INTERNATIONAL WELL BUILDING INSTITUTE™

IMT INSTITUTE FOR MARKET TRANSFORMATION

Building Performance Standard Module: Ventilation and Indoor Air Quality

Policy Brief

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Buildings are where we work, send our children to learn, and buy food to feed our families; the built environment touches on almost all aspects of our lives. However to date, building performance policy solutions have been created in silos and the results have typically been one-dimensional solutions that don't recognize the intersection points of health, affordable housing, and community resilience that provide the opportunity to do smarter, more holistic thinking. Recognizing this, IMT launched the **Social Priorities BPS Project** to explore these connections with an eye on providing national guidance on how to design policies that produce wider benefits.

Building performance standards (BPS) are quickly emerging as an innovative policy mechanisms that jurisdictions can use to drive action toward ambitious climate goals by improving energy use and reducing related emissions in many regions' largest emitters: Buildings. However, it is also quickly emerging that BPS policies can also serve as a platform to regulate dimensions of building performance beyond energy consumption and carbon emissions, such as health, housing affordability, and resilience. This document is part of a series of creative, impactful policy toolkits consisting of policy briefs and deployment modules that allow jurisdictions to add dimensions to a BPS to more comprehensively address complex social and environmental problems related to the built environment.

IMT seeks to inspire a shift in the way communities and governments define building performance policy, broadening the term to recognize the interconnectedness of the complex issues we face in our communities. IMT also is committed to reshaping the process by which policy is created to include traditionally excluded voices. Our team is working to help jurisdictions work alongside community-based practitioners to undertake deep community engagement initiatives at the beginning of the policy design process. By ensuring community needs and assets are integrated into the process from the beginning, jurisdictions can craft multifaceted BPS policy that addresses locally defined concerns and priorities. The solutions and tools included in the project's policy briefs and modules are meant to provide a starting point for jurisdictions to engage with community members on building-related issues that are important to the community. IMT sees this work as a living document that will continue to evolve.

This document is also part of a larger IMT suite of BPS resources, including the IMT Model BPS Ordinance and a forthcoming BPS Implementation guide (Winter 2022). Additional social priority toolkits are in development. For the most up-to-date collection of resources, visit imt.org/BPS.

Acknowledgements
This policy brief is the result of a near year-long collaboration between the Institute for Market Transformation and the International WELL Building Institute (IWBI). IWBI administers the WELL Building Standard, a roadmap for creating and certifying spaces that advance human health and well-being. The WELL Standard has been adopted in over 2.7 billion square feet of space, in 98 countries. We are grateful to the entire IWBI team for their collaboration and help to inform this work, particularly Nathan Stodola and Eric Sun. We would also like to thank Roger Chang (DLR Group), David Hsu (MIT), Joseph Allen (Harvard), and the members of IWBI's Air Advisory for their consultations on this document.

The Importance of Indoor Air Quality

Ambitious building performance standards—state and local policies that set and enforce performance targets for buildings—have the potential to generate massive energy and carbon savings critical to addressing the climate crisis. However, it's increasingly imperative that performance-based policy look beyond carbon and energy. Buildings are where we live and work, send our children to learn, and buy food to feed our families. The built environment touches on almost all aspects of our lives. As the SARS-COV-2 (COVID-19) pandemic has starkly emphasized, buildings can be both a refuge as well as a danger to our health.

Buildings serve as one of many nexus points where policymakers have the opportunity to address these layered issues in a more holistic way. Building performance standards can integrate requirements that touch on issues such as health by targeting ventilation system performance and indoor air quality. This policy brief outlines how interested jurisdictions can integrate specific health parameters into a BPS and, in parallel, start to build a more equitable policy solution.

