BSR/ASHRAE Addendum t
to ANSI/ASHRAE Standard 62.1-2016

Public Review Draft

Proposed Addendum t to Standard 62.1-2016, Ventilation for Acceptable Indoor Air Quality

Second Public Review (August 2018)
(Draft shows Proposed Changes to Current Standard)

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(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

This proposed addendum adds a new informative appendix which is a companion to the changes to the Natural Ventilation Procedure. It provides information for application of the new procedure.

[Note to Reviewers: This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the current standard are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed changes.]

Addendum t to 62.1-2016

Add a new Informative Appendix L as shown below.

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INFORMATIVE APPENDIX L
INFORMATION ON NATURAL VENTILATION

L.1 Outdoor Air Quality Data. Outdoor air quality data may be considered valid if it is demonstrated that the data is both physically representative and spatially representative.

Physically representative data accurately reflects the air quality conditions at the monitoring station from which it is derived. Data is considered physically representative if it is obtained from:

- i) reports of historical levels of air pollutants published by the relevant local, regional, or federal entity with statutory responsibility for collecting and reporting air quality information in accordance with applicable air quality regulations; OR
- ii) an on-site monitoring campaign that is verifiably comparable to local, regional, or federal guidelines and methods for demonstration of compliance with applicable air quality regulations.

Spatially representative data is collected from a monitoring site that may differ from the proposed project location but is informative of the air quality conditions at the proposed project location. Data may be considered spatially representative if it is:

- iii) the same as that used by the entity charged with demonstrating regulatory compliance for the geographic region that includes the proposed project location, OR
- iv) derived from an on-site monitoring campaign that also meets the requirement stated by criteria ii of this annotation.

L.2 Natural Ventilation Rate. When calculating the ventilation rate, specific path(s) of the intended airflow passage must first be determined as well as flow directions. There are two driving forces for natural ventilation:

buoyancy and wind. The two driving forces can work cooperatively or competitively based on the environmental conditions of wind speed, direction, indoor/outdoor air/surface temperatures, as well as the intentional airflow path and mechanisms.

1. In the case of an engineered NV system that results in multiple flow scenarios, each must be examined and considered separately.
2. Specific pressure-based calculation of natural ventilation flow rate is documented in ASHRAE Handbook Fundamentals Chapter 16, Section 6:
   a. Buoyancy induced airflow can be calculated following Equation (38).
   b. Wind-driven airflow can be calculated following Equation (37).
   c. The overall pressure (driven by both wind and stack effect) converted to resulting pressure difference between openings can found in Equation (36)

For obtaining wind-driven pressure, several methods are available:

1. ASHRAE Fundamentals Handbook Chapter 24 provide a method to convert wind speed and direction into pressure coefficients that can be used to determine wind-driven pressure
2. CIBSE AM10 provides a method to account for wind-driven ventilation in Chapter 4 and outlines specific challenges to it in 4.4.1.
3. If the building has undergone wind tunnel test for structural stress, the same test can provide detailed pressure coefficients.
4. Outdoor airflow simulation (such as computational fluid dynamics based simulation) can be used to obtain the specific flow condition at the intended openings

For intended openings that are large, such as open atrium or open balcony and/or when the flow path is not well defined such as when only single or single side openings are available, the pressure based method can be invalid, and Outdoor-indoor linked simulation should be used.

L.3 Prescriptive Path A Calculations

L.3.1 Ventilation Intensity

Spaces have been defined by a “ventilation intensity” which represents the amount of flowrate needed per Equation 6.2.2.1, divided by the floor area of the space. Its units are L/s per m^2 of floor area or cfm per sf of floor area.

$$\text{Ventilation Intensity} = \frac{V_{bz}}{A_z} = \frac{R_p \times P_z + R_a \times A_z}{A_z} \quad \text{(L.3.1)}$$

The following ventilation intensity brackets are used:

Bracket	**L/s per m^2**	**cfm per sf**	**Commonly encountered space typologies bracket**
1	0.0 – 1.0	0.0 – 0.2	Office, living room, main entry lobby
2	1.0 – 2.0	0.2 – 0.4	Reception area, general manufacturing, kitchen, lobby
3	2.0 – 3.0	0.4 – 0.6	Classroom, Daycare
4	3.0 – 4.0	0.6 – 0.8	Restaurant Dining Room, Places of Religious Worship
5	4.0 - 5.5	0.8 – 1.1	Auditorium, Health club/aerobics room, Bar, Gambling

Not addressed: Lecture Hall and spectator areas (6 L/s/m2), Disco / dance floors (10.3 L/s/m2)

Single openings:

The flow through a single sharp opening due to bi-directional buoyancy-driven flow [L-1] (V_{BD_sharp}) is expressed as:

$$V_{SO\_sharp} = 0.21 * A_W * \sqrt{g H_s \frac{\Delta T}{T_{ref}}} \qquad (L.3.1.1)$$

where:
A_w is the free unobstructed area of the window, or openable area
ΔT is the temperature difference between indoors and outdoors. Given the conservative nature of a prescriptive path, a temperature difference of 1 °C (1.8 °F) is assumed for these calculations. In reality, this temperature will depend on the internal gains in the space and will likely be higher than 1 °C (1.8 °F), leading to higher airflows (and a smaller window area requirement).
H_s is the vertical dimension of the opening.
g is the gravity constant
T_{ref} is a reference temperature in Kelvin (or Rankine), typically equal to T_{in}, T_{out} or an expected average. 21 °C (70 °F, 294 K) was assumed for these calculations.

