Enhanced Ventilation for Cleaner Air in Buildings

July 27, 2023

Today's Speakers

Brian Gilligan, PE
US General Services Administration
Deputy Director,
Office of Federal High-Performance Green Buildings

Vivian Loftness, FAIA
Carnegie Mellon University
Professor of Architecture
Center for Bldg Performance & Diagnostics

Bill Bahnfleth, PhD, PE
The University of Pennsylvania
Professor of Architectural Engineering
Chair, ASHRAE Std 241 Committee

Kevin Keene
Pacific Northwest National Labs
Building Performance Researcher

Ensuring Ventilation
A Field Study of 62 Buildings

July 27, 2023

ASHRAE Standard 241

July 27, 2023

Expert Panel
Prioritizing GSA's
Real World Research

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Pacific Northwest National Laboratory Healthy Buildings Toolkit

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Healthy Buildings Toolkit Poll

Slido.com: #cleanair to access polls and Q&A

Healthy Buildings and Energy Support Tool (H-BEST)

1. Benchmarks indoor environmental quality performance against acceptable and high-performance targets
2. Estimates the potential financial gains from improving productivity as a result of optimizing IEQ conditions
3. Identifies energy efficiency and health upgrades for buildings

U.S. DEPARTMENT OF ENERGY
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Healthy Buildings and Energy Support Tool (H-BEST)
Beta Version

https://www.energy.gov/femp/healthy-buildings-toolkit

Table 1. Estimated productivity improvement by achieving high-performance target levels.

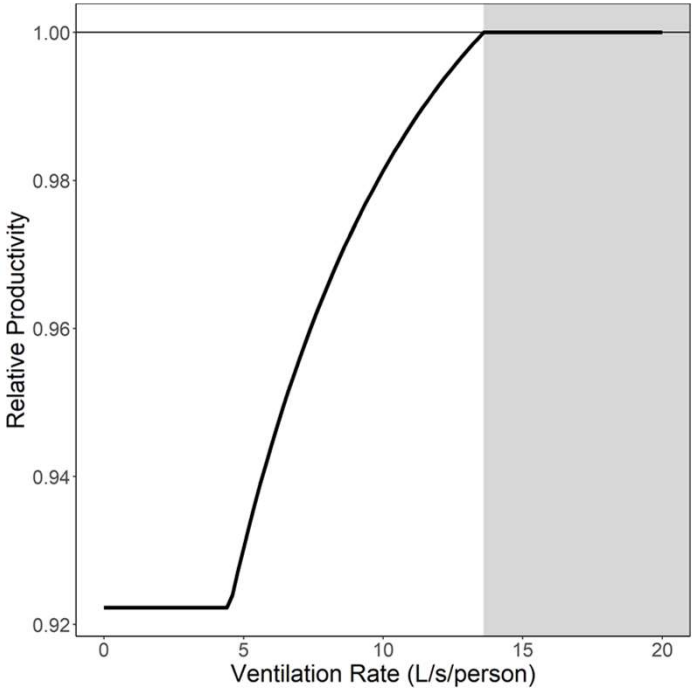
	Correlation Metric	High-Performance Target	Productivity Gain	Performance Rating	Health Savings
Indoor Air Quality	Carbon Dioxide	727 ppm	0.0%	Little improvement potential	$0
Thermal Comfort	Temperature	20°C to 24.4°C	0.2%	Moderate improvement potential	$762,000
Lighting	Horizontal Illuminance	500 lux	1.9%	Significant improvement potential	$2,732,000

