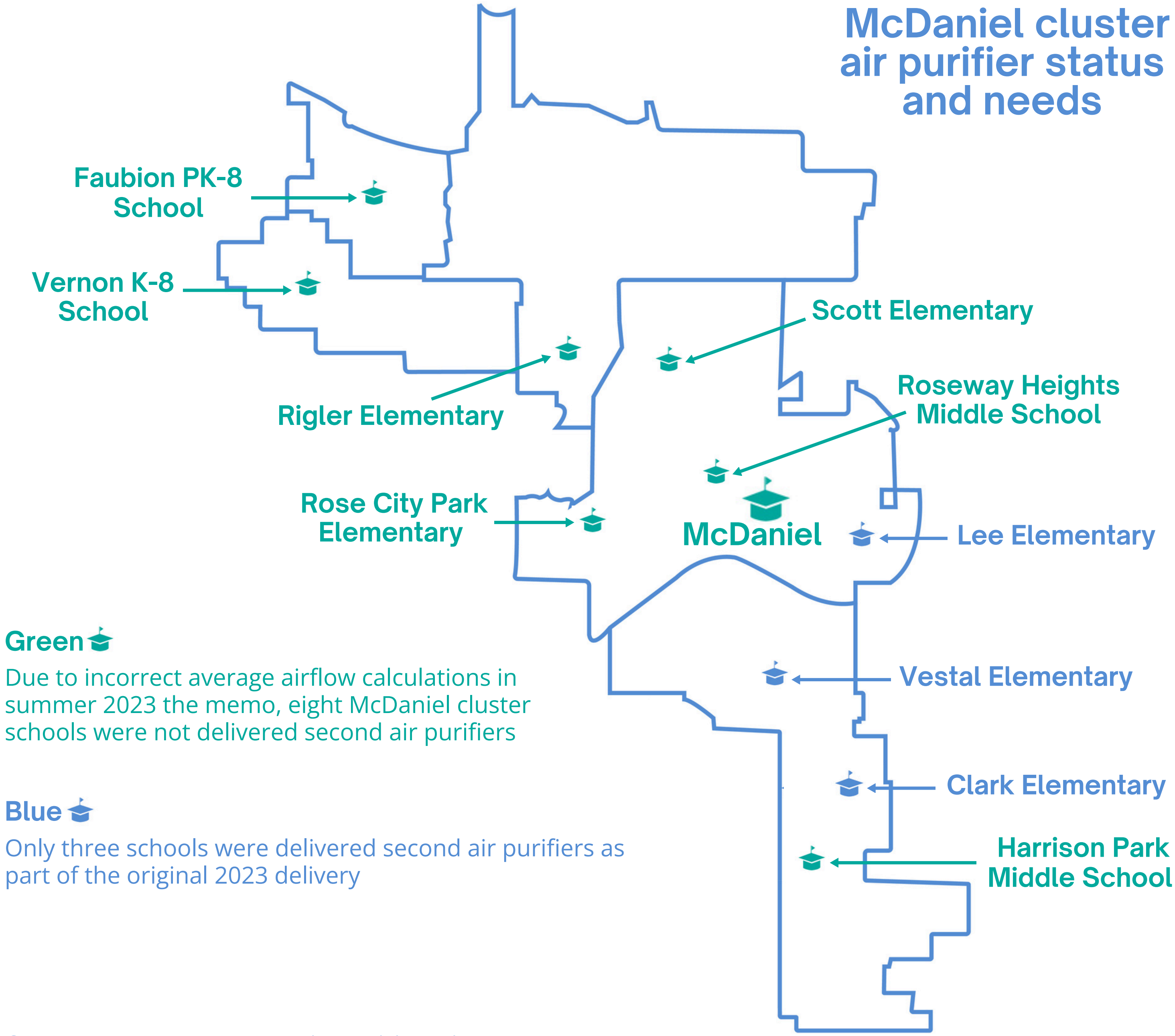
The storage of McDaniel's second air purifiers, along with units intended for other PPS schools, has left resources meant to improve classroom health and safety sitting unused, when they could be making a meaningful difference to health and learning. The second air purifiers should be in classrooms and other school spaces, not in storage.

Distributing and using this clean air infrastructure needs action at all levels, from district leadership to the classroom. A proactive plan for clean air must recognize the key role of teachers, principals, and staff. In-school staff need clear information about the benefits of additional air purifiers and which spaces need multiple units to meet targets, so they can make informed decisions about their use. They must also be equipped with information they need to confidently operate both units — students, staff, and schools benefit when staff run their units daily at quiet speeds to ensure clean airflow. Students can be engaged as well, participating in operations as simple as turning on units to their quiet yet effective settings. By embracing accurate science and correcting errors in communications and plans, the district can work with the community to lead this change, and empower staff to be active participants in creating healthier classrooms.

PPS needs help leading on air purifier deployment, management, and operation

The district needs a better air purifier distribution plan that re-commits to two air purifiers per classroom as key to clean air for student learning, staff performance, and overall health. Principals and teachers need clear, actionable guidance like turning on both units at quiet settings to achieve safe and healthy air. SIAFOS members are ready to offer our experience helping staff become clean air aware and effectively use multiple units.

McDaniel cluster air purifier status and needs



Status and needs for air purifiers in feeder schools

To the best of SIAFOS's knowledge as of report production

Clark Elementary School

- ✓ On original second air purifier delivery list for classrooms only
- ⚠ Current status of air purifiers: Unknown, but classrooms should have two each
- ✓ Two air purifiers per classroom needed to meet or approach clean airflow targets
- ⚠ Non-classrooms known to need two air purifiers: Main office, library, cafeteria, kitchen
- ⚠ # of non-classrooms SIAFOS needs more information to assess air purifier needs: 14
- ✗ Second air purifiers delivered for non-classrooms: None

Faubion PK-8 School

- ✗ Excluded from original second air purifier delivery list despite extremely poor ventilation
- ✗ Status of air purifiers: Lacking second air purifiers
- ✓ Two air purifiers per classroom needed to meet or get closer to clean airflow targets: 43 classrooms
- ⚠ Non-classrooms known to need two air purifiers: Main office, library, cafeteria, teacher's lounge
- ⚠ # of non-classrooms SIAFOS needs more information to assess air purifier needs: 72
- ✗ Second air purifiers delivered for classrooms and non-classrooms: None

Lee Elementary School

- ✓ On original second air purifier delivery list for classrooms only
- ⚠ Current status of air purifiers: Unknown, but classrooms should have two each
- ✓ Two air purifiers per classroom needed to meet or get closer to clean airflow targets
- ⚠ Non-classrooms known to need two air purifiers: Main office, library, cafeteria, kitchen
- ⚠ # of non-classrooms SIAFOS needs more information to assess air purifier needs: 11
- ✗ Second air purifiers delivered for non-classrooms: None

Rigler Elementary School

- ✗ Excluded from original second air purifier delivery list despite extremely poor ventilation
- ✗ Status of air purifiers: Unknown
- ✓ Two air purifiers per classroom needed to meet or get closer to clean airflow targets: 30 classrooms
- ⚠ Non-classrooms known to need two air purifiers: Auditorium, main office, library, kitchen
- ⚠ # of non-classrooms SIAFOS needs more information to assess air purifier needs: 10
- ✗ Second air purifiers delivered for classrooms and non-classrooms: Unknown

Rose City Park Elementary School

- ✗ Excluded from original second air purifier delivery list despite poor ventilation
- ⚠ Status of air purifiers: Has at least some second air purifiers
- ✓ Two air purifiers per classroom needed to meet or get closer to clean airflow targets: 27 classrooms
- ⚠ Non-classrooms known to need two air purifiers: Auditorium, library, cafeteria, kitchen
- ⚠ # of non-classrooms SIAFOS needs more information to assess air purifier needs: 10
- ✗ Second air purifiers delivered for classrooms and non-classrooms: Some but exact number unknown

Roseway Heights Middle School

- ✗ Excluded from original second air purifier delivery list despite poor ventilation
- ✗ Status of air purifiers: Lacking second air purifiers
- ✓ Two air purifiers needed to meet or get closer to clean airflow targets in most classrooms: 39 classrooms
- ⚠ Non-classrooms known to need two air purifiers: Auditorium, library
- ⚠ # of non-classrooms SIAFOS needs more information to assess air purifier needs: 28
- ✗ Second air purifiers delivered for classrooms and non-classrooms: None

Scott Elementary School

- ✗ Excluded from original second air purifier delivery list despite poor ventilation
- ✗ Status of air purifiers: Lacking second air purifiers
- ✓ Two air purifiers per classroom needed to meet or approach clean airflow targets: 29 classrooms
- ⚠ Non-classrooms known to need two air purifiers: Auditorium, library, cafeteria, kitchen
- ⚠ # of non-classrooms SIAFOS needs more information to assess air purifier needs: 15
- ✗ Second air purifiers delivered for classrooms and non-classrooms: None

Vernon K-8 School

- ✗ Excluded from original second air purifier delivery list despite extremely poor ventilation
- ✗ Status of air purifiers: Requested second air purifiers but swapped units out instead of adding units
- ✓ Two air purifiers per classroom needed to meet or get closer to clean airflow targets: 29 classrooms
- ⚠ Non-classrooms known to need two air purifiers: Auditorium, main office, cafeteria + 16 more rooms
- ⚠ # of non-classrooms SIAFOS needs more information to assess air purifier needs: 4
- ✗ Second air purifiers delivered for classrooms and non-classrooms: 48

Vestal Elementary School

- ✓ On original second air purifier delivery list for classrooms only
- ✓ Current status of air purifiers: Two units per classroom
- ✓ Two air purifiers per classroom needed to meet or get closer to clean airflow targets
- ⚠ Non-classrooms known to need two air purifiers: Auditorium, main office, library, cafeteria
- ⚠ # of non-classrooms SIAFOS needs more information to assess air purifier needs: 8
- ✗ Second air purifiers delivered for non-classrooms: None

Harrison Park
See highlight starting on the next page for details

Harrison Park Middle School: New HVAC needs a new airflow report

Over the past decade, PPS's use of bond funds has largely focused on the critically important work of rebuilding high schools. But in 2020, PPS's bond also provided $75 million for equally crucial work on HVAC systems at elementary and middle schools. Harrison Park, newly renovated as one of McDaniel's feeder middle schools, is one of four elementary and middle schools undergoing HVAC system overhauls with 2020 bond funds. These HVAC overhauls are not only an important step toward replacing HVAC systems from across the district that are far past their lifespan, but also a start on addressing kindergarten through 8th grade rooms that lack the ability to maintain safe temperatures due to climate change. According to the district, these upgrades are also a step toward improving poor ventilation in PPS.

However, Harrison Park's overhauled HVAC system lacks airflow measurements. The only available report is on the old system. With no updated report, we cannot verify whether the school's ventilation rates have actually improved or see how they compare to health-based goals. This lack of measurements is especially concerning given the district's history of poor airflows at other modernized schools — including McDaniel High School completed only one year before renovations at Harrison Park began.

PPS needs to complete an airflow report for Harrison Park

The district needs to re-measure airflows at Harrison Park. The existing airflow report is no longer valid for rooms where the HVAC upgrades are complete. New measurements are needed to inform air quality management in this new middle school.

The mistaken assumption that HVAC overhauls fix everything: Why Harrison Park's airflows are likely still far below health targets

There is a common, albeit understandable, misconception that HVAC overhauls in PPS automatically result in great air quality. However, Harrison Park and other schools that have been modernized or are undergoing HVAC overhauls since McDaniel's opening likely have similarly low rates of clean airflow.

One of the root causes of poor air quality in PPS buildings is the building code itself. Building codes are typically based on minimum ventilation rates from ASHRAE, whose main ventilation standard — Standard 62.1[114] — is widely known, and directly states, that the standard does not take the most fundamental health-based air quality needs of building occupants into account.[4,115] Dr. Richard Corsi and his colleagues, in a Lancet Task Force report, described this major ventilation standard as not designed for minimizing disease, instead focused primarily on "comfort" and "minimally acceptable" indoor air quality.[4] This lack of focus on occupant health is also a key reason why Dr. Joseph Allen of Harvard's Healthy Buildings program describes the last four-plus decades as the "era of sick buildings."[116]

In Oregon, the building code is even weaker. A provision in the Oregon Mechanical Code effectively allows building designers to provide only half of the outdoor airflow considered minimally acceptable under Standard 62.1.[117] As a result, new HVAC systems in PPS are at risk of being even less effective at delivering healthy indoor air than the also too-low ventilation required by Standard 62.1.

McDaniel has poor ventilation rates, despite being fully remodeled in the middle of a pandemic that has highlighted how poor ventilation rates make our school buildings perfect habitats for viruses, instead of healthy habitats for staff and students. Relying on our building codes for airflow requirements is the major driver behind this outcome for McDaniel — because our building codes for ventilation are not health-based. Only needing to meet as little as half of the already insufficient ASHRAE 62.1 standard also helps explain the especially poor ventilation rates at Faubion PK-8 school, the other fully modernized school in the McDaniel cluster where we have an airflow report. Outside the cluster, Rosa Parks Elementary School, built in 2006, and Roosevelt High School, modernized in 2018, are other new or modernized buildings with airflow reports showing particularly poor airflows as well (see p. 133-134).

You can't manage airflows you don't measure

Even with new HVAC systems, we lack verification of how the system is performing unless airflows are tested through a publicly available commissioning, TAB, or airflow report. Without measurements, we lack the ability to identify ventilation deficiencies that need to be addressed. In construction, commissioning ensures that systems meet standards before final approval and occupancy, and this same principle should apply to airflow testing in schools. Without a full and accurate airflow report, we have no clear picture of how much or how little clean air the HVAC overhaul at Harrison Park, or at any other school, is providing.

Harrison Park Middle School

- ✗ Excluded from original second air purifier delivery list despite having some of the worst ventilation in the district prior to the HVAC overhaul, and current ventilation rates unknown as the overhaul nears completion
- ✗ Status of air purifiers: Lacking second air purifiers
- ⚠ Two air purifiers per classroom needed unless an airflow report verifies excellent airflows and that one air purifier achieves closer to 12 air changes: 37 classrooms
- ⚠ Non-classrooms needing two air purifiers: Library, cafeteria
- ⚠ # of non-classrooms SIAFOS needs more information to assess air purifier needs: 39
- ✗ Second air purifiers delivered for classrooms and non-classrooms: None

Room-by-Room

AIR QUALITY PROFILES

Transparency at the room level: Air Quality Profiles for McDaniel

Achieving clean indoor air requires understanding ventilation and filtration at the level that matters most: the individual rooms where students and staff spend their days. While district reports include airflow data for most rooms in McDaniel High School and other schools, critical gaps and errors in analysis as well as communication have left staff and families without a clear picture of air quality in specific spaces. This report's Air Quality Profiles address those gaps for McDaniel with a detailed assessment in each room. This transparent, data-driven view of how air circulates in classrooms, science labs, performing arts spaces, and other key areas of McDaniel High School identifies where airflow falls short of health targets — and how much it improves with one or two air purifiers.

Each full Air Quality Profile includes:

- ✓ Room identity (room number and type)
- ✓ The SIAFOS Clean Air Score, a letter grade based on air changes per hour without air purifiers*
- ✓ How long aerosols linger in the room if no air purifiers are used
- ✓ Air changes per hour in three** scenarios:
  HVAC system only
  HVAC system + one Medify air purifier at speed 2
  HVAC system + two Medify air purifiers at speed 2
- ✓ How long it takes to clear out 90% of aerosols and other indoor air pollutants in each scenario
- ✓ Upgraded letter grades for air quality with one and two air purifiers*
- ✓ Impact of MERV 13 filter installation in the HVAC system on airflow, showing whether they improved or had little or no effect on air changes per hour
- ✓ Final assessment of aerosol clearance, emphasizing the impact of using two air purifiers

This print report contains Room-by-Room Air Quality Profiles for a subset of rooms and grade summaries of remaining rooms. All Room-by-Room Air Quality Profiles at McDaniel are available at: safeairoregon.org/mcdaniel-profiles

By breaking down air quality room by room, this report not only provides McDaniel staff and families with accurate information but also underscores a larger issue: schools may assume their air quality is sufficient when many spaces may in fact fall short of health-based ventilation and filtration targets.