The air we breathe can either support or harm our short- and long-term health. Given that we spend approximately 90% of our lives indoors, providing high indoor air quality and sufficient ventilation is imperative for building systems design and operations. The COVID-19 pandemic has made clear the importance of adequate mechanical ventilation, air source control, and filtration in fostering acceptable indoor air quality (IAQ).[i ii]

In spite of IAQ's importance to public health, there is currently a disconnect between its significance and the prevalence of air quality data measurement and collection. In particular, building owners and governments lack visibility into how buildings impact occupant health outcomes. The majority of ventilation design standards specify ventilation rates and other measures intended to provide indoor air quality that is merely "acceptable" to building users.[iii] This is inadequate because even with proper ventilation designed to meet ventilation standards, the concentration of indoor pollutants can exceed concentrations found in outdoor air.[iv]

The lack of accessibility to air quality data creates a burden that falls heaviest on our children, our elderly, and those with the fewest resources to address the resulting health challenges. While high-performing, sophisticated buildings often have the technologies in place to monitor air quality and ventilation system performance, the majority of our buildings still do not—especially those that house and serve vulnerable citizens. Indoor air quality affects children more than adults because their respiratory systems are not fully developed, and as a result, exposure to air pollutants increases the risk of severe respiratory illnesses, including chronic bronchitis and asthma.[v] Further, poor ventilation is linked to decreased productivity in students.[vi] An emerging body of evidence indicates that air pollution can disrupt physical and cognitive development in children.[vii]

Many older buildings were built without mechanical ventilation at all. This scenario puts building occupants at greater risks for not only respiratory illness, but also airborne contagious disease, including SARS-COV-2 (COVID-19).[viii ix]

Failing to address indoor air quality has costs for both the public and for businesses. Estimates by the U.S. Environmental Protection Agency suggest that net avoidable costs associated with indoor air pollution amount to well over $100 billion annually, with 45% of those costs attributable to avoidable deaths from radon and environmental tobacco smoke, about 45% from lost productivity and about 10% from avoidable respiratory diseases.[x] Researchers have also identified a clear relationship between indoor air quality and human productivity in buildings.[xi] An average of 10% of productivity loss in office buildings could be attributed to health issues related to poor indoor air quality. One U.S.-based study reported that the sick leave attributable to insufficient provision of fresh air in buildings contributed to an estimated 35% of total absenteeism.[xii] Economic costs of sick building syndrome (SBS) in under-ventilated buildings are significant and far exceed energy-related cost savings stemming from under ventilation.[xiii][xiv] If we factor in losses related to building closures during the pandemic, the costs of poor indoor air quality become even more dramatic.

Over the last 40 years building designers have devised technical solutions to address SBS, multiple building-related illnesses, and other chemical sensitivities that cause occupant discomfort.[xv] America has reduced childhood asthma rates and the presence of environmental tobacco smoke, and we are beginning to reap the positive impacts of improved indoor air quality on worker productivity. Now, it has become critical that our indoor environments help reduce the viral load of SARS-CoV-2 through improved ventilation and related sensing and testing regimens.

Relatedly, the emphasis on increased ventilation and guidance around opening windows lead many to wonder if energy performance requirements, like those imposed by a BPS, need to be eased.

While there are often trade-offs between increased filtration levels and energy performance in certain types of mechanical equipment, new technologies are increasingly enabling strategies to improve both ventilation and energy efficiency. It is now critical that policy-makers begin to holistically consider how requirements around building energy performance can align with ventilation considerations, so that conflicting mandates or unintended consequences do not result. Designing a building performance standard that includes requirements around ventilation and indoor air quality is one way to do just that and to start breaking down some of the silos that exist in our regulatory structures.

Lastly, locally relevant climate change impacts such as the wildfires that wreaked havoc on the West Coast in recent years underline the need for buildings as a refuge to provide healthy indoor air and climate resilience. Acknowledging the balance of the need to provide safe and comfortable indoor environments with the effect that the creation of these environments has on the climate is critical. Addressing both energy efficiency and IAQ in the same BPS incentivizes building owners to consider systems as a whole while investing in major upgrades that will be in place for decades to come. Many HVAC technologies, for example, have a useful life of 20 years or more. As climate change impacts continue to evolve and accelerate, it is imperative that policy makers take a long term view of these overlapping considerations.