A safety factor is incorporated assuming that an awning window is used. Awning (or top-hinged) windows, are amongst the most common windows used for natural ventilation, and because of their uneven vertical area distribution are more inefficient than a sliding window (sharp opening) at driving flow. An efficiency ε_v of around 83% (value used in these calculations) when compared to sliding windows is inferred from).

$$V_{SO} = V_{SO\_sharp} * \varepsilon_W \qquad (L.3.1.2)$$

Assuming a Height-to-width ratio for the window of $R_{H/W}$ (R=H/W), the window area can be re-written as

$$A_W = \frac{{H_s}^2}{R_{H/W}} \qquad (L.3..1.3)$$

The required openable area as a fraction of the zone's floor area is therefore calculated by equating the bi-directional buoyancy-driven flow through a single awning opening (V_{so}) to the goal flowrate (V_{bz}) obtained from Table 6.2.2.1.

$$Vso = Vbz \qquad (L.3.1.4)$$

And solving for window area

$$\frac{A_W}{A_z} = \left(\frac{V_{bz}}{0.21 * 0.83 * R^4_{\frac{H}{W}} * \sqrt{g \frac{\Delta T}{T_{ref}}}} \right)^{4/5} * \frac{1}{A_z} * 100 \qquad (L.3.1.5)$$

L.3.2 Vertically spaced openings:

The flowrate V_{vs} through vertically-spaced openings of areas A_s (the smallest sum of opening areas, either upper openings or lower openings) and A_l (the largest sum of opening areas, either upper openings or lower openings) is obtained using the following equation:

$$V_{VS} = A_{eff} * C_d * \sqrt{2 g \Delta H \frac{\Delta T}{T_{ref}}} \qquad (L.3.2)$$

where:
A_{eff} is the effective window area, defined as:

$$A_{eff} = \frac{1}{\sqrt{\frac{1}{A_s^2} + \frac{1}{A_l^2}}} = \frac{A_s}{\sqrt{1+R^2}} = \frac{A_w}{\sqrt{1+R^2} * \left(1 + \frac{1}{R}\right)} \quad \text{(L.3.2.1)}$$

A_w is the total sum of all opening areas.

$$A_w = A_s + A_l \quad \text{(L.3.2.2)}$$

R is the area ratio between A_s and A_l

$$R = \frac{A_s}{A_l} \quad \text{(L.3.2.3)}$$

ΔH is the shortest vertical distance between the center of the lowest openings and that of the upper openings. All other constants are the same as in the single opening scenario.

The required openable area as a fraction of the zone's floor area is therefore calculated by equating the flow through two sets of vertically spaces openings (V_{vs}) to the goal flowrate (V_{bz}) obtained from table 6.2.2.1

$$V_{VS} = V_{bz} \quad \text{(L.3.2.4)}$$

Solving for window area:

$$\frac{A_W}{A_z} = \frac{V_{bz}}{C_d * \sqrt{2g\Delta H \frac{\Delta T}{T_{ref}}}} * \sqrt{1+R^2} * \left(1 + \frac{1}{R}\right) * \frac{1}{A_z} * 100 \quad \text{(L.3.2.5)}$$

L.4 Control and Accessibility (Mixed Mode Ventilation).

Mixed mode ventilation is a hybrid system used to maintain indoor air quality and internal thermal temperatures year-round using both natural and mechanical ventilation systems.

- Natural ventilation systems use natural forces, such as wind and thermal buoyancy, used to ventilate and cool spaces.
- Mechanical ventilation systems use mechanical systems with fans to supply and exhaust air from a space, provide humidity control, and, if required, filter possible contaminants.

By preferentially using natural ventilation when outdoor air conditions are suitable, energy costs and carbon emissions can be minimized. Sensors are used to identify when natural ventilation is less effective at providing suitable indoor temperatures, humidity levels, and contaminant levels, and indicate that a transition to mechanical ventilation should occur. The transition between modes can be manual or automatic, as dictated by the needs of the owner/occupants. The use of each mode when appropriate will ensure year-round acceptable indoor air quality.

L.5 References

L-1 Etheridge, D. W., & Sandberg, M. (1996). *Building ventilation: theory and measurement* (Vol. 50). Chichester, UK: John Wiley & Sons.

L-2 von Grabe, J. (2013). Flow resistance for different types of windows in the case of buoyancy ventilation. *Energy and Buildings*, *65*, 516-522.