**See page 24 for details on SIAFOS Clean Air Scores. Note that we use air changes per hour to refer to effective air changes per hour throughout the report, including in Room-by-Room Air Quality Profiles. See pp. 22-24 for more on air changes and terminology.*
***Grades for two air purifiers are not provided in profiles of small rooms where one unit would provide excellent clean airflow.*

The following pages present Room-by-Room Air Quality Profiles that detail McDaniel's low ventilation rates and the clean airflows that could be achieved.

These profiles correct gaps and errors in PPS's reporting of airflow data for McDaniel and highlight opportunities to create healthier classrooms.

By analyzing airflow data for every measured room at McDaniel, this report and our online supplement aim to improve conditions at McDaniel while also illustrating broader challenges and opportunities across the district.

Correcting errors and filling gaps in McDaniel airflow data

The original airflow data provided by the district contained significant miscalculations, incorrect assumptions, and missing information that obscured the true ventilation conditions at McDaniel. The Room-by-Room Air Quality Profiles correct these errors to provide an accurate picture of baseline ventilation rates from the HVAC and the clean airflows that are achievable using air purifiers.

Key issues that were identified and fixed:

✓ **Fixed** ⟶ **Incorrect unit conversions**

The district's airflow reports included an error in units of measurement, leading to incorrect calculations of air changes per hour with one regular Medify air purifier in the room. As a result, airflow with the air purifier running was significantly overstated in every room. The Room-by-Room Air Quality Profiles use correct units in all calculations.
See pages 16-19 and 42 for more information about this error in district calculations

✓ **Fixed** ⟶ **Failure to account for realistic conditions**

The district's estimates did not account for the fan speed that staff can actually use on their regular Medify air purifier. Given noise guidelines for healthy learning environments and feedback from many teachers, airflow calculations must use speeds that the particular room can handle. The Room-by-Room Air Quality Profiles address this by calculating air changes per hour using the quiet, realistic fan speed setting on the Medify units: speed 2.
See pages 16-19 and 42 for more information about this gap in district calculations

✓ **Fixed** ⟶ **MERV 13 filter impact misrepresented**

MERV 13 filters are critical for improving air quality. They are particularly important for capturing outdoor air pollutants at the HVAC intake of outdoor air, before that outdoor air reaches indoor spaces. It was an important step forward when the district upgraded all schools to these more effective filters.

However, district memos, infographics, and staff presentations assumed that the district-wide MERV 13 filter upgrade had a much greater impact on airflow and filtration inside of PPS buildings than they did. In many cases, the data show that the MERV 13's had little or no effect on rooms' extremely low air changes per hour. The Room-by-Room Air Quality Profiles show how much or how little MERV 13 filters impacted clean airflow in McDaniel.

✓ **Fixed** ⟶ **Lack of airflow projections with additional air purifiers**

The district's analysis did not include calculations of the impact of second air purifiers. The Room-by-Room Air Quality Profiles present clear data showing how much airflow improvement is achievable with two of the air purifier models owned by the district.

✓ **Fixed** ⟶ **No assessment of aerosol clearance times**

The Room-by-Room Air Quality Profiles add critical context by calculating how long it takes to clear most aerosol particles from a room under the room's different achievable clean airflow conditions. These clearance times give staff a practical understanding of air quality risks and opportunities in each room detailed in these profiles.

Addressing these gaps and errors provides a more accurate and actionable understanding of McDaniel's indoor air quality. Room-by-Room Air Quality Profiles can also empower staff and decision-makers to take informed steps towards improving air quality, not only at McDaniel, but across all PPS schools.

Air Quality Profiles — Room type sections at a glance

The following pages contain detailed air quality profiles for nearly every room at McDaniel High School. To help readers navigate the data, profiles are grouped by room type.

Sections in this part of the report are:

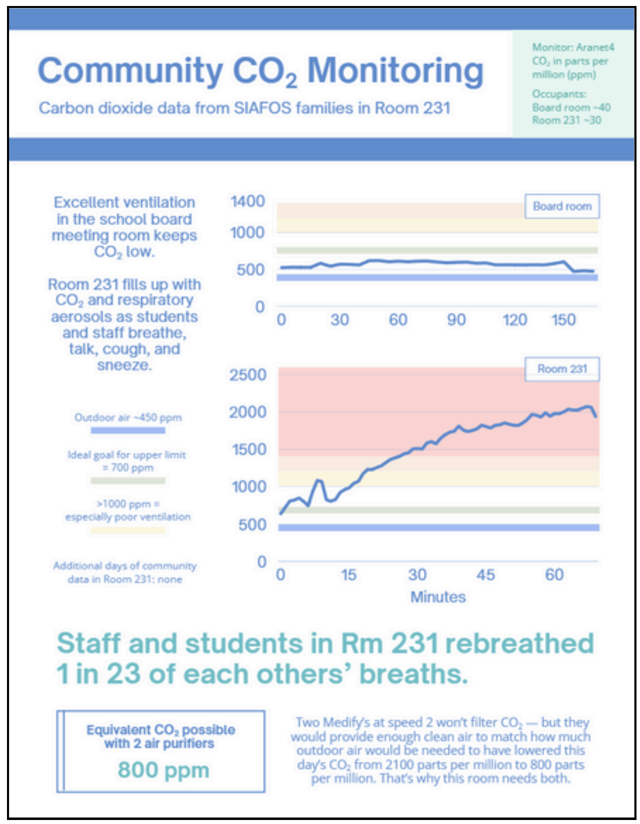
- Classrooms: General education classrooms across all floors of McDaniel
- Common Spaces: Large shared spaces where students gather
- CTE Rooms: Art, computer science, engineering, and other career technical education classrooms
- Health & Daycare: Student health center rooms, nurse's office, and daycare spaces
- Performing Arts: Choir room, band room, black box theater, and more
- Physical Education: Gyms, weight rooms, locker rooms, and adjacent spaces
- School Offices: Main office, counseling offices, teacher collaboration offices, etc.
- Science Labs: Chemistry, biology, and other specialized lab spaces
- Special Education: Learning Resource Center rooms, Intensive Skills rooms, sensory rooms, etc.

Community CO_2 Data in the Profiles

For some rooms at McDaniel, we have community-collected carbon dioxide (CO_2) readings from families who support SIAFOS. Families used Aranet4 carbon dioxide monitors, which are highly reliable* and widely recommended by indoor air quality specialists for trustworthy readings and ease of use.

Room profiles that include CO_2 data are:

- First floor classrooms 113, 115, 122, and 187
- Second floor classrooms 220 and 231
- Common and athletic spaces: Library 129, Commons 196, Main Gym G200



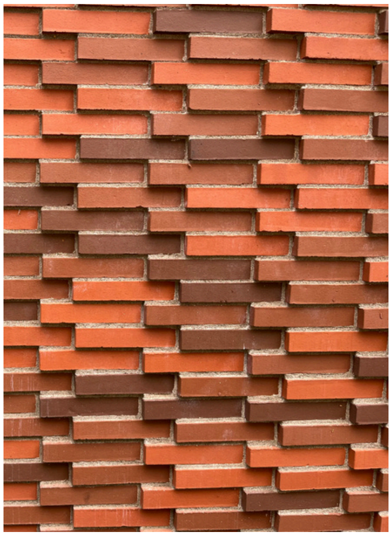
Each Community CO_2 Monitoring supplement provides:

✓ Community-collected CO_2 data from a typical school board meeting. This allows a visual comparison of patterns in a space with excellent ventilation (board room) vs. the student-facing space in McDaniel.

✓ A graph of community-collected CO_2 data from the McDaniel room, with context markers (outdoor air, ideal limit, levels indicating poor ventilation). These data provide a direct window into what students and staff actually experience day-to-day. They also complement ventilation and clean airflow findings based on the district airflow reports. Observations of high CO_2 show that McDaniel rooms do not get enough fresh outdoor air.

✓ The room's equivalent CO_2 if two air purifiers are run at our recommended levels. Equivalent CO_2 helps to put the clean air provided by purifiers in terms that are often more familiar to facilities staff and families alike. This metric helps translate clean air from filtration into the same "ppm" units commonly used to judge ventilation, allowing filtration's benefits to be more easily understood.

**For CO_2 up to 5000ppm, Aranet4 monitors accuracy is within 30 ppm + 3% of reading. Each monitor in use was also reading at expected values when outdoors (~420 to 450 ppm).*



Ground Floor

McDaniel High School

CLASSROOMS

Room-by-Room Air Quality Profiles

McDaniel High School

Room 015

Wrap-Around Classroom

Aerosols linger for over 51 minutes if no air purifier is run.

No air purifier

HVAC system only

2.7 air changes per hour

=

51 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

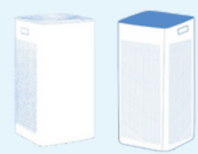
5.3 air changes per hour

=

26 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

8.9 air changes per hour

=

16 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

C A+

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.17

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow marginally from 2.5 to 2.7

With two air purifiers, most aerosols will clear out in only 16 minutes.

McDaniel High School

Room 037

Regular Classroom

CLASSROOMS

Aerosols linger for over 36 minutes if no air purifier is run.

No air purifier

HVAC system only

3.8 air changes per hour

=

36 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

5.9 air changes per hour

=

24 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers

Add Medify & Medify Pro at speed 2

8.7 air changes per hour

=

16 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

B-   A+

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.43

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 3.4 to 3.8

With two air purifiers, most aerosols will clear out in only 16 minutes.

MCDANIEL HIGH SCHOOL

CLASSROOMS

McDaniel High School

Room 039

Regular Classroom

Aerosols linger for over 38 minutes if no air purifier is run.

No air purifier

HVAC system only

3.7 air changes per hour

=

38 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

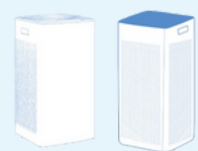
5.7 air changes per hour

=

24 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

8.5 air changes per hour

=

16 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

B-

A+

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.47

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 3.2 to 3.7

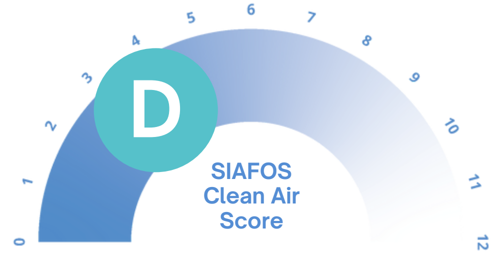
With two air purifiers, most aerosols will clear out in only 16 minutes.

MCDANIEL HIGH SCHOOL

McDaniel High School

Room 041

Regular Classroom



Aerosols linger for over 38 minutes if no air purifier is run.

No air purifier

HVAC system only

3.6 air changes per hour

=

38 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

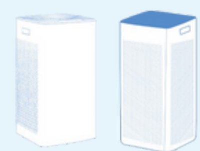
5.6 air changes per hour

=

25 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

8.3 air changes per hour

=

17 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.48

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 3.2 to 3.6

B-

A+

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 17 minutes.

McDaniel High School

Additional Ground Floor Classroom Profiles Available Online

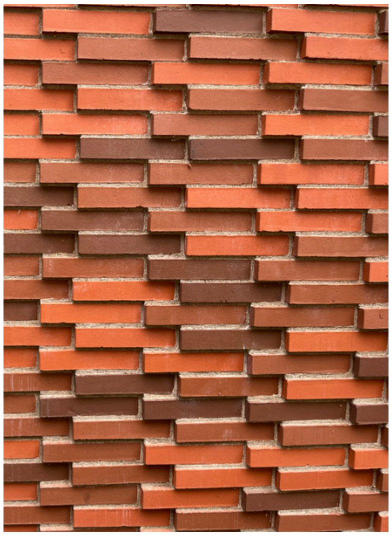
Room	No air purifier	HVAC + one air purifier	HVAC + two air purifiers
013A	D+	B	A+
013B	D+	B	A+
043	D	B-	A+
047	C-	B+	A+

Grades possible with consistent use of air purifiers

Small room instruction 045	No air purifier	HVAC + one air purifier
	A	A+

Full Room-by-Room Air Quality Profiles at

safeairoregon.org/mcdaniel-profiles



First Floor

McDaniel High School

CLASSROOMS

Room-by-Room Air Quality Profiles

McDaniel High School

Room 113

Regular Classroom

Aerosols linger for over 39 minutes if no air purifier is run.

No air purifier

HVAC system only

3.6 air changes per hour

=

39 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

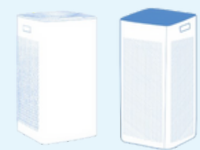
5.0 air changes per hour

=

27 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

7.0 air changes per hour

=

20 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

C

A+

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.65

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 2.9 to 3.6

With two air purifiers, most aerosols will clear out in only 20 minutes.

Community CO_2 Monitoring

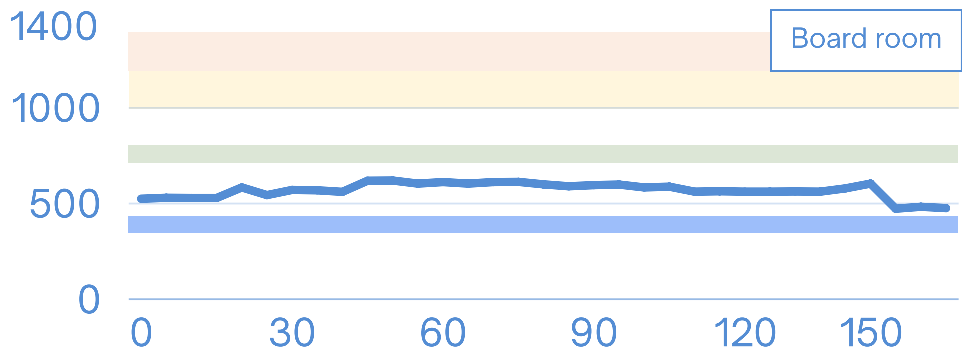
Carbon dioxide data from SIAFOS families in Room 113

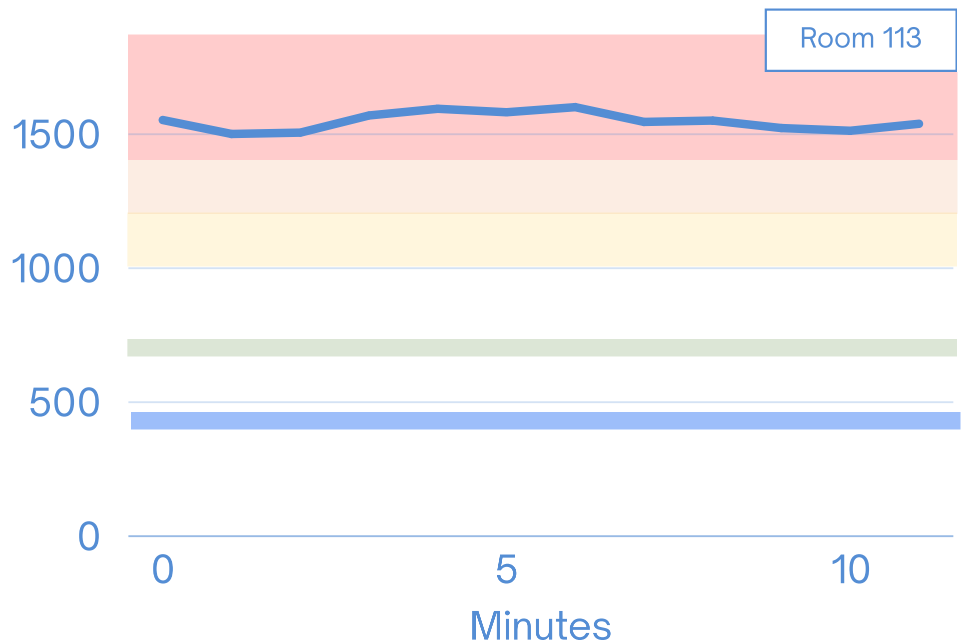
Monitor: Aranet4
CO_2 in parts per million (ppm)

Occupants:
Board room ~40
Room 113 ~42

Excellent ventilation in the school board meeting room keeps CO_2 low.

