



**BSR/ASHRAE Addendum ah
to ANSI/ASHRAE Standard 62.1-2016**

Public Review Draft

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

**First Public Review (February 2019)
(Draft shows Proposed Changes to Current Standard)**

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FOREWORD

This proposed addendum clarifies and expands the values of zone air distribution effectiveness (E_z) in Table 6.2.2.1 and adds Normative Appendix X (Zone Air Distribution Effectiveness – Alternate Procedures) to provide a procedure for calculating zone air distribution effectiveness. Notes on Table 6.2.2.1 have also been removed and replaced with definitions or specific requirements within the language of the standard.

[Note to Reviewers: This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~striketrough~~ (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 ah to 62.1-2016

Add New Definitions to Section 3 as shown below. The remainder of Section 3 is unchanged.

3. DEFINITIONS (SEE FIGURE 3.1)

air, cool: air whose temperature is less than the average space temperature.

air, warm: air whose temperature is greater than the average space temperature.

ceiling return: air removed from the space more than 4.5 ft (1.4 m) above the floor.

ceiling supply: air supplied to the space more than 4.5 ft (1.4 m) above the floor.

floor return: air removed from the space less than 4.5 ft (1.4m) above the floor.

floor supply: air supplied to the space less than 4.5 ft (1.4m) above the floor.

stratified air distribution system: a device or combination of devices applied to provide a stratified thermal and pollutant distribution within a zone.

zone air distribution effectiveness: the ratio of the change of contaminant concentration between the air supply and air exhaust to the change of contaminant concentration between the air supply and the breathing zone.

Modify Section 6.2.2.2.2 As shown below.

6.2.2.2 Zone Air Distribution Effectiveness. The zone air distribution effectiveness (E_z) shall be ~~not less than the default value~~ determined using in accordance with Table 6.2.2.2, or Normative Appendix X.

Informative Notes: For some configurations, the default value depends upon average space temperature and supply air temperature. Calculation of E_z using the procedures in Normative Appendix X may result in values greater than those listed in Table 6.2.2.2 for systems with the same description.

6.2.2.2.1 Stratified Air Distribution Systems. A stratified air distribution system shall be designed in accordance with the following subsections or the zone air distribution effectiveness (E_z) shall be determined in accordance with Normative Appendix X

6.2.2.2.1.1 Supply Air. Cool air shall be at least 4°F (2°C) less than the average room air temperature.

6.2.2.2.1.2 Return Air. The return air openings or pathways shall be located more than 9 ft (2.8 m) above the floor.

6.2.2.2.1.3 Stratification. The zone shall not contain any devices which mechanically mix the air and shall be protected from impinging air streams from adjacent ventilation zones.

Informative Note: Ceiling fans, blowers, air curtains, aspirating diffusers without adequate draft separation or other devices that disrupt the stratification cause the zone air distribution effectiveness to be similar to a well-mixed system.

6.2.2.2.2 Personalized Ventilation Systems. A personalized ventilation system shall be designed in accordance with the following subsections or the zone air distribution effectiveness (E_z) shall be determined in accordance with Normative Appendix X.

Informative Note: A personalized ventilation system is primarily for exposure control and dilution of contaminants in the breathing zone and may provide some spot cooling. Personalized ventilation is used when the occupant spends most of their time in one occupied space. The ventilation outlet is usually incorporated into or mounted on the furniture. It is used in conjunction with another air distribution system that handles the area ventilation requirements and thermal loads in the space.

6.2.2.2.2.1 Personalized Air. The personalized air shall be distributed in the breathing zone and designed such that the velocity is equal to or less than 50 fpm (0.25 m/s) at the head/facial region of the occupant.