$100+ billion net avoidable costs associated with indoor air pollution annually

~45% of those costs attributable to avoidable deaths from radon and environmental tobacco smoke

~45% from lost productivity

~10% from avoidable respiratory diseases

Adding Indoor Air Quality to Building Performance Standards

Building Performance Standards (BPS) are one of the most powerful tools for state and local governments to reduce building energy use and bring down climate emissions. These policies are primarily focused on incentivizing building owners and operators to reduce energy use and switch away from fossil-fuels. With the goal of protecting occupant health, BPS can be expanded to include one or more standard performance metrics focused on ventilation and indoor air quality. However, doing so is a challenge for a number of reasons.

Assessing ventilation and IAQ is often complicated and can be expensive. IAQ is dependent on several factors, including the number of individuals within a space, the activities they are performing, the capability of ventilation systems, and pollutants from both indoor and outdoor sources. While ventilation design standards have changed over time, inadequate ventilation is more likely to result from changes in building occupancy or use, or from failure to maintain a system, rather than from the ventilation having been designed to an older standard. At the same time, code ventilation requirements are prescriptive; they require only a minimum amount of outside air in a space and do not verify that adequate ventilation is reaching all spaces. Design alone does not guarantee performance.

Many building owners lack the financial and technical capabilities to measure ventilation rates and indoor air quality. Accurately assessing ventilation performance is challenging, as it requires continuous IAQ monitoring as well as the resources to interpret the resulting data and make necessary adjustments. On the other hand, relying on the original system design, especially as buildings change over time, could be costly in terms of the health and productivity impacts listed above. There is no one-size-fits-all approach for assessing the performance of a building's ventilation system or any single metric that would provide comprehensive, actionable information to both building owners and jurisdictions.

The result of this complicated landscape is a data and knowledge gap around how our buildings are performing in terms of indoor air quality. In the COVID-19 era, this means that building owners and policy makers lack clear information about the health risks imparted by spending time in buildings in their communities. For example, are office buildings providing occupants with enough well-distributed outdoor air for workers to safely return? What about school buildings? High-performing building standards such as LEED or WELL are a step closer to closing the knowledge gap, as those standards address ventilation system performance and indoor air quality; however, while these rating systems provide an important foundation for understanding how to approach this challenge, they are not an applicable policy solution for targeting all buildings. In order to address under-performing as well as potentially under-resourced buildings, we need a simple and relatively low-cost mandate that is accessible to everyone.

Policy Solution

Policy Planning

To assess how best to support residents through a BPS requirement, one must understand the landscape of health outcomes and potential inequities in the jurisdiction in buildings subject to and outside the proposed BPS coverage. BPS health metrics should be tailored to address community concerns, such as high incidences of asthma or smoke from wildfires. Further, it's important that policymakers understand related codes and regulations to ensure there is no conflict with other existing building requirements.

The BPS planning stage is also the right time to start an inclusive community engagement process, where frontline communities and community-based organizations that have local expertise can voice the health concerns community members are dealing with and co-design the best solution for the communities they represent. One of the mechanisms recommended in IMT's model Building Performance Standard is the creation of a Community Accountability Board which has formal authority to ensure community members have a role in the implementation of the BPS. In researching local health concerns, jurisdictions should consider including representative health experts, such as community health workers, or environmental justice stakeholders on the Community Accountability Board to ensure that health requirements speak to local needs and produce meaningful results.