Room 113 fills up with CO_2 and respiratory aerosols as students and staff breathe, talk, cough, and sneeze.





Outdoor air ~450 ppm

Ideal goal for upper limit = 700 ppm

>1000 ppm = especially poor ventilation

Additional days of community data in Room 113: none

CO_2 was 2.6x higher than in the board room, with ~the same number of people.

Equivalent CO_2 possible with 2 air purifiers

795 ppm

Two Medify's at speed 2 won't filter CO_2 — but together with the room's MERV 13 filters, they would provide enough clean air to match how much outdoor air would be needed to have lowered this day's CO_2 from 1601 ppm to 795 ppm. That's why this room needs two air purifiers.

McDaniel High School

Room 115

Regular Classroom

Aerosols linger for over 32 minutes if no air purifier is run.

No air purifier

HVAC system only

4.3 air changes per hour

=

32 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

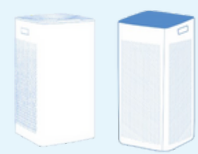
6.0 air changes per hour

=

23 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

8.4 air changes per hour

=

16 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.77

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 3.5 to 4.3

B

A+

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 16 minutes.

Community CO_2 Monitoring

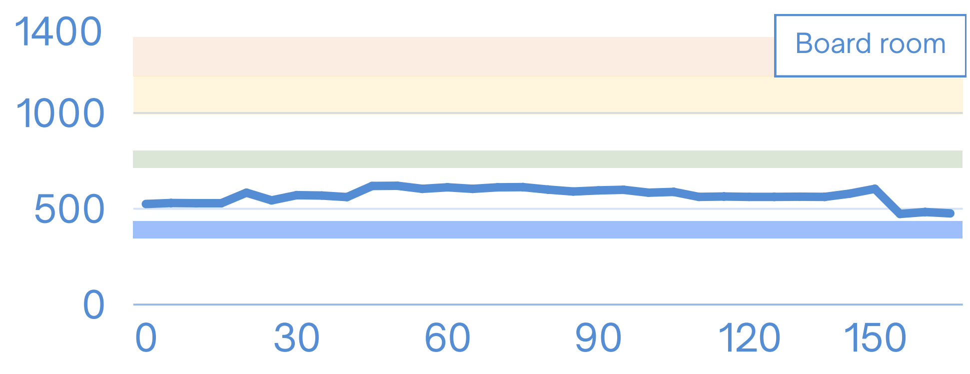
Carbon dioxide data from SIAFOS families in Room 115

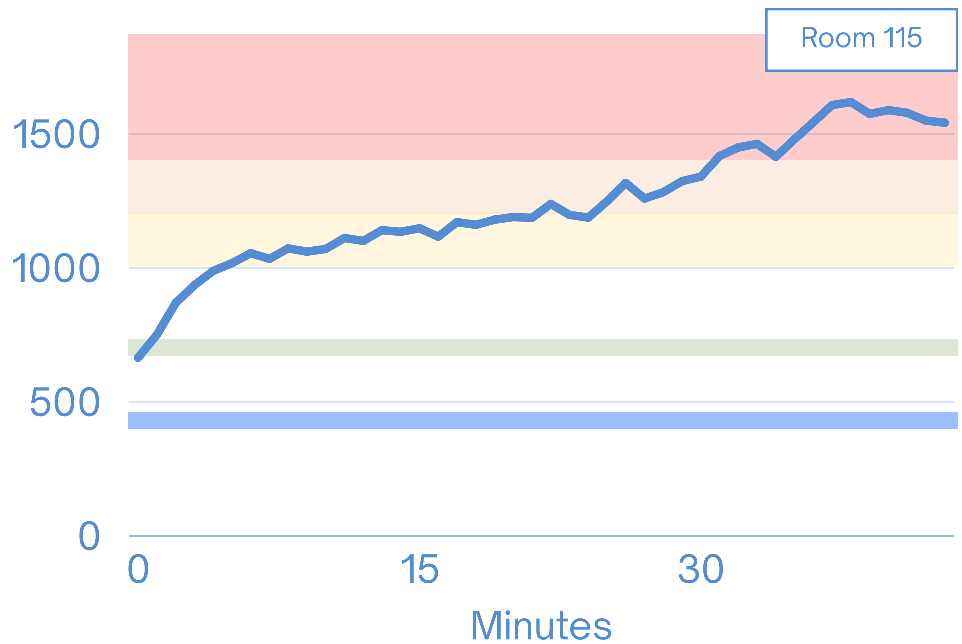
Monitor: Aranet4
CO_2 in parts per million (ppm)

Occupants:
Board room ~40
Room 115 ~40

Excellent ventilation in the school board meeting room keeps CO_2 low.

Room 115 fills up with CO_2 and respiratory aerosols as students and staff breathe, talk, cough, and sneeze.





Outdoor air ~450 ppm

Ideal goal for upper limit = 700 ppm

>1000 ppm = especially poor ventilation

Additional days of community data in Room 115: none

CO_2 was 2.6x higher than in the board room, with the same number of people.

Equivalent CO_2 possible with 2 air purifiers

730 ppm

Two Medify's at speed 2 won't filter CO_2 — but together with the room's MERV 13 filters, they would provide enough clean air to match how much outdoor air would be needed to have lowered this day's CO_2 from 1619 parts per million to 730 parts per million. That's why this room needs both.

McDaniel High School

Room 122

Regular Classroom

Aerosols linger for over 41 minutes if no air purifier is run.

No air purifier

HVAC system only

3.3 air changes per hour

=

41 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

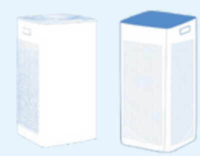
5.1 air changes per hour

=

27 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

7.5 air changes per hour

=

18 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

C — A

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.43

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 2.9 to 3.3

With two air purifiers, most aerosols will clear out in only 18 minutes.

Community CO_2 Monitoring

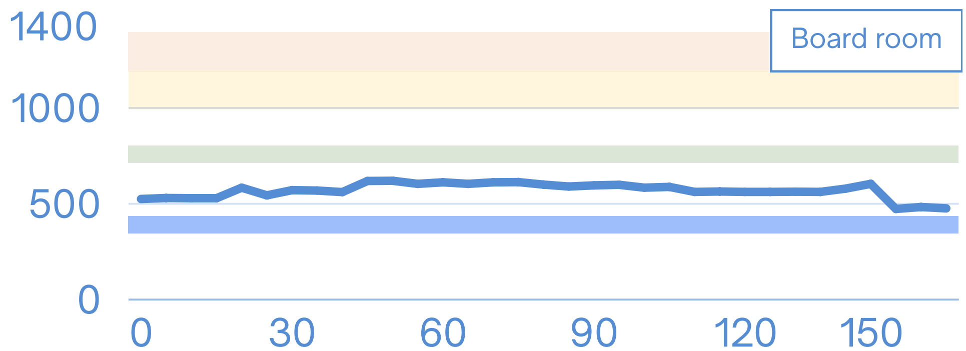
Carbon dioxide data from SIAFOS families in Room 122

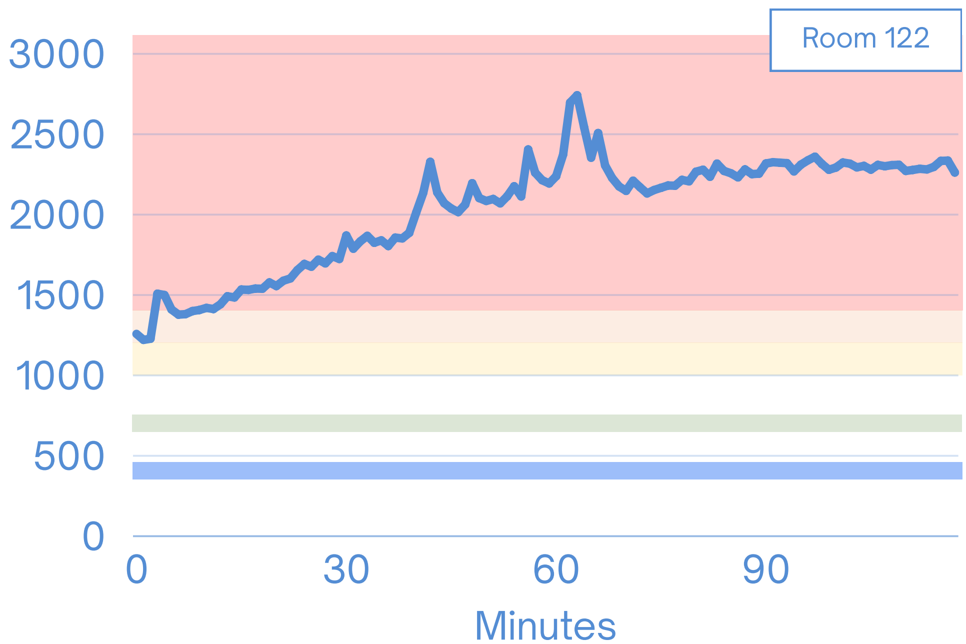
Monitor: Aranet4
CO_2 in parts per million (ppm)

Occupants:
Board room ~40
Room 122 ~33

Excellent ventilation in the school board meeting room keeps CO_2 low.

Room 122 fills up with CO_2 and respiratory aerosols as students and staff breathe, talk, cough, and sneeze.





Outdoor air ~450 ppm

Ideal goal for upper limit = 700 ppm

>1000 ppm = especially poor ventilation

Additional days of community data in Room 122: none

CO_2 in Rm 122 spiked past 2700 ppm — despite fewer occupants.

Equivalent CO_2 possible with 2 air purifiers

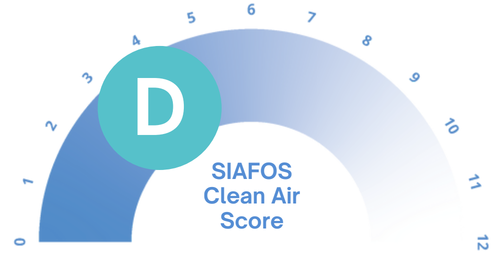
820 ppm

Two Medify's at speed 2 won't filter CO_2 — but together with the room's MERV 13 filters, they would provide enough clean air to match how much outdoor air would be needed to have lowered this day's CO_2 from 2742 parts per million to 820 parts per million. That's why this room needs both.

McDaniel High School

Room 187

Regular Classroom



Aerosols linger for over 38 minutes if no air purifier is run.

No air purifier

HVAC system only

3.7 air changes per hour

=

38 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

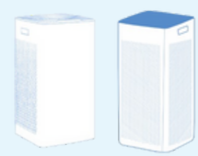
5.7 air changes per hour

=

24 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

8.4 air changes per hour

=

16 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

B-

A+

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.51

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 3.2 to 3.7

With two air purifiers, most aerosols will clear out in only 16 minutes.

Community CO_2 Monitoring

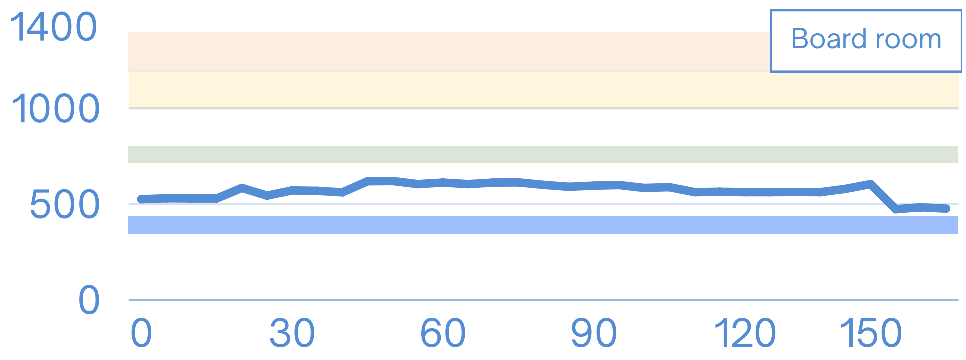
Carbon dioxide data from SIAFOS families in Room 187

Monitor: Aranet4
CO_2 in parts per million (ppm)

Occupants:
Board room ~40
Room 187 ~18

Excellent ventilation in the school board meeting room keeps CO_2 low.

Room 187 fills up with CO_2 and respiratory aerosols as students and staff breathe, talk, cough, and sneeze.

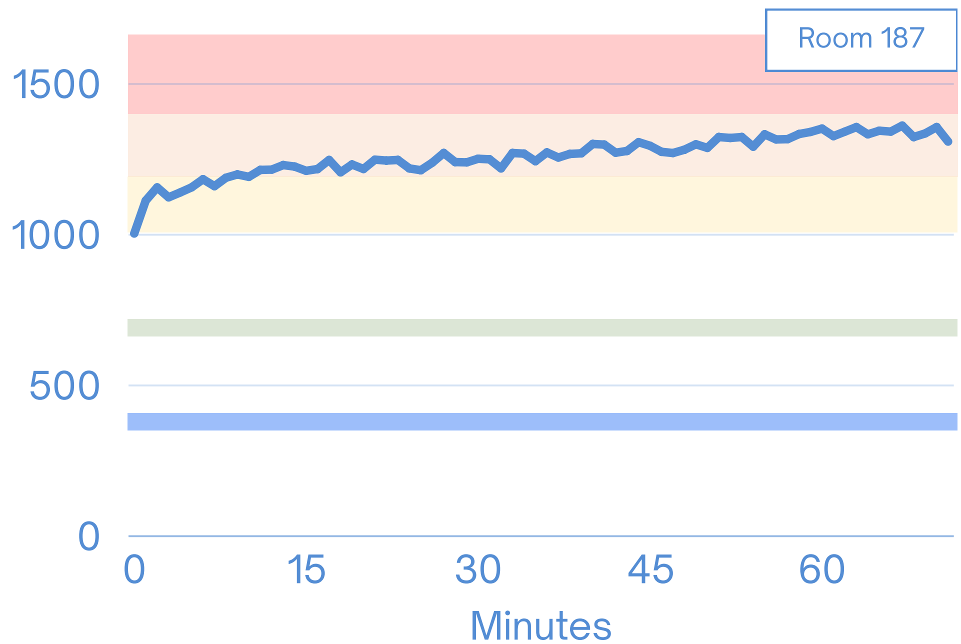


Outdoor air ~450 ppm

Ideal goal for upper limit = 700 ppm

>1000 ppm = especially poor ventilation

Additional days of community data in Room 187: none



CO_2 was twice as high as in the board room despite half the number of people.

Equivalent CO_2 possible with 2 air purifiers

630 ppm

Two Medify's at speed 2 won't filter CO_2 — but together with the room's MERV 13 filters, they would provide enough clean air to match how much outdoor air would be needed to have lowered this day's CO_2 from 1362 parts per million to 630 parts per million. That's why this room needs both.

McDaniel High School

Additional First Floor Classroom Profiles Available Online

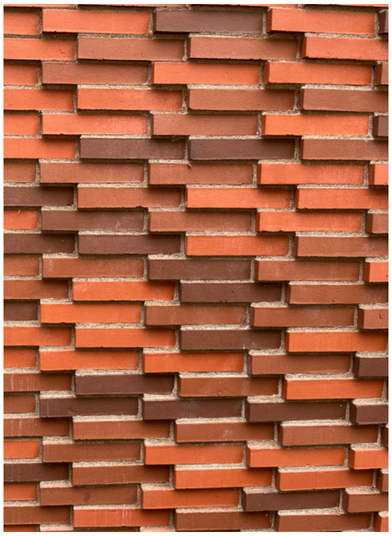
Room	No air purifier	HVAC + one air purifier	HVAC + two air purifiers
117	D+	C	A+
120	D	B-	A+
181	D	B-	A+
183	D	B-	A+
185	D	B-	A+
189	D	B-	A+

Grades possible with consistent use of air purifiers

	No air purifier	HVAC + one air purifier
Small room instruction 145	C	A+

Full Room-by-Room Air Quality Profiles at

safeairoregon.org/mcdaniel-profiles

Second Floor

McDaniel High School

CLASSROOMS

Room-by-Room Air Quality Profiles

McDaniel High School

Room 215

Regular Classroom

Aerosols linger for over 1 hour if no air purifier is run.