6.2.2.2.2.2 Return Air. The return air openings or pathways shall be located more than 9 ft (2.8 m) above the floor.

TABLE 6.2.2.2 Zone Air Distribution Effectiveness

| Air Distribution Configuration | E_z |
|--|-------------------------|
| Well Mixed Air Distribution Systems | |
| Ceiling supply of cooling air | 1.0 |
| Ceiling supply of warm air and floor return | 1.0 |
| Ceiling supply of warm air 15°F (8°C) or more above space temperature and ceiling return | 0.8 |
| Ceiling supply of warm air less than 15°F (8°C) above average space temperature where the supply air jet velocity is less than 150 fpm (0.8 m/s) within 4.5ft(1.4 m) of the floor and ceiling return | 0.8 |
| Ceiling supply of warming air less than 15°F (8°C) above average space temperature where the supply air jet velocity is equal to or greater than 150 fpm (0.8 m/s) within 4.5 ft (1.4 m) of the floor and ceiling return provided that the 150 fpm (0.8 m/s) supply air jet reaches to within 4.5 ft (1.4 m) of floor level (See Note 6) | 1.0 |
| Floor supply of cool air and ceiling return, provided that the vertical throw is greater than 50 fpm (0.25 m/s) at a height of 4.5 ft (1.4 m) or more above the floor | 1.0 |
| Floor supply of cool air and ceiling return, provided low velocity displacement ventilation achieves unidirectional flow and thermal stratification, or underfloor air distribution systems where the vertical throw is less than or equal to 50 fpm (0.25 m/s) at a height of 4.5 ft (1.4 m) above the floor | 1.2 |

| | |
|--|-------------|
| Floor supply of warm air and floor return | 1.0 |
| Floor supply of warm air and ceiling return | 0.7 |
| Makeup supply outlet located more than half the length of the space from drawn in on the opposite side of the room from the exhaust, return, or both. | 0.8 |
| Makeup supply outlet located less than half the length of the space from drawn in near to the exhaust, return, or both locations | 0.5 |
| <u>Stratified Air Distribution Systems (6.2.2.2.1)</u> | |
| Floor supply of cool air where the vertical throw is greater than or equal to 60 fpm (0.25 m/s) at a height of 4.5 ft (1.4 m) above the floor and ceiling return at a height less than or equal to 18 ft (5.5 m) above the floor | <u>1.05</u> |
| Floor supply of cool air where the vertical throw is less than or equal to 60 fpm (0.25 m/s) at a height of 4.5 ft (1.4 m) above the floor and ceiling return at a height less than or equal to 18 ft (5.5 m) above the floor | <u>1.2</u> |
| Floor supply of cool air where the vertical throw is less than or equal to 60 fpm (0.25 m/s) at a height of 4.5 ft (1.4 m) above the floor and ceiling return at a height greater than 18 ft (5.5 m) above the floor | <u>1.5</u> |
| <u>Personalized Ventilation Systems (6.2.2.2.2)</u> | |
| Personalized air at a height of 4.5 ft (1.4 m) above the floor combined with ceiling supply of cool air and ceiling return | <u>1.40</u> |
| Personalized air at a height of 4.5 ft (1.4 m) above the floor combined with ceiling supply of warm air and ceiling return | <u>1.40</u> |
| Personalized air at a height of 4.5 ft (1.4 m) above the floor combined with a stratified air distribution system with non-aspirating floor supply devices and ceiling return | <u>1.20</u> |
| Personalized air at a height of 4.5 ft (1.4 m) above the floor combined with a stratified air distribution system with aspirating floor supply devices and ceiling return | <u>1.50</u> |

1. “Cool air” is air cooler than space temperature.
2. “Warm air” is air warmer than space temperature.
3. “Ceiling supply” includes any point above the breathing zone.
4. “Floor supply” includes any point below the breathing zone.
5. As an alternative to using the above values, E_z may be regarded as equal to air change effectiveness determined in accordance with ASHRAE Standard 12916 for air distribution configurations except unidirectional flow.
6. For lower velocity supply air, $E_z = 0.8$.

Modify Normative Appendix A as shown below. The remainder of Appendix A is unchanged.

A3. SYMBOLS

E_z *zone air distribution effectiveness*: a measure of the effectiveness of supply air distribution to the breathing zone. E_z is determined in accordance with Section 6.2.2.2 or Normative Appendix X.

Add New Normative Appendix X as shown below.

(This is a normative appendix and is part of the standard.)

NORMATIVE APPENDIX X **ZONE AIR DISTRIBUTION EFFECTIVENESS – ALTERNATE PROCEDURES**

This appendix provides a procedure for determining zone air distribution effectiveness (E_z) for all system types.