Performance targets

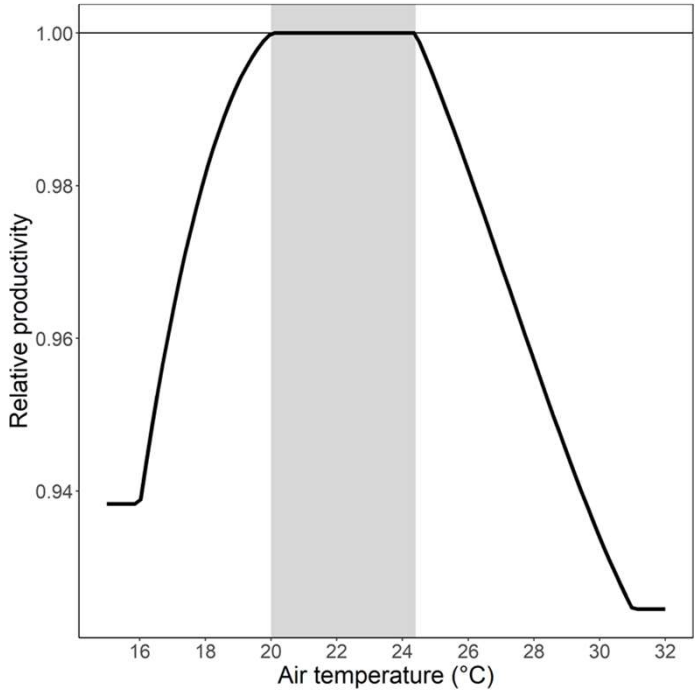
Metric	Acceptable Target	High-Performance Target	Sources
Ventilation Rate (Carbon Dioxide)	8.5 L/s per person (924 ppm steady state)	13.6 L/s per person (727 ppm steady state)	ASHRAE 62.1 WELL
Particulate Matter ($PM_{2.5}$)	25 ug/m^3	15 ug/m^3	WHO
Air Temperature	20 - 24.4 C (68 - 75 F)		OSHA
Predicted Mean Vote	-1.0 to +1.0	-0.5 to +0.5	ASHRAE 55 WELL
Relative Humidity	30 to 65%	40 to 60%	EPA/CDC Recent Research

Lighting metrics and more information about these HVAC-related targets available in H-BEST, which can be found through the link on the previous page.

Regression models for productivity



Increasing ventilation rate from 5 L/s per person to 13.6 would give an estimated 7% productivity gain



Changing temperature from 28 C (82 F) to 24 C (75 F) would give an estimated 4% productivity gain

Improvement recommendations

Indoor Air Quality	Thermal Comfort	Lighting
Demand Controlled Ventilation	Upgrade Heating/Cooling	Clean/Repair Overhead Lights
Ventilation Schedule	Adjust Temperature Setpoint	Upgrade to LED
Re-tune HVAC	Add Window Film	Install Light Diffusers
Test and Balance HVAC	Weatherize	Light-Toned Interior Colors
Increase Outdoor Air Supply	Upgrade Windows/Glazing	De-Lamp or Dimming Controls
Replace or Upgrade AHU	Energy Recovery	Translucent/Lower Cube Partitions
Upgrade to MERV 13	Dehumidification/Humidification	Window Blinds/Shading
Green Cleaning Policy	Hoteling Policy	Daylight Harvesting
Install Economizer	Adjust Air Diffuser Speed	Task Lighting

Case study - Federal office building in Illinois

Environmental Factor	JCK (400 ppl)	
	Total Expected Value (over 10 years)	Improvement Recommendations
Indoor Air Quality (6.2/10)	$12,300	Scorecard: Evaluate focus room use and OA rates; disperse CO2 with personal fans Focus: Consider automation for targeted opportunities
Thermal Comfort (3.8/10)	$2,025,150	FEMP: Check thermostat locations; adjust temperature setpoints. Scorecard: Comfort-based seat suggestions Focus: Consider automation, and options to address individual comfort

- IAQ data revealed an estimated $2M 10-year savings potential for thermal comfort, compared to $12k for air quality (data collected in March, August, and November).
- GSA Scorecard showed similar results (3.8 for thermal comfort and 6.2 for IAQ out of 10).
- Survey results aligned as well, with 72.5% of people too cool year round, and only 13% with IAQ complaints (odors and stuffiness specifically).
- Reducing HVAC cooling load in summer by calibrating sensors and adjusting thermostats could save energy and improve comfort.

Case study - Federal office building in Texas

- Lighting had the greatest room for improvement (38% of spaces too dim)
- However, occupant surveys found high levels of dissatisfaction (complaints of odor, mold, and dust)
- Research has shown an occupant's perception of air quality can be affected other IEQ factors; they often do not have a good sense of contaminant levels
- Improvements to lighting could benefit perceived IAQ satisfaction

	Percent Worse Than Target	Expected Productivity Improvement	Expected 10-yr NPV Gains
Indoor Air Quality (CO_2)	1.9%	<0.1%	<$1k
Thermal Comfort (PMV)	0.0%	0.0%	$0
Lighting (Horizontal Illuminance)	38.0%	0.6%	$965k
Combined		0.6%	$966k[a]