No air purifier

HVAC system only

2.3 air changes per hour

=

1 hour

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

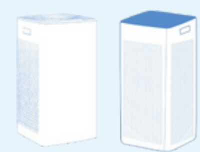
4.1 air changes per hour

=

33 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

6.6 air changes per hour

=

21 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

D+ B+

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

With two air purifiers, most aerosols will clear out in only 21 minutes.

McDaniel High School

Room 217

Regular Classroom

Aerosols linger for over 56 minutes if no air purifier is run.

No air purifier

HVAC system only

2.5 air changes per hour

=

56 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

4.4 air changes per hour

=

32 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers

Add Medify & Medify Pro at speed 2

6.9 air changes per hour

=

20 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

D+ A+

Grades possible with consistent use or air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

With two air purifiers, most aerosols will clear out in only 20 minutes.

McDaniel High School

Room 218

ELL / ESL Classroom

Aerosols linger for over 1 hour if no air purifier is run.

No air purifier

HVAC system only

2.2 air changes per hour

=

1 hour 2 min

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

4.1 air changes per hour

=

34 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers

Add Medify & Medify Pro at speed 2

6.7 air changes per hour

=

21 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

D+ B+

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

With two air purifiers, most aerosols will clear out in only 21 minutes.

McDaniel High School

Room 220

Regular Classroom

Aerosols linger for over 57 minutes if no air purifier is run.

No air purifier

HVAC system only

2.4 air changes per hour

=

57 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

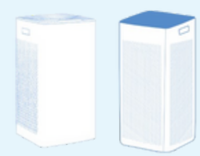
4.2 air changes per hour

=

33 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

6.7 air changes per hour

=

20 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

D+ B+

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 20 minutes.

Community CO_2 Monitoring

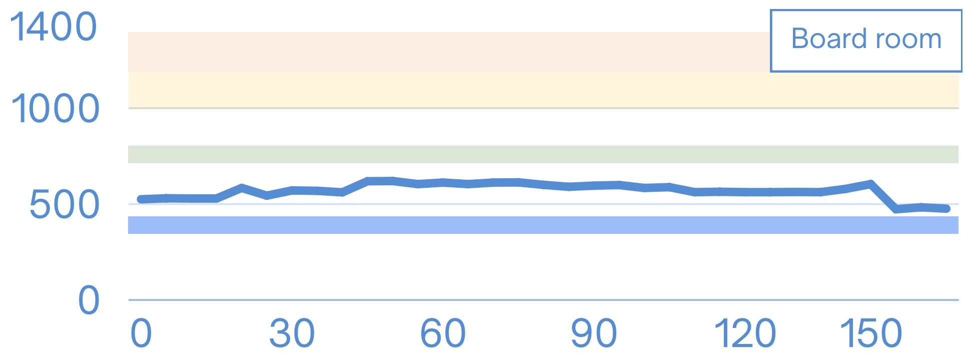
Carbon dioxide data from SIAFOS families in Room 220

Monitor: Aranet4
CO_2 in parts per million (ppm)

Occupants:
Board room ~40
Room 220 ~30

Excellent ventilation in the school board meeting room keeps CO_2 low.

Room 220 fills up with CO_2 and respiratory aerosols as students and staff breathe, talk, cough and sneeze.

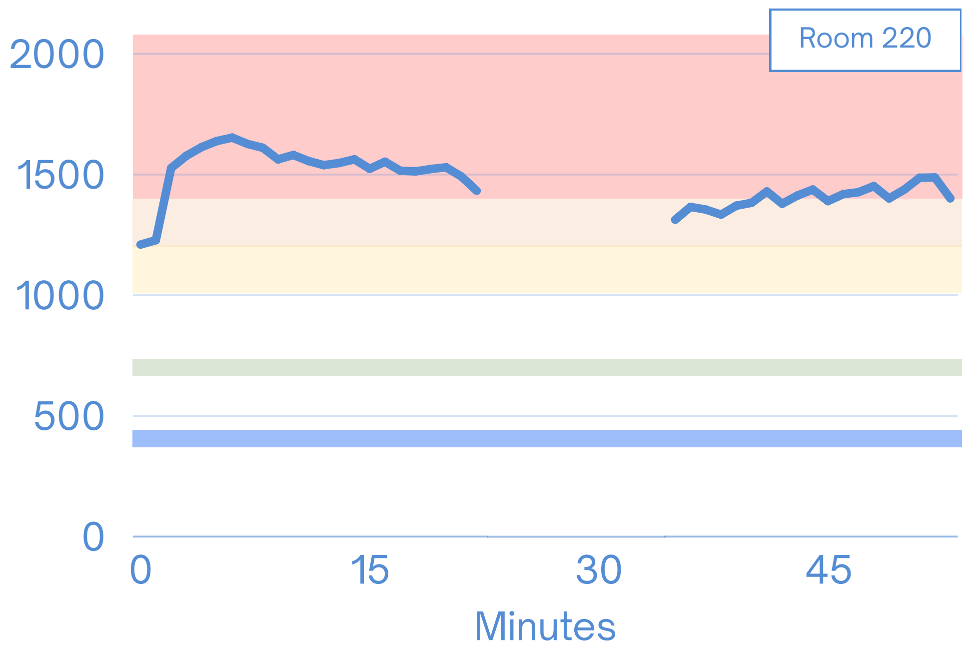


Outdoor air ~450 ppm

Ideal goal for upper limit = 700 ppm

>1000 ppm = especially poor ventilation

Additional days of community data in Room 220: none



Staff and students in Rm 220 rebreathed 1 in 31 of each others' breaths.

Equivalent CO_2 possible with 2 air purifiers

765 ppm

Two Medify's at speed 2 won't filter CO_2 — but they would provide enough clean air to match how much outdoor air would be needed to have lowered this day's CO_2 from 1653 parts per million to 765 parts per million. That's why this room needs both.

McDaniel High School

Room 229

Regular Classroom

Aerosols linger for over 1 hour if no air purifier is run.

No air purifier

HVAC system only

1.8 air changes per hour

=

1 hour 16 min

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

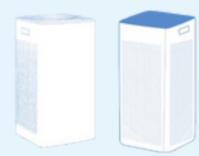
4.3 air changes per hour

=

32 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

7.8 air changes per hour

=

18 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

D+ A

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

With two air purifiers, most aerosols will clear out in only 18 minutes.

McDaniel High School

Room 231

Regular Classroom

Aerosols linger for over 55 minutes if no air purifier is run.

No air purifier

HVAC system only

2.5 air changes per hour

=

55 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

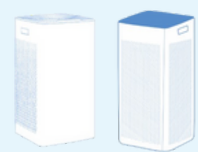
4.6 air changes per hour

=

30 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

7.6 air changes per hour

=

18 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

C-

A

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 18 minutes.

Community CO_2 Monitoring

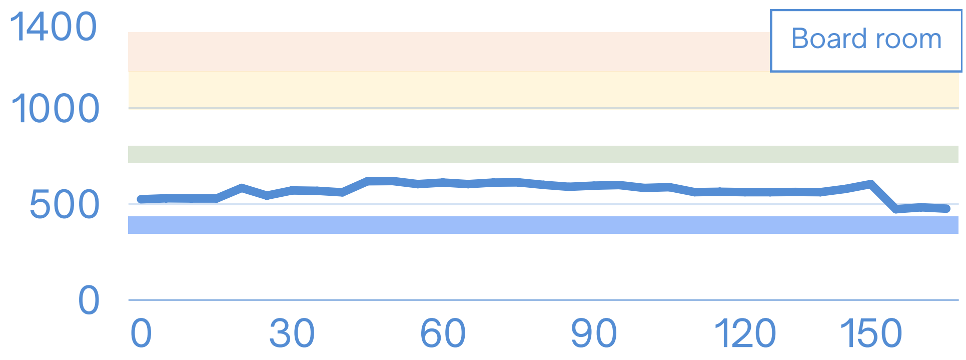
Carbon dioxide data from SIAFOS families in Room 231

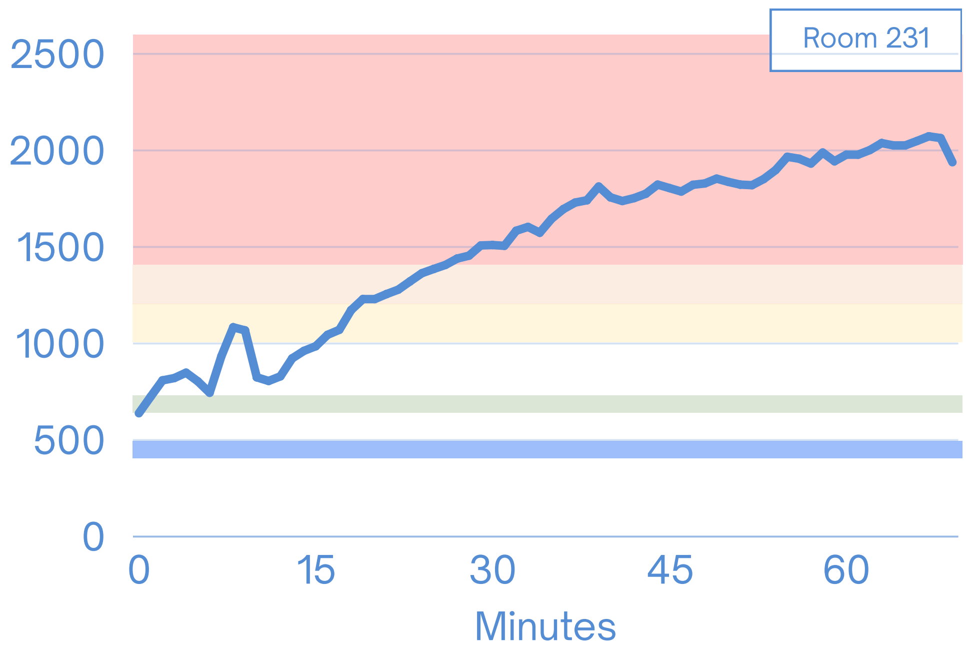
Monitor: Aranet4
CO_2 in parts per million (ppm)

Occupants:
Board room ~40
Room 231 ~30

Excellent ventilation in the school board meeting room keeps CO_2 low.

Room 231 fills up with CO_2 and respiratory aerosols as students and staff breathe, talk, cough, and sneeze.





Outdoor air ~450 ppm

Ideal goal for upper limit = 700 ppm

>1000 ppm = especially poor ventilation

Additional days of community data in Room 231: none

Staff and students in Rm 231 rebreathed 1 in 23 of each others' breaths.

Equivalent CO_2 possible with 2 air purifiers

800 ppm

Two Medify's at speed 2 won't filter CO_2 — but they would provide enough clean air to match how much outdoor air would be needed to have lowered this day's CO_2 from 2100 parts per million to 800 parts per million. That's why this room needs both.

McDaniel High School

Room 242

Regular Classroom

Aerosols linger for over 1 hour if no air purifier is run.

No air purifier

HVAC system only

2.1 air changes per hour

=

1 hour 5 min

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

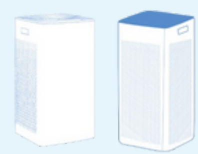
3.9 air changes per hour

=

35 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

6.4 air changes per hour

=

21 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

D

B

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

With two air purifiers, most aerosols will clear out in only 21 minutes.

McDaniel High School

Room 243

Regular Classroom

Aerosols linger for over 53 minutes if no air purifier is run.

No air purifier

HVAC system only

2.6 air changes per hour

=

53 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

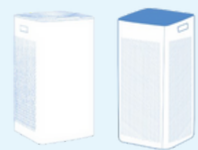
4.7 air changes per hour

=

30 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

7.5 air changes per hour

=

18 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

C-

A

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 18 minutes.

McDaniel High School

Room 247

Regular Classroom

Aerosols linger for over 1 hour if no air purifier is run.

No air purifier

HVAC system only

1.9 air changes per hour

=

1 hour 13 min

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

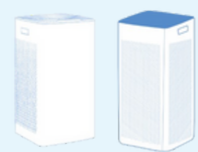
3.9 air changes per hour

=

36 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

6.6 air changes per hour

=

21 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

D

B+

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

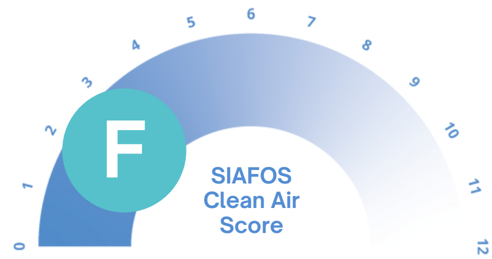
The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

With two air purifiers, most aerosols will clear out in only 21 minutes.

McDaniel High School

Room 281

Regular Classroom



Aerosols linger for over 55 minutes if no air purifier is run.

No air purifier

HVAC system only

2.5 air changes per hour

=

55 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

4.6 air changes per hour

=

30 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers

Add Medify & Medify Pro at speed 2

7.5 air changes per hour

=

18 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

C-

A

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

With two air purifiers, most aerosols will clear out in only 18 minutes.

McDaniel High School

Room 290

Regular Classroom

Aerosols linger for over 58 minutes if no air purifier is run.

No air purifier

HVAC system only

2.4 air changes per hour

=

58 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

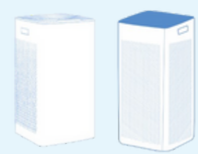
4.4 air changes per hour

=

31 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

7.2 air changes per hour

=

19 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

D+ A

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

With two air purifiers, most aerosols will clear out in only 19 minutes.

McDaniel High School

Room 292

Regular Classroom

CLASSROOMS

Aerosols linger for over 57 minutes if no air purifier is run.

No air purifier

HVAC system only

2.4 air changes per hour

=

57 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

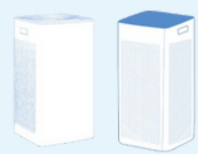
4.4 air changes per hour

=

31 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

7.2 air changes per hour

=

19 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

D+ A

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

With two air purifiers, most aerosols will clear out in only 19 minutes.

MCDANIEL HIGH SCHOOL

McDaniel High School

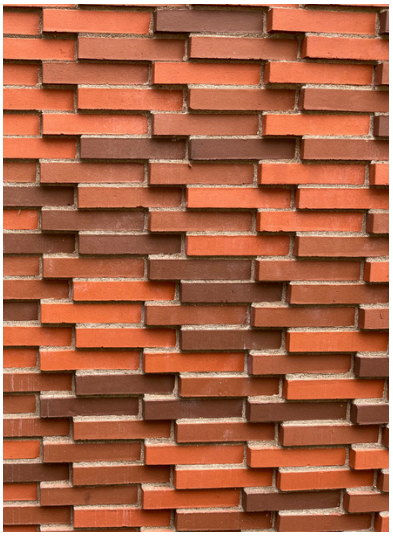
Additional Second Floor Classroom Profiles Available Online

Room	No air purifier	HVAC + one air purifier	HVAC + two air purifiers
234	F	C-	A
236	F	C-	A
238	F	D+	B+
239	F	C-	A
240	F	D+	B+
241	F	C-	A
283	F	C-	A
284	F	D+	B+
285	F	C-	A
286	F	D+	B+
287	F	C-	A
289	F	C-	A

Small instruction rooms 245 and 288 also online

Full Room-by-Room Air Quality Profiles at

safeairoregon.org/mcdaniel-profiles



McDaniel High School

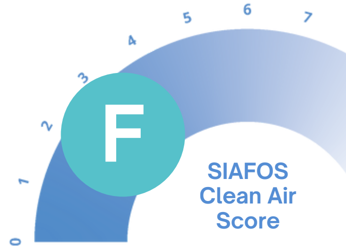
COMMON SPACES

Room-by-Room Air Quality Profiles

McDaniel High School

Library 129

Media Center/Library



SIAFOS Clean Air Score not a good fit for scoring clean air in libraries of this size

Aerosols linger for over 43 minutes even with two air purifiers, but McDaniel's library has a reservoir of clean air at typical library occupancies.