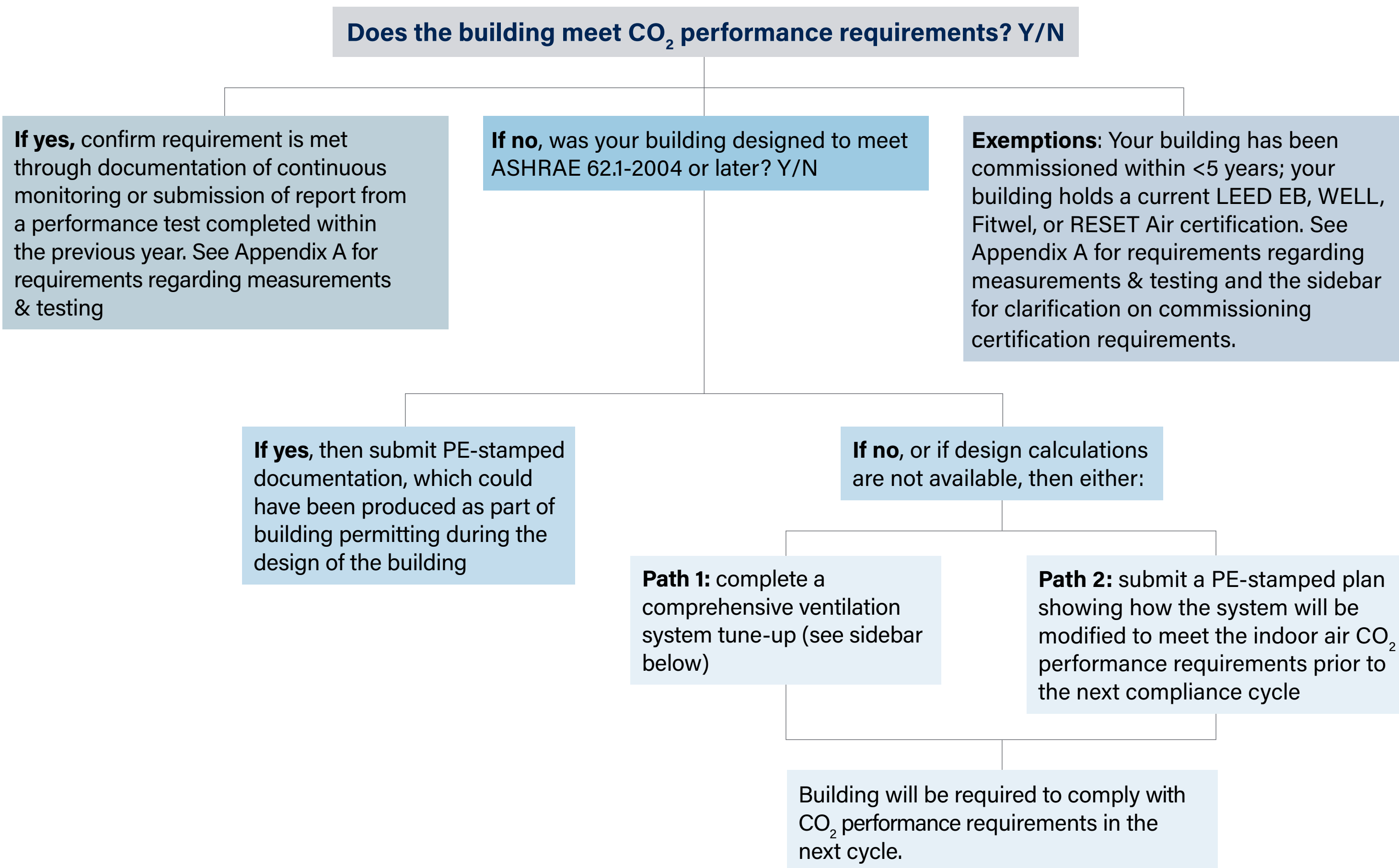
Policy Design

As part of baseline health protections for new buildings, building codes and many high-performance building frameworks reference ASHRAE 62.1 as the requisite standard for starting point for mechanical ventilation design and adequate IAQ. However, in most cases, jurisdictions don't have insight into how many buildings meet even this baseline level of design protection. To further protect health, jurisdictions should consider adopting a BPS that assesses ventilation system baseline design and then integrates the measurement and collection of an additional set of IAQ parameters, starting with carbon dioxide (CO_2) and expanding later to include other pollutants. Due to the measurement and verification challenges discussed above, we recommend a graduated approach towards this goal. The technology to detect CO_2 is widely available and less expensive than the equipment necessary for other potential pollutants. Measuring CO_2 will provide owners and occupants with an indication of how much outside air is getting to the space, and how well the air is circulated. Thus CO_2 levels can serve as a proxy for other indoor pollutants. Nevertheless, measuring additional air pollutants will provide building operators with a more comprehensive awareness of buildings performance. A few critical pollutants include:

- **Formaldehyde**, a common indoor air pollutant that can act as an irritant and carcinogen, off-gasses from many composite wood products, paints, and other finishes,[xvi] and is commonly found above thresholds considered acceptable.[xvii]
- **Particulate matter** from natural or anthropogenic sources can infiltrate buildings through the envelope or be introduced via the ventilation system; in fact nearly ⅔ of the average person's exposure to outdoor air particle inhalation occurs while indoors.[xviii]
- **Ozone** is a component of smog that can cause long damage and shortness of breath;[xix] it is produced as a byproduct of some electronic air cleaners.[xx]

By starting to collect more accessible, relevant performance data and then setting ambitious but achievable long-term performance targets, this approach to IAQ measurement would align with the trajectory approach to BPS design recommended in IMT's model BPS. As with the trajectory approach to energy reduction, an important component for improved IAQ would be setting interim targets to ensure that building owners make timely progress toward achieving the final standard.

BPS compliance cycle 1 (years 1-5), IAQ requirement



Sample Reference HVAC Tune-up Guidance

1. Conduct a complete HVAC inspection and perform any necessary maintenance and/or cleaning procedures prescribed. The HVAC systems must be regularly inspected and maintained in accordance with ASHRAE Standard 180-2018: Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems requirements (or approved alternative).

   References for HVAC Inspection, Maintenance, and Cleaning guidelines

   ASHRAE Standard 180-2018: Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems

   Recommend a focus on airside systems specifically as this policy does not look at chilled or hot water systems

   https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-commercial-c19-guidance.pdf

   NADCA ACR Standard 2021

2. Conduct a HVAC Testing, Adjusting, and Balancing (TAB) audit in accordance with ASHRAE Standard 111-2008 (RA 2017) Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems through a qualified MEP/HVAC Engineer that produces a TAB report. Perform any recommended adjustments recommended in the report. References: http://www.nebb.org/assets/1/7/PST_TAB_2005.pdf

3. Seattle Retuning Guidance, HVAC tab - all items listed as voluntary should be considered mandatory for this purpose. https://www.seattle.gov/environment/climate-change/buildings-and-energy/building-tune-ups/resources

BPS compliance cycle 2 (years 6-10), IAQ requirement

Does the building meet CO_2 performance requirements? Y/N

If yes, confirm requirement is met through documentation of continuous monitoring or submission of report from a performance test completed within the previous year

If no, did the building comply with cycle 1 via path 2 (system modification)? Y/N

Exemptions: Your building has been commissioned within <5 years; your building holds a current LEED EB, WELL, Fitwel, or RESET Air certification. See Appendix A for requirements regarding measurements & testing and the sidebar for clarification on commissioning certification requirements.

If yes, were all planned modifications implemented? Y/N

If yes, complete a comprehensive ventilation system tune-up and demonstrate ability to meet CO_2 performance requirements within one year

If no, complete all planned modifications and demonstrate ability to meet CO_2 Performance Requirements within one year; an alternative compliance payment may be assessed

If no, was the building issued its certificate of occupancy within the previous cycle?

If yes, complete a comprehensive ventilation system tune-up and demonstrate ability to meet CO_2 performance requirements within one year

If no, submit a PE-stamped plan showing how the system will be modified to meet the CO2 performance requirements; implement and demonstrate compliance within one year

BPS compliance cycle 3 (years 11-15), IAQ requirement

Does the building meet IAQ performance as defined in Appendix A? Y/N

If yes, confirm requirement is met through documentation of continuous monitoring or submission of report from a performance test completed within the previous year

If no, was the building issued its certificate of occupancy within the previous cycle?

Exemptions: Your building holds a current LEED EB, WELL, Fitwel, RESET Air certification. See Appendix A for requirements regarding measurements & testing and Appendix B for clarification on certification requirements.

If yes, complete a comprehensive ventilation system tune-up and/or necessary system upgrades and demonstrate ability to meet IAQ performance standards within one year

If no, submit a PE-stamped plan showing how the system will be modified to meet the IAQ performance standards; implement and demonstrate compliance within one year. An alternative compliance payment may be assessed

Policy Implementation

Jurisdictions will have to invest significant rulemaking, implementation, and enforcement resources to ensure compliance with the ventilation and IAQ requirements outlined above. Monitoring, enforcement, and compliance support infrastructure are key elements to the success of any policy, and this is doubly so for new types of requirements. Jurisdictions will need to develop data collection systems to work in parallel with energy benchmarking portals, such as ENERGY STAR Portfolio Manager. Jurisdictions that are considering expanding the purview of their performance standard must ensure they have adequate staff capacity, resources, and technical capabilities to implement these requirements successfully.