Informative Note: Table 6.2.2.2 provides default values of E_z that are permitted to be used for the air distribution configurations described in the table. The reference E_z value of 1 is typical of ideal mixing in the

zone. The strategy of removing contaminants or displacing contaminants from the breathing zone may result in an effective E_z value greater than unity, which is typical of stratified systems.

X1 Zone Air Distribution Effectiveness. Zone air distribution effectiveness shall be calculated in accordance with equation X-1.

$$E_z = \frac{(C_e - C_s)}{(C - C_s)} \quad (X-1)$$

where

E_z = zone air distribution effectiveness

C = average contaminant concentration at the breathing zone

C_e = average contaminant concentration at the exhaust

C_s = average contaminant concentration at the supply

X1.1 Personalized Ventilation Systems. For the purpose of calculating zone air distribution effectiveness for personalized ventilation systems the breathing zone shall be 9 ft² (0.8 m²) centered on each occupant with a height of 4.5 ft (1.4 m) from the floor.

X2. Modeled Air Distribution System.

X2.1 Computational Model. The computational fluid dynamics (CFD) model for calculating zone air distribution effectiveness shall be in accordance with the following subsections:

X2.1.1 Computational Domain. The computational domain shall comprise of all sensible heat sources, all major obstructions to airflow, and all air distribution devices. The calculation domain shall include all boundary walls.

X2.1.2 Solution Variables. Analysis shall include the solutions for fluid flow, heat transfer, and chemical species transport. The buoyancy (gravitational) effects shall be included in the calculation procedure.

X2.1.3 Boundary Conditions. Sensible heat sources shall be permitted to be modeled as volumetric heat sources to allow the air to pass through the source or as hollow blocks (no mesh inside) specified with either heat flux or constant temperature on the surfaces of the blocks. Boundary walls shall be modeled as adiabatic (zero heat flux), specified heat flux, or specified temperature boundary.

X2.1.4 Species Transport. The sources shall be modeled as volumetric source or a boundary flux with known generation rate with zero release velocity. The analysis shall be performed with a uniformly distributed source at the breathing zone level of the occupants. All the boundary walls shall be modeled as impermeable to the chemical species.

Informative Note: The species modeled should be a tracer gas, such as CO₂. Discretion is left to the modeler to determine the appropriate model depending on the design compounds in the zone.

X2.1.5 Turbulence Model. Reynolds (Ensemble) Averaging turbulence models shall be utilized.

Informative Note: RNG and realizable k-ε models meet the requirements of this section.

X2.1.6 Computational Mesh. A fine mesh shall be generated near the sensible heat sources such as occupants and computers to resolve the thermal plume surrounding these sources. The fine mesh shall be generated on all supply air and return air locations.

X2.1.7 Solution Convergence. The solution convergence levels shall include the monitoring of relevant physical quantities such as temperature or species concentration at strategic locations. The globally scaled residuals shall

be decreased to 10^{-3} for all equations except the energy and species equations, for which the residuals shall be decreased to 10^{-7} . The mass and energy balance shall be calculated up to at least 4 decimal places.

Informative Note: Review of the thermal comfort of occupants in the computational model may be desirable.

X2.2 Zone Air Distribution Effectiveness. Zone air distribution effectiveness (E_z) shall be computed in accordance with equation X1 for each computational cell in the breathing zone. The zone air distribution effectiveness (E_z) of the system shall be the average value of the zone air distribution effectiveness of each computational cell within the breathing zone. The analysis shall be performed for both summer cooling conditions and winter heating conditions.

Informative Note: Validation of the computational model with physical measurements during design can improve the accuracy of the computational model and the zone air distribution effectiveness of the system, Field measurements could also be performed post building occupancy to verify zone air distribution effectiveness.

INFORMATIVE REFERENCES

- X-1. ASHRAE Research Project (RP-1373), 2009. Air Distribution Effectiveness with Stratified Air Distribution Systems.
- X-2. ASHRAE Research Project (RP-1009), 2001. Simplified Diffuser Boundary Conditions for Numerical Room Airflow Models.