No air purifier

HVAC system only

2.6 air changes per hour

=

52 minutes

to clear out 90% of the students' and librarians' respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

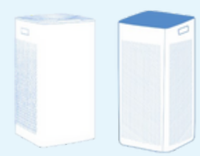
2.9 air changes per hour

=

48 minutes

to clear out 90% of the students' and librarians' respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

3.2 air changes per hour

=

43 minutes

to clear out 90% of the students' and librarians' respiratory aerosols and other indoor air pollutants

F

D-

Library's clean air is higher than these grades suggest

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.57

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution and improved airflow from 2 to 2.6

This large library's scores don't tell the full story

The McDaniel library gets low scores based on air changes, but the room is uniquely large; air changes don't account for how comparatively few people likely use this large space at any one time. While SIAFOS needs more information on occupancies to fully evaluate the library, the size of the room means there is more clean air at typical library occupancies than these scores reflect. The library's equivalent CO_2 data may better reflect its clean air levels.

Community CO_2 Monitoring

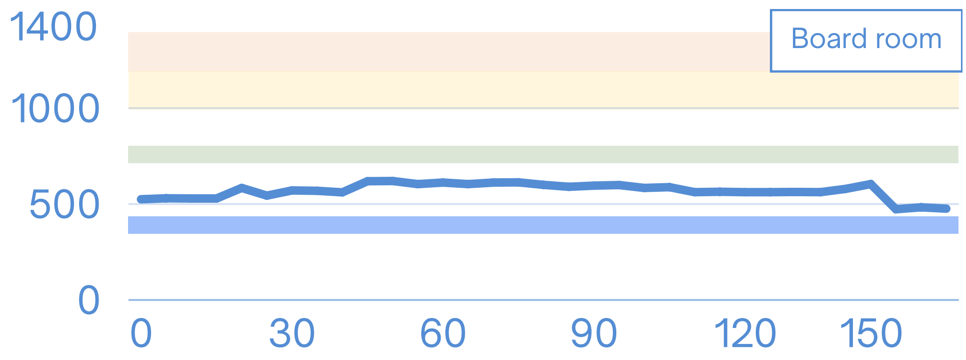
Carbon dioxide data from SIAFOS families in Library 129

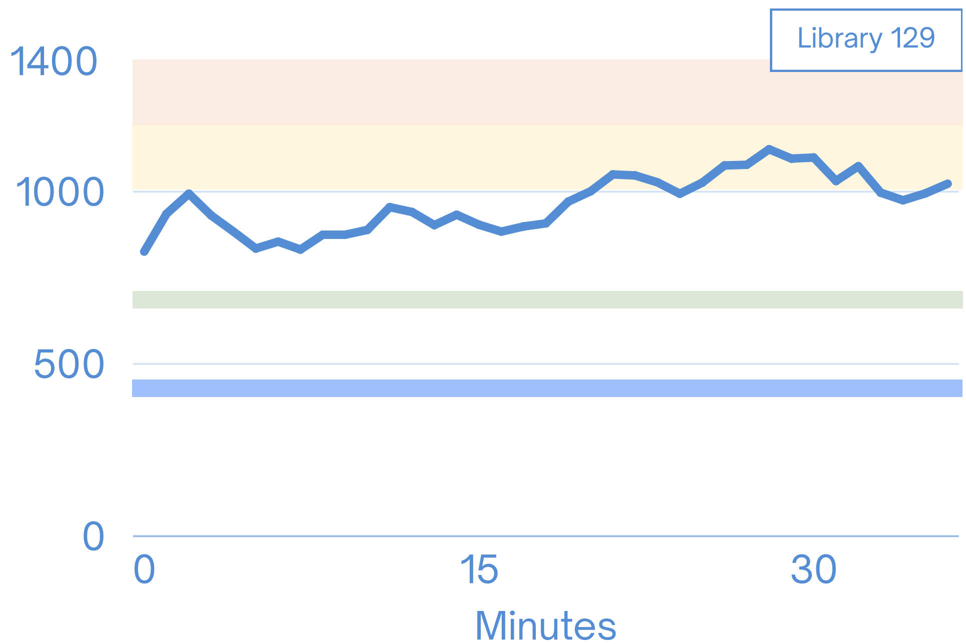
Monitor: Aranet4
CO_2 in parts per million (ppm)

Occupants:
Board room - 40
Library - 36

Excellent ventilation in the school board meeting room keeps CO_2 low.

McDaniel's library fills up with CO_2 but recirculation and filtration will clear aerosols well *at this occupancy*.





Outdoor air ~450 ppm

Ideal goal for upper limit = 700 ppm

>1000 ppm = especially poor ventilation

Additional days of community data in Room 129: none

CO_2 was high but recirculation and filtration can match this occupancy.

Equivalent CO_2 possible with 2 air purifiers

563 ppm

Two Medify's at speed 2 won't filter CO_2 — but together with the room's MERV 13 filters, they would provide enough clean air to match how much outdoor air would be needed to lower this day's CO_2 from 1123 parts per million to 563 parts per million. That's why this room needs both.

McDaniel High School

Servery 184

Common Space

Aerosols linger for over 29 minutes if no air purifier is run.

No air purifier

HVAC system only

4.8 air changes per hour

=

29 minutes

to clear out 90% of the students' and staff's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

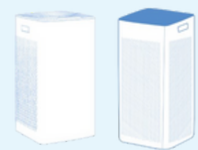
6.2 air changes per hour

=

22 minutes

to clear out 90% of the students' and staff's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

8.1 air changes per hour

=

17 minutes

to clear out 90% of the students' and staff's respiratory aerosols and other indoor air pollutants

B

A+

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

1.6

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution. MERV 13 also improved airflow, raising it from ~3.2 to 4.8.

With two air purifiers, most aerosols will clear out in only 17 minutes.

McDaniel High School

Commons

Commons 196

COMMON SPACES

Airflow in the Commons was not measured.

But with community CO_2 monitoring, we can estimate it.

No air purifier

HVAC system only

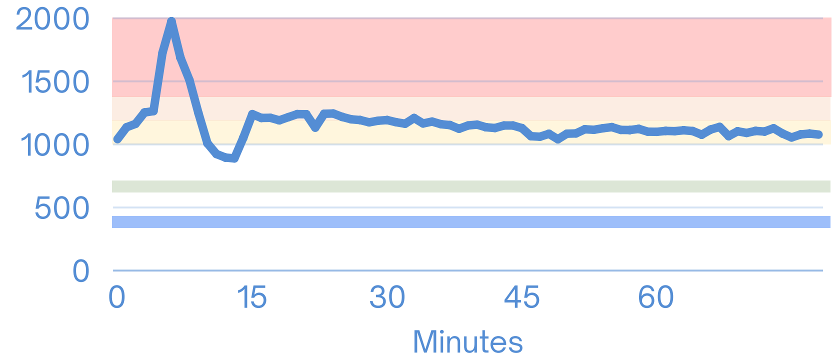
? air changes per hour

=

? minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

Carbon dioxide data from SIAFOS families in Commons 196



Estimate of outdoor airflow via HVAC

~1.3 air changes per hour

Based on 8.5 hours of data across 3 dates total, estimates of outdoor air changes/hour ranged from 0.7 to 1.3

MERV 13 filters

Increase in air changes/hour due to better furnace filters

?

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but their impact on airflow in this room cannot be estimated

District air purifiers are not a good match for the Commons.

Two air purifiers only adds

0.08 air changes per hour

Two units will not meaningfully improve clean airflow

Two Medify air purifiers at speed 2 would only increase air changes per hour in the Commons by 0.08. These units are too small to improve overall clean airflow in such a large space. District air purifiers are better placed in other rooms.

MCDANIEL HIGH SCHOOL

McDaniel High School

Additional Common Space Profiles Available Online

Room	No air purifier	HVAC + one air purifier	HVAC + two air purifiers
131	F	D-	C
FX105	C-	B-	A

Grades possible with consistent use of air purifiers

Room	No air purifier	HVAC + one air purifier
Multi-Use 129A	F	A++
Office 129B	F	A+
Office 186F	D+	A+
Kitchen 186	A++	A++

Full Room-by-Room Air Quality Profiles at

safeairoregon.org/mcdaniel-profiles

McDaniel High School

CTE ROOMS

Room-by-Room Air Quality Profiles

CAREER TECHNICAL EDUCATION

McDaniel High School

Career Center

Room 227

Aerosols linger for over 2 hours if no air purifier is run.

No air purifier

HVAC system only

1.1 air changes per hour

=

2 hours

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

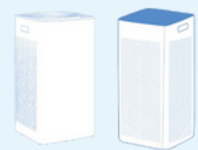
2.9 air changes per hour

=

48 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

5.4 air changes per hour

=

26 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

F

C

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

With two air purifiers, most aerosols will clear out in only 26 minutes.

MCDANIEL HIGH SCHOOL

McDaniel High School

Computer Lab

Computer Lab 230

CAREER TECHNICAL EDUCATION

Aerosols linger for over 25 minutes if no air purifier is run.

No air purifier

HVAC system only

5.5 air changes per hour

=

25 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

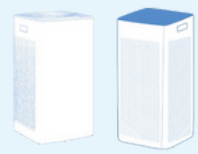
7.3 air changes per hour

=

19 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

9.7 air changes per hour

=

14 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

1.1

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution. MERV 13's also improved airflow, raising it from 4.3 to 5.4.

A

A+

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 14 minutes.

MCDANIEL HIGH SCHOOL

CAREER TECHNICAL EDUCATION

McDaniel High School

Digital Media

CTE Digital Media Room 132

Aerosols linger for over 36 minutes if no air purifier is run.

No air purifier

HVAC system only

3.8 air changes per hour

=

36 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

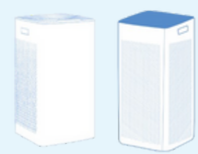
5.4 air changes per hour

=

26 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

7.6 air changes per hour

=

18 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

C

A

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

With two air purifiers, most aerosols will clear out in only 18 minutes.

MCDANIEL HIGH SCHOOL

McDaniel High School

Engineering

CTE Engineering Room 134

CAREER TECHNICAL EDUCATION

Aerosols linger for over 32 minutes if no air purifier is run.

No air purifier

HVAC system only

4.4 air changes per hour

=

32 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

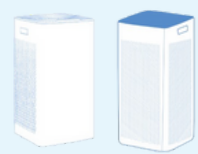
5.6 air changes per hour

=

25 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

7.3 air changes per hour

=

19 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

1.0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution. MERV 13's also improved airflow, raising it from 3.4 to 4.4.

B-

A

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 19 minutes.

MCDANIEL HIGH SCHOOL

CAREER TECHNICAL EDUCATION

McDaniel High School

Textiles

CTE Textiles Room 137

Aerosols linger for over 37 minutes if no air purifier is run.

No air purifier

HVAC system only

3.7 air changes per hour

=

37 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

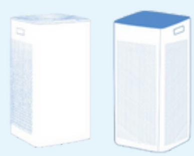
5.8 air changes per hour

=

24 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

8.6 air changes per hour

=

16 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.5

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 3.2 to 3.7

B- A+

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 16 minutes.

MCDANIEL HIGH SCHOOL

McDaniel High School

Small Art Rooms

Kiln, Glaze, Screen Printing

Airflows in these rooms were not measured.

If airflow is similar to the Digital Media room, aerosols linger for over 36 minutes with no air purifier on.

	No air purifier HVAC system only	**HVAC + one air purifier** Add Intellipure at half speed
Kiln 168A	**3.8** air changes per hour*	**7.8** air changes per hour
Glaze 168B	**3.8** air changes per hour*	**7.8** air changes per hour

A

Grades possible with consistent use of air purifiers

A++

		Add Medify MA-112 at speed 2
Screen Print 132A	**3.8** air changes per hour*	**13** air changes per hour

With just one air purifier, most aerosols will likely clear out in 18 minutes or less.

*If these small art rooms have HVAC airflows similar to the Digital Media room, then they get ~3.8 air changes per hour.

MERV 13 filters — **Increase in air changes/hour due to better furnace filters** — ?

The impact of MERV 13 filters cannot be estimated for these rooms.

McDaniel High School

Additional CTE Classroom Profiles Available Online

Room	No air purifier	HVAC + one air purifier	HVAC + two air purifiers
Makerspace 130	D+	C	B+
Computer Sci 138	D+	C	A
Construction Lab 156	B-	B	A
Ceramics 168	B	A	A+
Photography 172	B+	A+	A++
Art 2D 176	C	B+	A+

Grades possible with consistent use of air purifiers

	No air purifier	HVAC + one air purifier
CTE Flex Room 136	D	B
CTE Flex Room 174	C	A+

Full Room-by-Room Air Quality Profiles at

safeairoregon.org/mcdaniel-profiles

McDaniel High School

HEALTH & DAYCARE

Room-by-Room Air Quality Profiles

DAYCARE

McDaniel High School

Infant Room 159D

Daycare Infant Room + Nap Area

Aerosols linger for over 42 minutes if no air purifier is run.

No air purifier

HVAC system only

3.3 air changes per hour

=

42 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

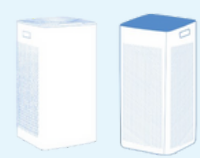
5.8 air changes per hour

=

24 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

9.2 air changes per hour

=

15 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.67

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 2.6 to 3.3

B-

A+

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 15 minutes.

MCDANIEL HIGH SCHOOL

McDaniel High School

Health 161

Health Center Waiting / Reception

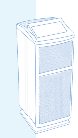
Aerosols linger for over 40 minutes if no air purifier is run but only 16 minutes with a Medify air purifier.

	No air purifier	HVAC + one air purifier
	HVAC system only	Add Medify MA-112 at speed 2
Health 161 & Reception 161K	3.5 air changes per hour	8.8 air changes per hour A+

Sick/Exam Rooms

Nurse's Room & Health Center

Aerosols linger for over 27 minutes if no air purifier is run but only ~17 minutes with an Intellipure air purifier.

	No air purifier	HVAC + one air purifier
	HVAC system only	Add Intellipure at half speed 
Sick Room 100M	5.1 air changes per hour	8.0 air changes per hour A+
Exam 161J	5.3 air changes per hour	9.7 air changes per hour A+

McDaniel High School

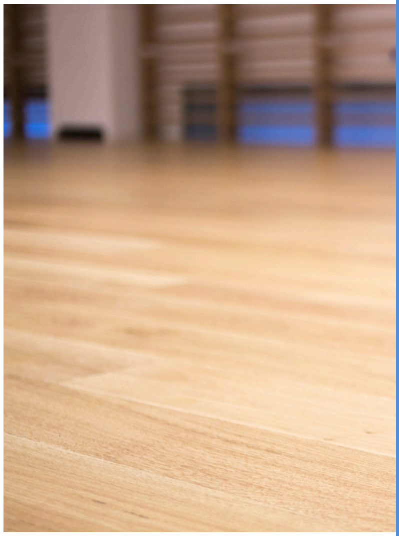
Additional Second Floor Classroom Profiles Available Online

Room	No air purifier	HVAC + one air purifier
Toddler 159B	C-	A+
Crawler 159C	C	A+
Office 159A	D+	A+
Office 100O	A+	A++
Office 161A	A+	A++
Office 161B	B	A++
Office 161C	A+	A++
Conf Rm 161D	A++	A++
Lab 161E	A++	A++
Exam 161G	B	A++
Exam 161H	B	A++

Breastfeeding 157 & Daycare Kitchen 159J also online

Full Room-by-Room Air Quality Profiles at

safeairoregon.org/mcdaniel-profiles

McDaniel High School

PERFORMING ARTS

Room-by-Room Air Quality Profiles

PERFORMING ARTS

McDaniel High School

Choir Room 163

Performing Arts Classroom

Aerosols linger for over 45 minutes if no air purifier is run.