To assure successful implementation jurisdictions will also need to ensure that the local workforce is trained and has capacity to support building owner compliance. Jurisdictions should engage with engineering firms that specialize in IAQ testing to design the IAQ testing parameters; this will ensure owners can comply using locally-based contractors.

For more guidance on implementation, see IMT's forthcoming BPS Implementation Guidance.

Appendices

Appendix A

Additional IAQ Parameters and Testing

The table below lays out IAQ parameters often discussed by building engineers, as well as references to best practice testing methodologies. The table can be used as part of a policy dialogue with the local professional community to adopt the right mix of parameters to speak to priority health issues or climate risks. The thresholds may be adjusted to relate to local codes or updated as technologies advance. And, the testing methodology you specify should be written to be in line with local practitioner preferences. Our intent is to illustrate the technical nuances of adopting this approach, rather than to provide a definitive list.

Parameter	Threshold	References	Performance Test Methodology Requirements	Continuous Monitor Sensor Requirements	Related Health Outcome or Climate Related Risk
Suggested Maximum CO_2 Performance Requirements					
Carbon Dioxide	1000 ppm or +700 ppm above outdoor CO_2 levels	ASHRAE 62.1 EN13779	**Standard**: ASTM D-6245-98 Continuous Monitor Requirements Accepted	**Sensor**: NDIR Range: 400-2000 ppm Accuracy: ± 10% or 50 ppm **Resolution**: 1 ppm	CO_2 is a proxy metric for ventilation performance in a space. High performing ventilation systems will help reduce the spread of airborne pathogens such as S ARS-COV-2 (COVID-19). Sick building syndrome symptoms decrease significantly, when CO_2 concentrations are less than 800 ppm.[1]
Suggested Minimum Indoor Air Quality Performance Requirements					
PM 2.5	15 ug/m3	Environmental Protection Agency[2], World Health Organization[3]	**Sensor**: Particle Counter Range: 1-1000 ug/m3 Accuracy: ± 15% Resolution: 1 ug/m3 LOD: 1 ug/m3 Note: submission must include density factor used for particulate matter	**Sensor**: Particle Counter Range: 1-1000 ug/m3 Accuracy: ± 15% Resolution: 1 ug/m3 LOD: 1 ug/m3 Note: submission must include density factor used for particulate matter	Exposure to particulate matter (PM) is associated with many negative health outcomes. ▪ $PM_{2.5}$ can penetrate deep into the lungs, enter the bloodstream and as a result, cause a variety of health issues, including heart disease and other cardiovascular complications.[4]

1 Seppänen OA. Association of ventilation rates and CO2 concentrations with health and other responses in commercial and institutional buildings. Indoor Air. 1999;9(4):226-252.

2 EPA National Ambient Air Quality Standards. https://www.epa.gov/criteria-air-pollutants/naaqs-table.

3 World Health Organization. Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide. Geneva, Switzerland; 2005.

4 World Health Organization. Health Effects of Particulate Matter: Policy Implications for Countries in Eastern Europe, Caucasus and Central Asia. Geneva, Switzerland http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/health-effects-of-particulate-matter.-policy-implications-for-countries-in-eastern-europe,-caucasus-and-central-asia-2013