IEQ Measurement	Observations	Recommendations
PMV	· PMV is within comfort range · High levels of unsatisfaction	· Collect PMV data in summer and winter
CO_2	· Some high CO_2 on Wednesday and Thursday afternoons · Many complaints of odor, dust, and allergens	· Check return air filters · Consider ventilation schedule
PM	· PM levels well below threshold · Many complaints of dust and allergens	· Check return air filters
CS	· High dissatisfaction and lack of window access · CS significantly below target · High cubicle partitions with dark colors block overhead light	· Reduce partition height or incorporate translucent panels and choose partitions with light-toned surface colors or reflective interior finishes
Horizontal Illuminance	· Some dissatisfaction · Some measurements below the target and some much higher · Cubicle layout makes some too bright and others too dim	· Reduce partition height or incorporate translucent panels and choose partitions with light-toned surface colors or reflective interior finishes · Re-calibrate overhead light levels to achieve 400 to 600 lux

Integrating with the Data to Decisions (D2D) platform

Introduction | Executive Summary | Carbon Dioxide | **Particulate Matter** | Total Volatile Organic Compound | Air Temperature | Relative Humidity

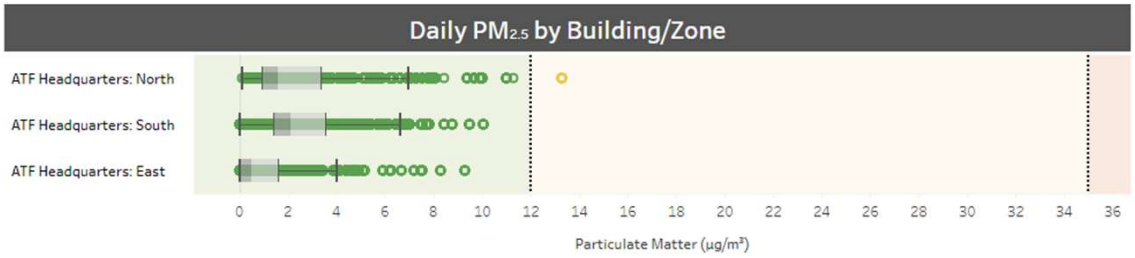
Particulate Matter

Particulate matter is a predominant indoor air pollutant. Small particulates less than 2.5 microns in diameter ($PM_{2.5}$) can enter the lungs and bloodstream when inhaled and pose a significant health risk (EPA, n.d. (a)). Larger particulates than are less than 10 microns (PM_{10}) are less of a health concern but can cause irritation to the eyes, threat, and nose. Particulate matter is produced by vehicles and industrial processes and can be transported indoors if there is not sufficient outdoor air filtration or envelope sealing. Particulate matter can arise from onsite combustion if the ducts are not properly sealed and leak into occupied spaces.

This tool uses the WELL v2 A05 Part 1 one-point threshold and the RESET Standard threshold of 12 µg/m³ or lower for $PM_{2.5}$ and 30 µg/m³ or lower for PM_{10} (WELL Building Standard 2021b)(RESET 2018). For acceptable conditions, the tool uses the RESET Standard acceptable benchmark of 35 µg/m³ or lower for $PM_{2.5}$ and the EPA benchmark of 150 µg/m³ or lower for PM_{10}. GSA's Sustainable Facilities Tool (SFTool) is a resource with more detailed information about particulate matter and targets (GSA, n.d. (a)). Particulate matter data is not correlated to any occupant outcomes in the tool but is used for developing improvement strategies.

There are various potential sources for high particulate matter levels. There could be elevated outdoor levels due to pollution, such as wildfires, industrial buildings, or automobiles. These particulates could enter the building through leaks in the envelope or through the air handler if there is insufficient filtration. The particulates could come from internal combustion or equipment that produces particulates.

Measure: Building/Zone | Date of Analysis: Previous year | Building: ATF Headquarters



The daily average $PM_{2.5}$ during occupied times are is plotted in a boxplot. Compare the charted values to the acceptable conditions (35 ug/m³) and high-performance target (12 ug/m³) shown. The values that are within the green zone are days that have no room for improvement. Each value in the yellow zone (acceptable) are days that have some room for improvement. and each value in the red zone has significant room for improvement.

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