No air purifier

HVAC system only

3.1 air changes per hour

=

45 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

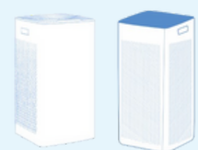
3.9 air changes per hour

=

36 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

5.0 air changes per hour

=

28 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.63

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 2.5 to 3.1

D

C

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 28 minutes.

MCDANIEL HIGH SCHOOL

McDaniel High School

Band Room 165

Performing Arts Classroom

PERMORMING ARTS

Aerosols linger for over 1 hour if no air purifier is run.

No air purifier

HVAC system only

2.0 air changes per hour

=

1 hour 8 min

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

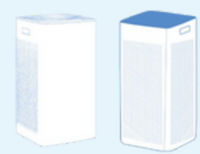
2.5 air changes per hour

=

56 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

3.2 air changes per hour

=

44 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.39

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 1.6 to 2

F

D-

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in 44 minutes.

An improvement, but still far too long

MCDANIEL HIGH SCHOOL

McDaniel High School

Additional Performing Arts Room Profiles Available Online

Room	No air purifier	HVAC + one air purifier	HVAC + two air purifiers
Blackbox Theater 171	F	F	D
Dressing Room 175	F	D	B
Theater 177	F	F	F

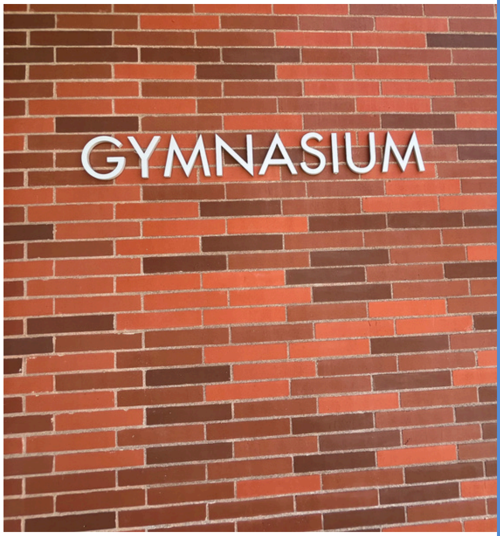
Grades possible with consistent use of air purifiers

Practice Rooms		No air purifier	HVAC + one air purifier
	Rm 163B	D+	A++
	Rm 165B	D+	A++
	Rm 165C	D+	A++
	Rm 165D	D+	A++
	Rm 165E	D+	A++
	Rm 165H	D+	A++

Offices 163A, 165A, 171A & 179E1 also online

Full Room-by-Room Air Quality Profiles at

safeairoregon.org/mcdaniel-profiles

McDaniel High School

PHYSICAL EDUCATION

Room-by-Room Air Quality Profiles

PHYSICAL EDUCATION

McDaniel High School

Weight Room

Physical Education Room G122

Aerosols linger for over 43 minutes if no air purifier is run.

No air purifier

HVAC system only

3.2 air changes per hour

=

43 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

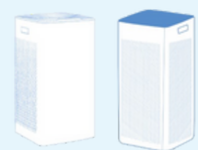
3.9 air changes per hour

=

36 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

4.8 air changes per hour

=

29 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

D

C-

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.68

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 2.5 to 3.2

With two air purifiers, most aerosols will clear out in only 29 minutes.

MCDANIEL HIGH SCHOOL

McDaniel High School

Training G103

Physical Education Training Room

PHYSICAL EDUCATION

Aerosols linger for over 43 minutes if no air purifier is run.

No air purifier

HVAC system only

3.2 air changes per hour

=

43 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

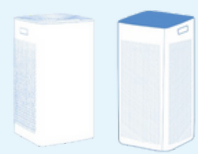
6.7 air changes per hour

=

21 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

12 air changes per hour

=

12 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.85

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 2.35 to 3.2

B+ A++

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 12 minutes.

P.E. activities produce more indoor air pollutants / aerosols. Excellent air cleaning is critical.

MCDANIEL HIGH SCHOOL

McDaniel High School

Main Gym

Physical Education Room G200

Aerosols linger for over an hour, but these air purifiers are not a good match.

No air purifier

HVAC system only

2.3 air changes per hour

=

60 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

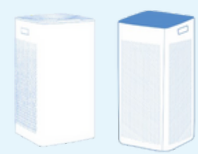
2.4 air changes per hour

=

59 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

2.4 air changes per hour

=

57 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

F F

These units do not meaningfully improve clean airflow

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.6

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution and improved airflow from 1.7 to 2.3

These air purifiers are too small for gyms of this size.

The Medify air purifiers are a poor match for improving airflow in the main gym. Gym activities also frequently result in these types of units getting broken. These models of air purifiers are better placed in other rooms.

Community CO_2 Monitoring

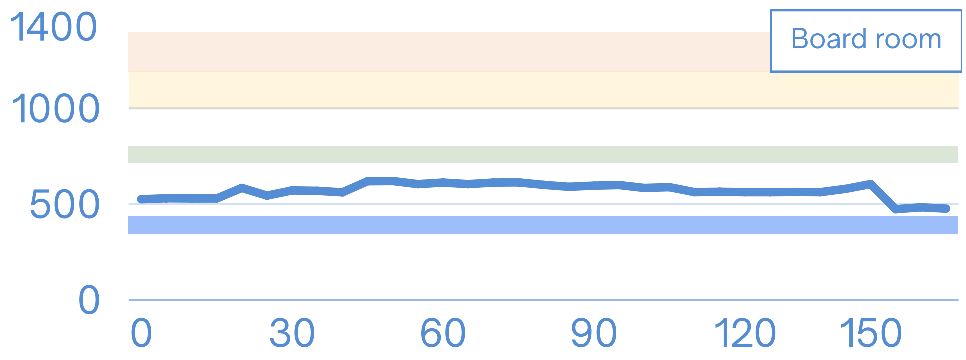
Carbon dioxide data from SIAFOS families in the Main Gym

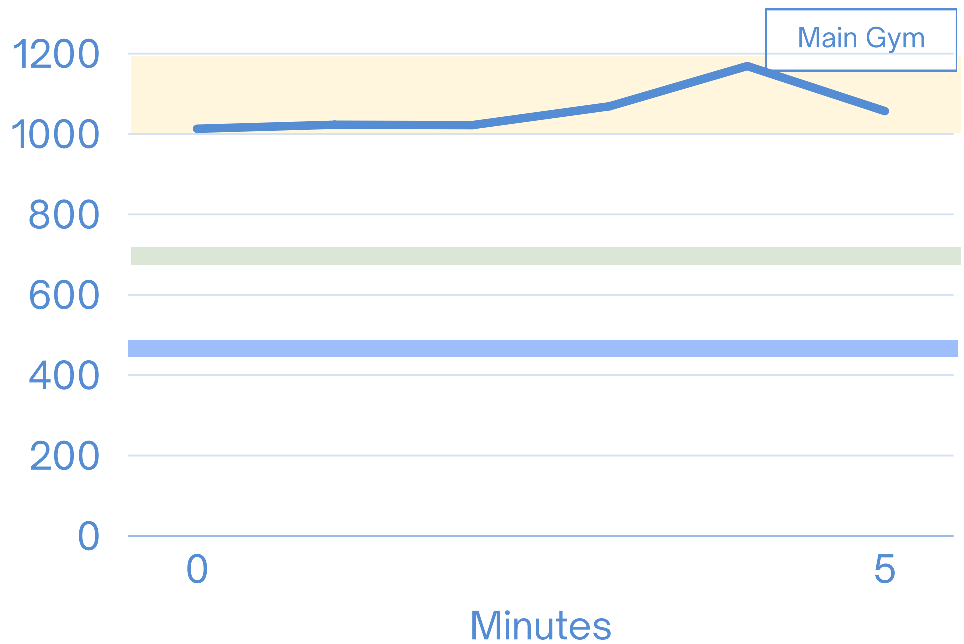
Monitor: Aranet4
CO_2 in parts per million (ppm)

Occupants:
Board room ~40
Main Gym ~275

Excellent ventilation in the school board meeting room keeps CO_2 low.

The Gym fills with CO_2 as students and staff breathe, but recirculation clears aerosols well *at this specific occupancy and low activity level.*





Outdoor air ~450 ppm

Ideal goal for upper limit = 700 ppm

>1000 ppm = especially poor ventilation

Additional days of community data in Room 231: none

CO_2 was high but recirculation in the gym was well-matched to this occupancy.

Equivalent CO_2 accounting for recirculation

660 ppm

Recirculation of air through the HVAC system provides enough clean air to match how much outdoor air would be needed to have lowered this day's CO_2 from 1169 parts per million to 660 parts per million. ***However, higher occupancies and activity levels may not have sufficient clean air. SIAFOS and partners need more information on occupancies and use of the gym to fully evaluate the gym's clean airflow.***

PHYSICAL EDUCATION

McDaniel High School

Additional P.E. Room Profiles Available Online

Room	No air purifier	HVAC + one air purifier	HVAC + two air purifiers
Wrestle/Dance G100	B-	B	A
Auxillary Gym G201	F	F	D-

Grades possible with consistent use of air purifiers

Team Rooms & Offices	No air purifier	HVAC + one air purifier
Rm G105	B+	A+
Rm G107	A++	A++
Rm G109	A++	A++
Rm G119	A+	A++
Office G121A	A++	A++
Office G125A	A++	A++

Locker rooms, Concessions & Food Pantry/Closet also online

Full Room-by-Room Air Quality Profiles at

safeairoregon.org/mcdaniel-profiles

MCDANIEL HIGH SCHOOL

McDaniel High School

SCHOOL OFFICES

Room-by-Room Air Quality Profiles

McDaniel High School

Office 033

Teacher Collaboration Office

Aerosols linger for over 50 minutes if no air purifier is run.

No air purifier

HVAC system only

2.8 air changes per hour

=

50 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

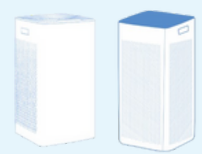
4.9 air changes per hour

=

28 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

7.8 air changes per hour

=

18 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.8

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 2 to 2.8

C-

A

Grades possible with consistent use of air purifiers

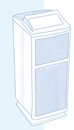
With two air purifiers, most aerosols will clear out in only 18 minutes.

McDaniel High School

Counseling

Counseling Offices 210B-210F

Aerosols linger for over 2 hours if no air purifier is run in counseling offices.



	No air purifier HVAC system only	HVAC + one air purifier Add Intellipure at half speed
Office 210B	1.2 air changes per hour	6.9 air changes per hour
Office 210C	1.2 air changes per hour	6.8 air changes per hour
Office 210D	1.1 air changes per hour	6.5 air changes per hour
Office 210E	1.1 air changes per hour	6.1 air changes per hour
Office 210F	1.1 air changes per hour	6.4 air changes per hour

Grades possible with consistent use of air purifiers: B+ (Offices 210B–210D), B (Offices 210E–210F)

With just one air purifier, most aerosols will clear out in only 23 minutes.

A Medify unit would provide 16+ air changes per hour to these offices; however, the Medify units may be physically larger than these small offices can accommodate.

MERV 13 filters	Increase in air changes/hour due to better furnace filters	0

McDaniel High School

Additional School Office Profiles Available Online

	No air purifier	One air purifier	Two air purifiers
Main Office 100	F	C-	A+
Teacher Collaboration 140	D	B+	A++
Teacher Collaboration 206	D-	C	A

Additional profiles for school offices that would also benefit from two air purifiers are online:

Partner Office 031
Main Office 100A
Teacher Collaboration 237
Teacher Collaboration 291

	No air purifier	HVAC + one air purifier
Student Govt Rm 027	B-	A+
Partner Conf Room 029	C	A+
Partner Office 031A	D-	A+
Partner Office 031B	B-	A++
Partner Office 031D	D-	A+
Partner Office 031E	F	A+
Principal Office 100B	B-	A+
Vice Principal 100C	B	A++
Vice Principal 100D	A	A++
Vice Principal 100E	B+	A++
Dean Office 100F	C-	A+
Campus Monitors 100K	D+	A+

	No air purifier	HVAC + one air purifier
Resource Officer 102	B-	A++
Attendance 110	F	A
Work Room 112C	B-	A++
Book Room 114	F	A
IT Repair 116	C-	A++
PTA/Alumni Office 118A	D+	B+
Bus 118B	B+	A++
AD 118C	B+	A++
Athletic Director Sup 118D	D-	A
Office 118E	D	A+
Student Store 124	C-	A
Custodian 155A	B+	A++

Additional profiles for school offices that would also benefit from one air purifier are online:

Partner Office 031C
Conference Rm 100J
Staff Room 112B
Custodian Break Rm 155B
Interns 201H

Counseling Conf Rm 209
Counseling Waiting Rm 210
Conference Rm 210G
Psych 210J
Psych 210K

Speech 210L
Conference Rm 210M
Speech 210N
D/A 210P

Full Room-by-Room Air Quality Profiles at

safeairoregon.org/mcdaniel-profiles

McDaniel High School

SCIENCE LABS

Room-by-Room Air Quality Profiles

SCIENCE LABS

McDaniel High School

Room 101

General Science Lab / CTE

Aerosols only linger for ~18 minutes if no air purifier is run.

No air purifier

HVAC system only

7.9 air changes per hour

=

18 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

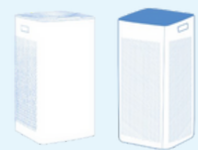
9.2 air changes per hour

=

15 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

11.1 air changes per hour

=

12 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

A+ A++

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

2.1

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution. MERV 13's also improved airflow, raising it from ~5.7 to 7.9.

With two air purifiers, most aerosols will clear out in only 12 minutes.

Science lab activities often produce more indoor air pollutants. Excellent air cleaning is useful.

MCDANIEL HIGH SCHOOL

McDaniel High School

Room 103

General Science Lab / CTE

SCIENCE LABS

Aerosols only linger for ~18 minutes if no air purifier is run.

No air purifier

HVAC system only

7.5 air changes per hour

=

18 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

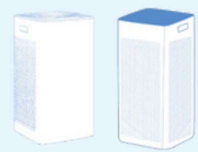
8.8 air changes per hour

=

16 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

10.6 air changes per hour

=

13 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

2.0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution. MERV 13's also improved airflow, raising it from ~5.5 to 7.5.

A+ A++

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 13 minutes.

Science lab activities often produce more indoor air pollutants. Excellent air cleaning is useful.

MCDANIEL HIGH SCHOOL

SCIENCE LABS

McDaniel High School

Room 104

General Science Lab

Aerosols only linger for ~26 minutes if no air purifier is run.

No air purifier

HVAC system only

5.2 air changes per hour

=

26 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

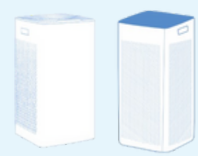
6.5 air changes per hour

=

21 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

8.3 air changes per hour

=

17 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

1.16

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution. MERV 13's also improved airflow, raising it from ~4.1 to 5.2.

B+ A+

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 17 minutes.

Science lab activities often produce more indoor air pollutants. Excellent air cleaning is useful.

MCDANIEL HIGH SCHOOL

McDaniel High School

Lab 213

General Science Lab

SCIENCE LABS

Aerosols linger for over 47 minutes if no air purifier is run.

No air purifier

HVAC system only

2.9 air changes per hour

=

47 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

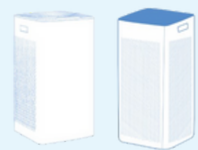
4.1 air changes per hour

=

34 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

5.8 air changes per hour

=

24 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

C- A

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 24 minutes.

MCDANIEL HIGH SCHOOL

McDaniel High School

Additional Science Lab Profiles Available Online

Room	No air purifier	HVAC + one air purifier	HVAC + two air purifiers
Science Lab 105	A	A+	A++
Science Lab 106	A+	A+	A++
Science Lab 200	B-	A	A+
Science Lab 201	B+	A+	A++
Science Lab 202	B	A	A+
Science Lab 203	B+	A	A+
Science Lab 204	B	A	A+
Science Lab 205	A	A+	A++

Grades possible with consistent use of air purifiers

Science Prep Rooms

	No air purifier	HVAC + one air purifier
Rm 101A	F	B
Rm 104A	F	B
Rm 200A	F	B
Rm 201A	F	B
Unmarked Prep Rm	F	B

Full Room-by-Room Air Quality Profiles at

safeairoregon.org/mcdaniel-profiles



McDaniel High School

SPECIAL EDUCATION

Room-by-Room Air Quality Profiles

SPECIAL EDUCATION

McDaniel High School

Room 133

Learning Resource Center

Aerosols linger for over 36 minutes if no air purifier is run.