Parameter	Threshold	References	Performance Test Methodology Requirements	Continuous Monitor Sensor Requirements	Related Health Outcome or Climate Related Risk
Formaldehyde	50 ug/m3	Health Canada[5]	Lab: ISO 16000-3, ASTM D5197, NIOSH 2016, EPA TO-11 (or 11A) or EPA Compendium Method IP-6 (or 6A)		Many buildingb materials, carpets, furniture finishes, other furnishings, fabrics, cleaning products, personal care products, adhesives, solvents, and air fresheners emit VOCs or semi-volatile organic compounds (SVOCs) into the indoor environment.[1,2] VOCs include benzene, formaldehyde and other chemical compounds, which at high concentrations can lead to the irritation of the nose and pharynx and have been associated with leukemia and Nasopharyngeal cancer.[3,4] Health effects can also include damage to the liver, kidneys and central nervous system.[5]
Carbon Monoxide	9 ppm	Environmental Protection Agency[6]	Lab: ISO 4224 (NDIR) Continuous Monitor Requirements Accepted	Sensor: NDIR, Electrochemical Range: 0-25 ppm Accuracy: +/- 15% Resolution: 0.1 ppm LOD: 0.1 ppm	Carbon monoxide is a colorless and odorless gas that can be lethal. It is found as a byproduct of incomplete combustion and can be generated from vehicles and gas appliances such as stoves, grills, fireplaces, lanterns, furnaces, etc. Common symptoms of carbon monoxide poisoning include headaches, confusion, weakness, dizziness, vomiting, chest pain, and can lead to unconsciousness and death.
Ozone	100 ug/m3 (51 ppb)	World Health Organization. [7]	Lab: OSHA ID-214, ISO 13964, ASTM D5149-02 -- Sensor: NDIR, Electrochemical Range: 0-500 ppb Accuracy: +/- 15% Resolution: 5 ppb LOD: 5 ppb	Sensor: NDIR, Electrochemical Range: 0-500 ppb Accuracy: +/- 15% Resolution: 5 ppb LOD: 5 ppb	Elevated ozone is particularly threatening for individuals with asthma, young children, older adults and people who work outdoors, and is linked to a variety of health outcomes including chest pain, throat irritation, airway inflammation, lung tissue damage and risk of death from respiratory causes.[27,28] Ozone can also react with other airborne contaminants and disinfectants to form harmful by-products such as aldehydes and ketones, which can cause other health issues.

5 Health Canada. Residential Indoor Air Quality Guideline: Formaldehyde.; 2006. https://www.canada.ca/content/dam/canada/health-canada/migration/healthy-canadians/publications/healthy-living-vie-saine/formaldehyde/alt/formaldehyde-eng.pdf.

6 EPA National Ambient Air Quality Standards. https://www.epa.gov/criteria-air-pollutants/naaqs-table

7 World Health Organization. Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide. Geneva, Switzerland; 2005.

Additional IAQ Testing Methodologies

Alternative Allowable Performance Test Methodologies: WELL V2 (Performance Verification Guidebook (Q1 2021 Addenda), LEED, and BREEAM

Alternative Allowable Continuous Monitor Sensor Requirements: WELL V2 (Performance Verification Guidebook (Q1 2021 Addenda), RESET Air Accredited Monitors (Grade A or Grade B)

Other Methodology Requirements:

- Performance Test -- Lab: minimum two continuous hours or duration of sampling volume prescribed by the referenced testing methodology
- Performance Test -- Direct-read Sensors: minimum two continuous hours with measurements recorded once every minute
  - Monitors are recalibrated annually or per manufacturer's recommendations
  - Continuous Monitoring – Sensors: measurements are taken at intervals of no longer than 1 hour
- Monitors require at least 90% uptime
- Monitors are recalibrated annually or per manufacturer's recommendations

Calculating Compliance:

- Performance Test -- Lab: based on measured concentrations at each location must pass threshold requirements
  - For benzene analysis, it is recommended to utilize a lab that can express results utilizing a benzene calibration standard instead of express in toluene equivalents (TELs)
- Performance Test -- Direct-read Sensors: minimum two continuous hours (120 minutes total data logging period; 10 minutes acclimation period followed by 110 minutes of measurement time)
  - Compliance is based on the average value collected during the measurement time (data logging period – acclimation period). Each location must pass threshold requirements
    - Continuous Monitoring – Sensors: measurements are taken at intervals of no longer than 1 hour
  - Compliance is based on the annual average of the hourly data during occupied hours for each location. 90% of all monitoring locations must pass threshold requirements
  - Monitors require at least 90% uptime

Continuous Monitoring or Performance Testing Location Guidance

Selected locations will be representative of all commonly regularly occupied spaces. A regularly occupied space is defined as a space within a building where at least one individual normally spends time (at least one continuous hour per person) as they work / perform typical activities within the space.