No air purifier

HVAC system only

3.8 air changes per hour

=

36 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

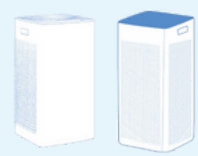
5.9 air changes per hour

=

23 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

8.8 air changes per hour

=

16 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

B-

A+

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.45

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 3.4 to 3.8

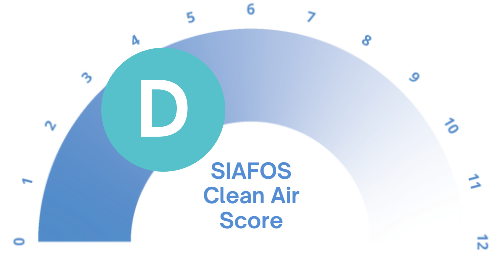
With two air purifiers, most aerosols will clear out in only 16 minutes.

MCDANIEL HIGH SCHOOL

McDaniel High School

Room 139

Intensive Skills Room



SPECIAL EDUCATION

Aerosols linger for over 38 minutes if no air purifier is run.

No air purifier

HVAC system only

3.7 air changes per hour

=

38 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

5.8 air changes per hour

=

24 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers

Add Medify & Medify Pro at speed 2

8.7 air changes per hour

=

16 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.7

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 3 to 3.7.

B-

A+

Grades possible with consistent use of air purifiers

With two air purifiers, most aerosols will clear out in only 16 minutes.

MCDANIEL HIGH SCHOOL

SPECIAL EDUCATION

McDaniel High School

Room 141

Intensive Skills Room

Aerosols linger for over 50 minutes if no air purifier is run.

No air purifier

HVAC system only

2.8 air changes per hour

=

50 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

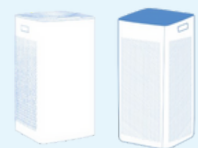
4.9 air changes per hour

=

28 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

7.9 air changes per hour

=

18 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

C-

A

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0.5

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but only improved airflow somewhat from 2.3 to 2.8.

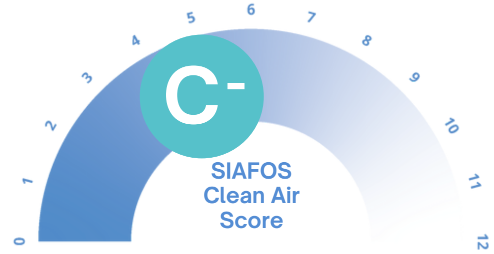
With two air purifiers, most aerosols will clear out in only 18 minutes.

MCDANIEL HIGH SCHOOL

McDaniel High School

Room 147

Behavioral



SPECIAL EDUCATION

Aerosols linger for over 29 minutes if no air purifier is run.

No air purifier

HVAC system only

4.8 air changes per hour

=

29 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

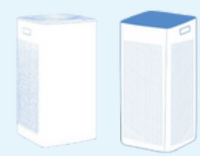
6.7 air changes per hour

=

21 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

9.3 air changes per hour

=

15 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

B+ A+

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

1.0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution. MERV 13's also improved airflow, raising it from 3.8 to 4.8.

With two air purifiers, most aerosols will clear out in only 15 minutes.

MCDANIEL HIGH SCHOOL

SPECIAL EDUCATION

McDaniel High School

Room 232

Learning Resource Center

Aerosols linger for over 1 hour if no air purifier is run.

No air purifier

HVAC system only

2.3 air changes per hour

=

1 hour 1 min

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + one air purifier

Add Medify MA-112 at speed 2

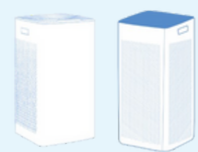
4.3 air changes per hour

=

32 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

HVAC + two air purifiers



Add Medify & Medify Pro at speed 2

6.9 air changes per hour

=

20 minutes

to clear out 90% of the students' and teacher's respiratory aerosols and other indoor air pollutants

D+ B+

Grades possible with consistent use of air purifiers

MERV 13 filters

Increase in air changes/hour due to better furnace filters

0

The new MERV 13 filters in the HVAC system are important for filtering out wildfire smoke and car pollution but did not improve airflow

With two air purifiers, most aerosols will clear out in only 20 minutes.

MCDANIEL HIGH SCHOOL

McDaniel High School

Additional SPED Profiles Available Online

Room	No air purifier	HVAC + one air purifier	HVAC + two air purifiers
233	F	C-	A

Grades possible with consistent use of air purifiers

	No air purifier	HVAC + one air purifier
Sensory Active Rm 141C	F	A++
SPED Office 141D	D+	A++

	No air purifier
Sensory Support Rm 141E	A++
SPED Conference Rm 143	A+

Full Room-by-Room Air Quality Profiles at

safeairoregon.org/mcdaniel-profiles

Next Steps for Healthy Air in PPS

Science-based solutions for clean air in
McDaniel High School, McDaniel feeder schools,
and the other eight clusters in the district

Working toward healthy air in PPS: Recommendations and goals

Every student and educator deserves to breathe healthy air. PPS has made real progress toward this goal and generally meets basic legal requirements for air quality. But the lack of regulations, lax building codes, and gaps in environmental law for indoor air[118] mean that simply meeting regulations leaves our schools with far too little airflow and far too little air quality monitoring. The findings in this report — especially from the newly modernized McDaniel building — show how far we still have to go to achieve the safe, clean air that current regulations fail to deliver.

The findings in this report also show a clear path forward for clean air. Many rooms can reach the key minimum of 6 air changes per hour if they get a second air purifier the district has had in storage. Two in-room filters can even bring some rooms closer to the ideal stretch goal of 12 air changes. Setting a minimum clean airflow target for new HVAC systems is also well within reach, while better balancing of existing systems to distribute outdoor air more evenly is possible as well. Pairing a health-based goal for airflows from new HVAC systems with in-room filtration is the critical next step to achieve both climate change goals and clean air for students, teachers, and essential student-facing staff. We have the tools, the data, and the opportunity to get clean airflow right.

This shift is urgent, to make sure we learn the lessons of the pandemic — about how respiratory viruses spread through the air. One lesson identified in Dr. Allen's keynote at the White House is that cleaning the air needs to be the first line of defense against respiratory illness.[75] We learned that airborne spread of viruses like flu, colds, and RSV is common, so if we only wash hands and clean surfaces, we are failing to prevent most transmissions.[119] As one of our partners puts it, we also have a whole new way to get sick:[120] the new coronavirus in the mix spreads when we breathe air laced with infectious aerosols. But we can cut virus transmission when we clean classroom air. These lessons aren't just scientific findings — they are calls to action.

PPS needs help improving air quality measures as it spends a $1.8 billion bond

The new campuses in the McDaniel cluster (McDaniel and Harrison Park) are part of PPS's critical effort to rebuild and upgrade schools to improve student and worker health and safety. This long-term investment in school facilities has led to significant progress in areas where parents and community members have actively engaged with the district—such as removing lead from drinking water, seismic upgrades, and prioritizing equity in high school rebuilds. These successes demonstrate the power of informed community involvement in shaping better outcomes for Portland schools.

However, ventilation and air quality remain areas that need stronger oversight and engagement. The 2020 bond provided much-needed funding to address HVAC issues across elementary, middle, and K-8 schools, but implementation has often been inconsistent, and many upgrades have fallen short of delivering truly healthy indoor air. This report further highlights the need for improved HVAC design, air quality monitoring, and data-driven ventilation strategies in both new and modernized school buildings.

As PPS moves forward with school rebuilds and HVAC system overhauls under the new $1.8 billion bond, it is essential that there is real community involvement, clear accountability measures, and a commitment to ensuring that air quality improvements are fully realized. This means engaging stakeholders in the details, following long-standing best practices in indoor air quality, pushing for new health-based practices, and getting fundamentals — like accurate airflow assessments and transparent data reporting — right.

A roadmap for improving clean airflow and air quality in PPS

As the district plans HVAC system overhauls and new buildings funded by a $1.8 billion bond, and manages systems and operations daily, air quality must be treated as a central priority with an ongoing, science-based commitment to clean air in every school. We can get there, working together, with air quality goals grounded in science and collaboration:

Set health-based airflow goals — and reach for 6-12 air changes per hour
Classrooms, learning spaces, and other occupied rooms in new buildings and HVAC system overhauls should be designed to provide at least 6 air changes per hour from the HVAC system alone, with in-room filtration retained or replaced to reach higher targets. Some spaces, like cafeterias, gyms, and auditoriums, need even more clean air when new HVAC systems are designed. Strong airflow at these levels already exists in district leadership spaces. Students and staff deserve the same clean air.

Use cleaned outdoor air effectively — and measure it right
All classrooms should receive filtered outdoor air capable of keeping CO_2 concentrations below 1,000 ppm, with additional efforts to further reduce CO_2. When windows are part of the design, they should include operable windows. The district should also consider energy recovery ventilation — not only in new schools, but across the district. Proven strategies from Portland State University's work at Harriet Tubman Middle School, where near-freeway pollution was reduced through strategic design and filtration, should be implemented at the 12 other PPS schools located near freeways.[121,122]

Make in-room filtration a permanent, quiet, and classroom-friendly priority
In-room air filtration is essential for achieving both clean air and energy efficiency goals. Every classroom and staff/student space should have air purifiers or other in-room filtration running at quiet but effective speeds. In-room filtration is key because it is cost-effective, provides air mixing, captures viruses and pollutants right in the room where they are generated, still runs when the HVAC breaks down, and is critical to energy efficiency above 4 to 6 air changes. We cannot meet climate goals if we push all of the air that needs to be filtered through the whole HVAC system in order to filter it. That kind of whole-building airflow requires fans and systems to work much harder, driving up energy use, when we aim for 8, 10, or 12 air changes per hour.

Increasing awareness and understanding of the benefits of multiple air purifiers in PPS schools will get air purifiers the district has out of storage and into classrooms, libraries, cafeterias, and other spaces that need excellent air quality. After schools are re-built or undergo HVAC overhauls, the building's inventory of air purifiers should be retained and returned, or replaced with units that are even more effective, hands-off, and/or energy-efficient.

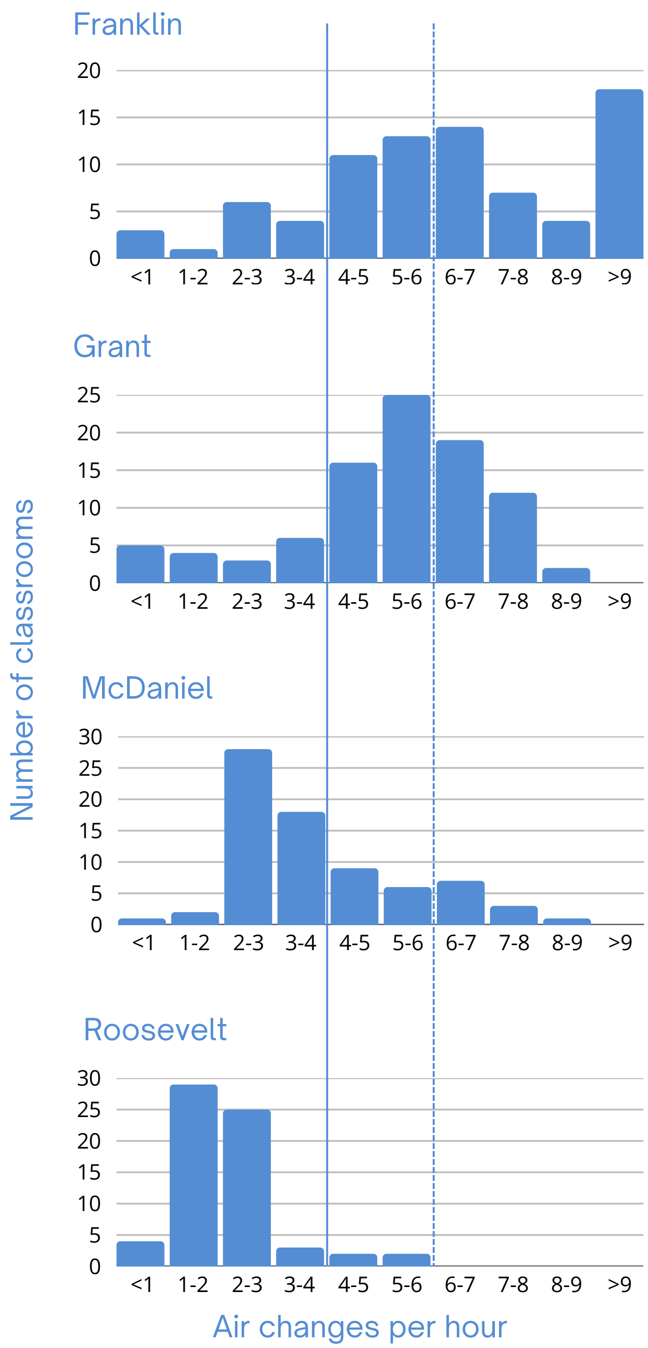
Fix the airflow data — and keep measuring it right
Accurate airflow reports should be the standard every time a school is rebuilt or upgraded. In the McDaniel cluster, Harrison Park needs a new report. Schools in other clusters currently needing new reports are: ACCESS Academy, Benson, Bridger Creative Science, Kelly, Lent, and Lincoln. Errors and inconsistencies in the current airflow reports — such as missing air purifier data and incorrect unit conversions — need correction. SIAFOS and partners have already made corrections and can work with PPS to incorporate QA'd data. Future commissioning should include accurate air purifier counts, realistic settings, rigorous QA/QC of measurements, and full public reports of testing and balancing.

Monitor what matters — where it matters
In every new or modernized building, PPS should implement transparent CO_2, particulate matter, and heat index monitoring that is accessible to staff, families, and the public, as Boston Public Schools has done.[123] In schools still waiting for new HVAC systems, PPS should support a community monitoring model, with tools like CO_2 monitors placed in the hands of school safety committees and PTAs.

Lessons from modernized schools to guide PPS's clean air plan:
6 air changes is a reachable target in future modernizations and new schools

PPS is capable of reaching truly great airflow targets. The superintendent's office and the school board meeting room, for example, get 7.5 and 13.4 air changes per hour from the HVAC system in the central office (see p. 23). These spaces also have or were assigned two air purifiers in addition to the airflow provided by the HVAC, boosting their air change rates to even better air quality. But airflows measured in district leadership spaces are not the only data showing that 6 to 12 air changes are targets PPS can reach. Data from two modernized schools that have valid airflow reports show that 4 to 6 air changes from the HVAC system, plus in-room filtration to get classrooms closer to 12 air changes are realistic goals. Unfortunately, McDaniel and three other new or modernized schools show that PPS needs to set such goals and not leave airflow rates up to the discretion of building contractors.

High school modernizations — HVAC only



53% of classrooms at Franklin get 6 or more air changes per hour from the HVAC system alone.

Nearly 30% get more than 8.

36% of classrooms at Grant get 6 or more air changes per hour from the HVAC system alone.

72% get more than 4.5 air changes.

More than 4 to 6 air changes per hour from the HVAC alone was doable for most of these rooms.

6 air changes from the HVAC is doable in Wells, Cleveland, Jefferson, and all other future modernizations.

Only 15% of classrooms at McDaniel get 6 or more air changes per hour from the HVAC.

65% get less than 4 air changes.

No Roosevelt classrooms are above 6 air changes per hour.

89% of Roosevelt classrooms get less than 3 air changes.

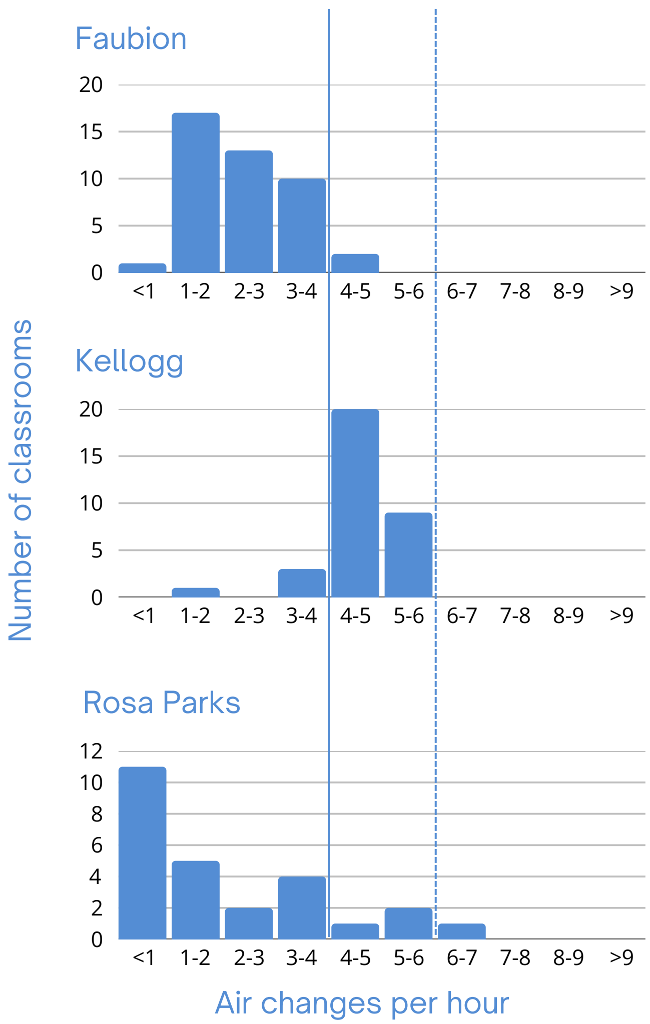
Failing to set airflow goals has left other modernized schools with extremely poor airflows

Lessons from other new and modernized schools: PPS needs goals

Airflow rates from the HVAC system in two more new buildings with valid airflow reports — Faubion K-8 School and Rosa Parks Elementary — are extremely poor, while they are average but below our minimum goal in Kellogg Middle School. In total, five new or modernized schools show low airflows in classrooms in their airflow reports.

Air quality outcomes in PPS's new and modernized schools have more examples of failure than success, but poor airflows are not inevitable. Two modernizations — Franklin and Grant — show that stronger airflows from PPS HVAC systems are achievable. The difference isn't age or construction quality — it's the absence of clear, health-based airflow targets. The pattern of low airflows in new schools also underlies our assessment that other schools with recent or ongoing HVAC overhauls, including McDaniel feeder Harrison Park (see p. 46), likely do not meet health-based goals for clean airflow, and reinforces the need for PPS to adopt those goals explicitly going forward.

New elementary, middle schools, and K-8 schools — HVAC only



72% of Faubion classrooms get less than 3 air changes per hour from the HVAC system.

42% get less than 2 air changes.

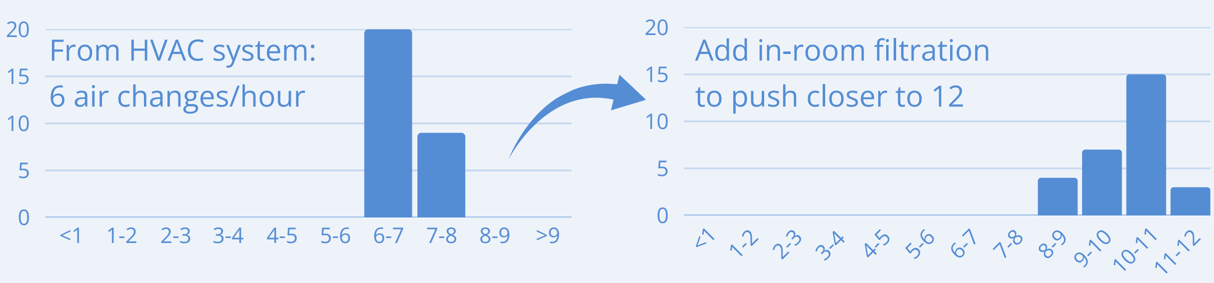
No Kellogg classrooms get above 6 air changes per hour from the HVAC. But 76% are above 4.5 air changes.

62% of Rosa Parks classrooms get less than 2 air changes per hour from the HVAC.

Only one classroom gets more than 6.

More examples of low airflows in new schools, underscoring the need for clean airflow goals.

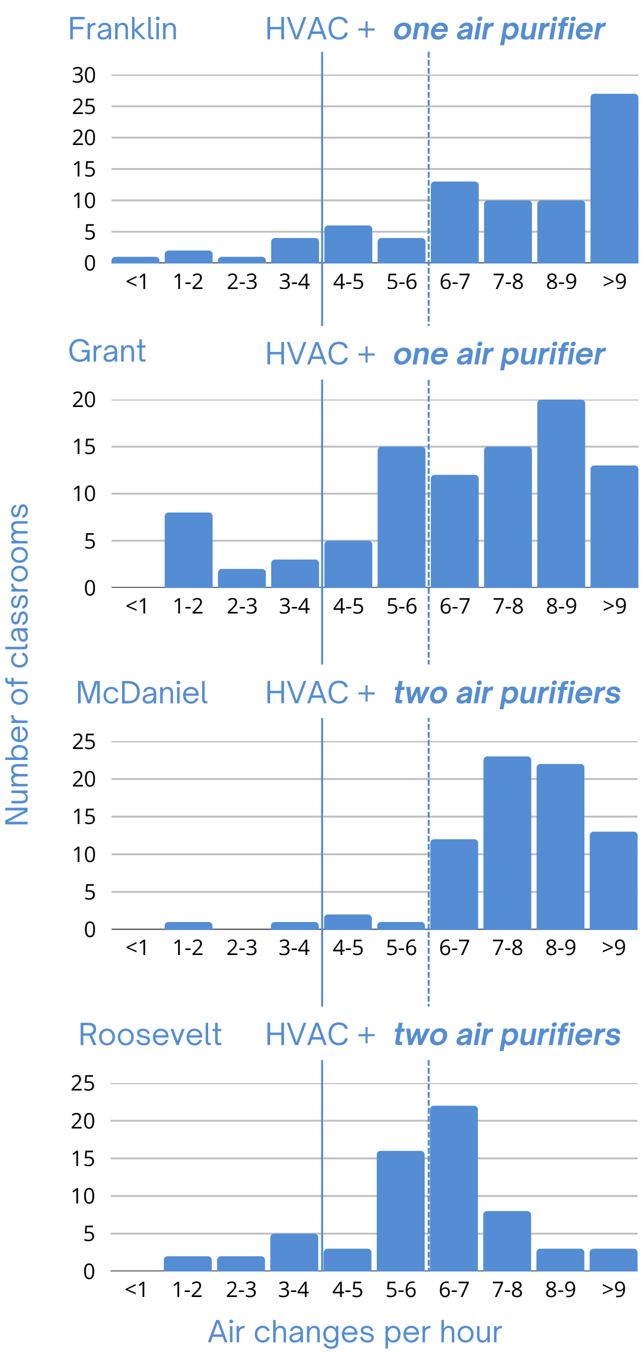
Ideal classroom airflow distributions



Lessons from modernized schools to guide PPS's clean air plan:
Closer to 12 air changes per hour is achievable with in-room filtration

Adding in-room filtration can get many classrooms above 6, and even closer to 12 air changes per hour. Franklin and Grant demonstrate this clearly: with just one Medify air purifier running at its reasonable noise level, a majority of classrooms are over 7 air changes per hour. At McDaniel and Roosevelt, two air purifiers are needed to move these buildings to health-based targets and the kinds of strong airflows most rooms at Franklin and Grant get with one unit. These clean airflow distributions echo our ideal classroom airflow distributions: the best path to safe, high-performing air quality in classrooms is HVAC systems that provide a strong baseline of clean airflow, paired with in-room filtration that builds on that baseline to reach 8, 9, 10, even 12 air changes. This isn't theoretical. It's already happening in parts of PPS. Reaching these levels of clean air districtwide just takes follow-through.

High school modernizations — HVAC + in-room filtration



62% of classrooms at Franklin get 7 or more air changes per hour from the HVAC system and the one assigned air purifier running at its reasonable noise level.

More than half of classrooms at Grant get 7 or more air changes per hour from the HVAC system and one assigned air purifier running at speed 2.

One unit gets many rooms to 7, 8, 9, or more air changes per hour.

Some rooms do need more than one unit to reach 6 air changes.

93% of classrooms in McDaniel can reach our goal of 6 or more air changes per hour with 2 air purifiers.

55% of classrooms in Roosevelt can reach our goal of 6 or more air changes per hour with 2 air purifiers.

Two units are needed to get these schools to a similar range of excellent airflows Franklin and Grant can get with just one unit.

The path to more clean air for less energy in new schools and HVAC overhauls: Balance HVAC airflows and in-room filtration

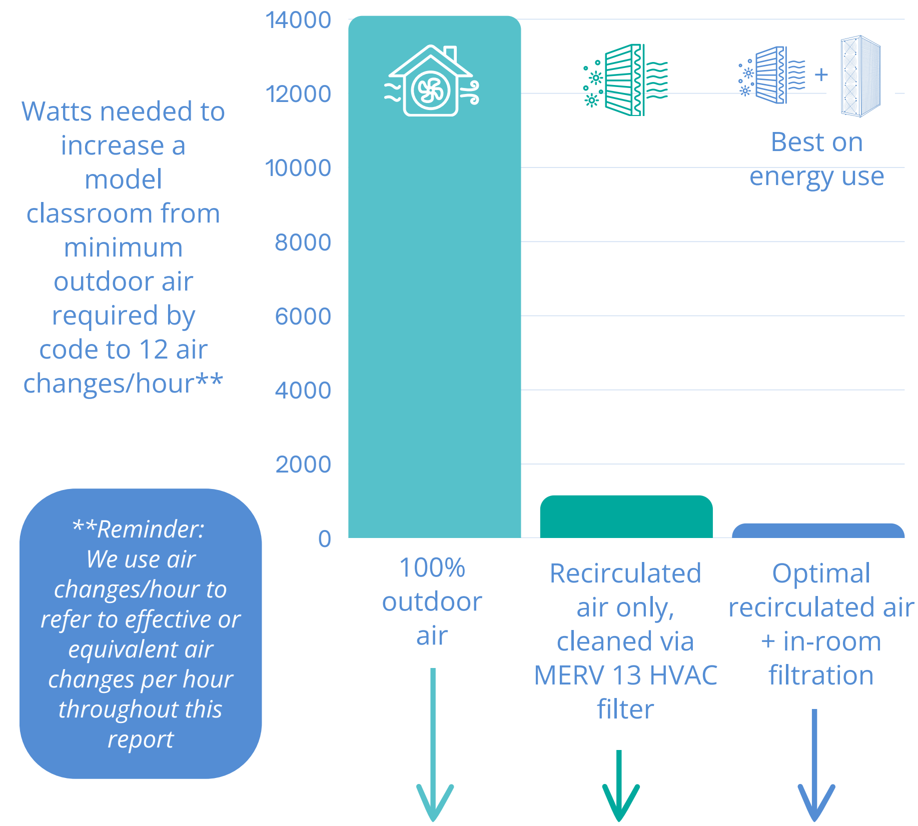
Although McDaniel's modernization is complete, with no further HVAC upgrades on the horizon, its example shows why upcoming modernizations, new schools, and new HVAC systems planned under the new bond must go further in providing clean air for student and staff health and performance. But is aiming for 12 air changes per hour realistic, or would that require unsustainable amounts of energy?

Reaching 12 air changes per hour using traditional HVAC system design would indeed be far too energy intensive. Conditioning and moving 12 changes of air from outside to inside using standard HVAC systems would take huge amounts of power. Moving and heating that much cold outdoor air into a typical classroom during winter would consume over 14,000 watts of power. That's the same amount of energy needed to run 2 to 5 U.S. homes at peak hours with multiple appliances running.

Another conventional HVAC design relies on recirculating air through MERV 13 filters, but scaling this to 12 air changes per hour is far from efficient. While recirculating air through MERV 13 filters in the HVAC would avoid the extreme energy burden of 12 air changes of outdoor air, the energy penalty of that much cleaned air is still steep. At over 1100 watts of continuous fan power for our model classroom, recirculation only would be like running a high-powered microwave continuously in the classroom.

These realities of energy use by HVAC systems often result in engineers dismissing 12 air changes per hour in schools as impossible. But what sounds impossible with HVAC alone is readily achievable with the right balance. Pairing moderate HVAC airflows with well-designed in-room filtration makes 12 air changes per hour not only achievable but energy smart and health forward. Six air changes per hour could be added to most PPS classrooms using only 28 watts — about the same energy of 2 or 3 LED bulbs. The technology to do this is not futuristic — it is already on the market. Classroom-friendly units combine high efficiency with quiet operation, small footprints in the floorplan, and long-term reliability without daily teacher attention. When combined with a health-protective minimum of 6 air changes from the HVAC, high clean airflows of 12 air changes per hour are both practical and sustainable.

Classroom energy demands under different airflow scenarios*



Watts to increase from:	Highly energy intensive	Lower but still too much energy use	Highly energy efficient
3.2 to 6 air changes/hour	4516	370	370
6 to 12 air changes/hour	9575	784	28
Total watts	14091	1154	398

**Scenarios are based on a 900-ft² classroom with a 9-ft ceiling and typical HVAC performance in winter. Zone air distribution effectiveness: 0.8. HVAC fan energy: 1250 CFM/745.7 W. MERV 13 effectiveness: 77%. Outdoor air scenario includes heating outdoor air from 40°F to 68°F using the sensible heat equation. In-room filtration scenario adds 28 W, based on measured draw of two classroom-tested units designed for and proven to provide high energy efficiency (ENERGY STAR 2025 Most Efficient).*

From McDaniel to across the district, clean air for every PPS student and teacher is possible

McDaniel High School and its feeder schools highlight both the challenges and the opportunities facing Portland Public Schools and provide lessons beyond the buildings explored. McDaniel cluster data reveal that poor ventilation rates are not just at older schools; modernizations fall short of health-based airflow goals, too. But data from the McDaniel cluster and modernized schools in other clusters also show what's possible when existing systems are paired with effective in-room filtration, and when goals are set for modernizations.

Clean classroom air is a basic building block of student and staff health, attendance, equity, and academic success. PPS has tools to achieve healthier air in all classrooms and learning spaces. By setting clear goals, prioritizing science-based solutions, and deploying practical tools like air purifiers, PPS can turn the lessons from the McDaniel cluster and other modernizations into districtwide success.

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This report is a science communication resource to advance community knowledge of ventilation, airflow, HVAC systems, and air filtration that impact the health of students, educators, and the wider community. It summarizes district and community data and analyses to inform decision-making on ventilation, air filtration, and indoor air quality. While every effort has been made to ensure accuracy, the analyses and recommendations presented are based on best-available data and reasonable assumptions; results may vary by building, system, and operating conditions. This report is not a substitute for professional engineering advice or for compliance with building codes and regulations.

THANKS TO OUR PARTNERS AND COMMUNITY ADVOCATES

This report was developed by Safe Indoor Air For Oregon Schools (SIAFOS) in collaboration with clean air advocates, scientists, and PPS community members committed to improving indoor air quality in Portland Public Schools.

We invite parents, teachers, administrators, and community members to join us in advocating for clean, healthy air in every classroom.

Learn more, sign on to our letter, or get involved at safeairoregon.org.

LET'S BRING CLEAN AIR TO YOUR SCHOOL

We're here to support parents, teachers, principals, and PPS staff working to improve classroom air. If you'd like help understanding airflow data, requesting air purifiers, or using them effectively, reach out to us at info@safeairoregon.org.

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