- Open office spaces – 1 per 400 m2
- 20% of other normally occupied space types, including but not limited to:
  - Private offices
  - Meeting rooms
  - Pantries/cafeterias
  - Training Room
  - Specialty Rooms (nursing, exercise, etc.)

- Unique Space Types
  - For projects containing large open spaces (gyms, conference/ball rooms, etc.), one monitoring location is sufficient for an area of up to 2,500 m2 if there is evidence that the air is evenly mixed and contaminant sources are uniform
  - Hotels and Resorts Guest Rooms and School Classrooms – 5% of each unit type, minimum 2 and maximum of 20 per unit type
  - Locations should be in areas that are representative of occupant breathing zones
  - 1-1.7m above the floor, within the "breathing zone" (chest and head height of normal adult)
  - At least 1 m away from HVAC supply/exhaust outlets, doors, operable windows, newly painted surfaces, etc.
- Monitoring or Sampling should be HVAC system under normal operating conditions and under normal occupancy

Appendix B

Details on Building Commissioning and Certifications Qualifying as Compliance Paths

Commissioning

The building has undergone comprehensive systems retro- or recommissioning in accordance with ASHRAE (or equivalent) guidelines.

WELL v2

- Applicable to new and existing buildings, applies the most comprehensive approach to IAQ
- Certification qualifies for cycles 1, 2, and 3

LEED EB

- **LEED v4:**
  - For cycle 1, all certified buildings qualify
  - For cycle 2, exceptions are only awarded for buildings that achieved EQ Credit: Enhanced Indoor Air Quality Strategies, Option 2
  - Exceptions are not made for cycle 3
- **LEED v4.1**
  - For cycles 1 and 2, all certified buildings qualify
  - For cycle 3, buildings must show that contaminants tested for the Indoor Environmental Quality Performance prerequisite align with contaminants listed in BPS ordinance

Fitwell

- For cycles 1 and 2, exceptions are only awarded for buildings that achieve strategies for either Indoor Air Quality Policy or Indoor Air Quality Testing
- For cycle 3, buildings must achieve the Indoor Air Quality Testing strategy

RESET Air Standard

Technical Resources

ASHRAE Standards:

ASHRAE Standard 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size. This standard establishes a test procedure for evaluating the performance of air-cleaning devices as a function of particle size.

ASHRAE Standard 55 - Thermal Environmental Conditions for Human Occupancy. The purpose of this standard is to specify the combinations of indoor thermal environmental factors and personal factors that will produce thermal environmental conditions acceptable to a majority of the occupants within the space.

ASHRAE Standard 62.1 - Ventilation for Acceptable Indoor Air Quality. The purpose of this standard is to specify minimum ventilation rates and other measures intended to provide indoor air quality that is acceptable to human occupants and that minimizes adverse health effects.

ASHRAE Standard 90.1 - Energy Standard for Buildings, Except Low-Rise Residential Buildings. The purpose of this standard is to provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings.

ASHRAE Standard 100 - Energy Efficiency in Existing Buildings. This standard provides a comprehensive approach to the retrofit of existing buildings for increased energy efficiency.

ASHRAE Standard 145.2 - Laboratory Test Method for Assessing the Performance of Gas-Phase Air-Cleaning Systems: Air-Cleaning Devices. This standard provides a standard laboratory test method for assessing the performance of sorptive media gas-phase air cleaning devices. The results of these tests can provide information to the engineer useful for the design and selection of air cleaning equipment and the design of air cleaning systems for controlling indoor concentrations of gaseous air contaminants.

ASHRAE Standard 189.1 - Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings. The purpose of this standard is to provide minimum requirements for the siting, design, construction, and plans for operation of high-performance green buildings.

Understanding the Roles and Requirements for Verifying Commercial Building Applications for ENERGY STAR® Certification

Analysis of Ventilation Data from the U.S. Environmental Protection Agency Building Assessment Survey and Evaluation (BASE) Study

Endnotes

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