



ADDENDA

**ANSI/ASHRAE Addendum a to
ANSI/ASHRAE Standard 55-2020**

Thermal Environmental Conditions for Human Occupancy

Approved by ASHRAE and the American National Standards Institute on April 30, 2021.

This addendum was approved by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. Instructions for how to submit a change can be found on the ASHRAE® website (<https://www.ashrae.org/continuous-maintenance>).

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FOREWORD

Addendum a adds a new method for the assessment of local thermal discomfort with vertical air temperature gradient between the head level and ankle level. Recent studies found that the current limits of 3°C (5.4°F) for sitting and 4°C (7.2°F) for standing occupants between head and feet are unnecessarily strict. These limits may impede the application of thermally stratified systems that are believed to be more energy efficient and associated with better ventilation effectiveness. The new method applies to occupants with clothing insulation less than 0.7 clo and metabolic rate less than 1.3 met, complying with the entire Section 5.3.3, “Local Thermal Discomfort.” The addendum was added using mandatory language in the body of the standard. Informative Appendix I has been updated to take into account the new method. The new method is based on the work described in Liu et al. (2020).

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strike through~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum a to Standard 55-2020

Modify Section 3 as shown. The remainder of Section 3 is unchanged.

local thermal discomfort: the thermal discomfort caused by locally specific conditions such as a vertical air temperature ~~difference gradient~~ between the feet and the head, by radiant temperature asymmetry, by local convective cooling (draft), or by contact with a hot or cold floor.

Modify Section 5.3.3.4 as shown. A new Figure 5-7 has been added; renumber existing figures accordingly.

5.3.3.4 Vertical Air Temperature ~~Difference-Gradient~~. Air temperature ~~difference gradient~~ between head level and ankle level shall not exceed the value resulting from the following formula or in the shaded region of Figure 5-7 ~~3°C (5.4°F) for seated occupants or 4°C (7.2°F) for standing occupants~~ (see note in Section 5.3.4.1).

$$\nabla T < 7.82 - 0.87(TS - 1.91)^2 \quad (\nabla T \text{ in } ^\circ\text{C/m})$$

$$\nabla T < 4.29 - 0.48(TS - 1.91)^2 \quad (\nabla T \text{ in } ^\circ\text{F/ft})$$

where

∇T = air temperature gradient between head and ankles, °C/m (°F/ft)

TS = whole-body thermal sensation. This is equal to the PMV calculated using the input air temperatures over two heights: 0.6 m (24 in.) and 1.1 m (43 in.) for seated occupants and 1.1 m (43 in.) and 1.7 m (67 in.) for standing occupants.

Exception to 5.3.3.4: The requirement in this section does not apply when using elevated air speed in Section 5.3.3.

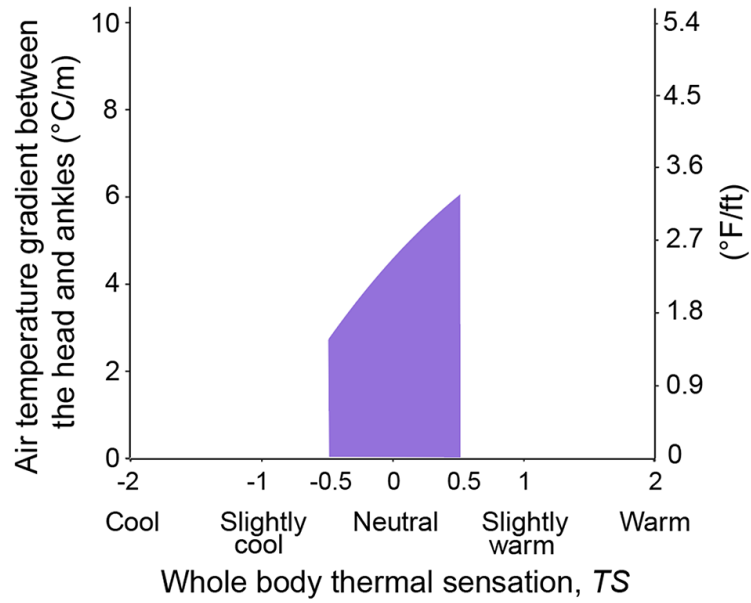


Figure 5-7 Vertical air temperature gradient limit as a function of whole body thermal sensation.

Modify Informative Appendix, Section 14 as shown.

14. VERTICAL AIR TEMPERATURE DIFFERENCE GRADIENT

Thermal stratification that results in the air temperature at the head level being warmer than that at the ankle level may cause thermal discomfort. Section 5.3.3.34 of this standard specifies allowable differences gradients of the air temperature between the air temperature at head level and the air temperature at ankle level. The maximum air temperature gradient is deduced from the predicted percentage dissatisfied with vertical air temperature gradient ($PPD_{\nabla T}$). $PPD_{\nabla T}$ is an index that establishes a quantitative prediction of the percentage of thermally dissatisfied people with air temperature gradient. $PPD_{\nabla T}$ is calculated according to the following formula deduced from Figure I-3.

$$PPD_{\nabla T} = \frac{e^{0.13(TS - 1.91)^2 + 0.15\nabla T - 1.6}}{1 + e^{0.13(TS - 1.91)^2 + 0.15\nabla T - 1.6}} - 34.5\% \quad (\nabla T \text{ in } ^\circ\text{C/m})$$

$$PPD_{\nabla T} = \frac{0.55e^{0.13(TS - 1.91)^2 + 0.083\nabla T - 1.6}}{1 + e^{0.13(TS - 1.91)^2 + 0.083\nabla T - 1.6}} - 34.5\% \quad (\nabla T \text{ in } ^\circ\text{F/ft})$$

where

$PPD_{\nabla T}$ \equiv predicted percentage dissatisfied with vertical air temperature gradient for local discomfort, %. $PPD_{\nabla T}$ is 0% if a negative value is calculated.

TS \equiv whole-body thermal sensation. This is equal to the PMV calculated using the input air temperatures over two heights: 0.6 m (24 in.) and 1.1 m (43 in.) for seated occupants and 1.1 m (43 in.) and 1.7 m (67 in.) for standing occupants.

∇T \equiv air temperature gradient between the head and ankles, $^\circ\text{C/m}$ ($^\circ\text{F/ft}$)

The vertical air temperature gradient limits in Section 5.3.3.4. are derived by setting $PPD_{\nabla T}$ equal to 5%.

Figure I-3 shows the expected percentage of occupants who are dissatisfied due to the air temperature difference where the head level is warmer than the ankle level. Thermal stratification in the opposite direction is rare, is perceived more favorably by occupants, and is not addressed in this standard.

The allowable difference in air temperature from ankle level to head level is based on Figure I-3 and assumes that a maximum of 5% of occupants are dissatisfied by the vertical air stratification.

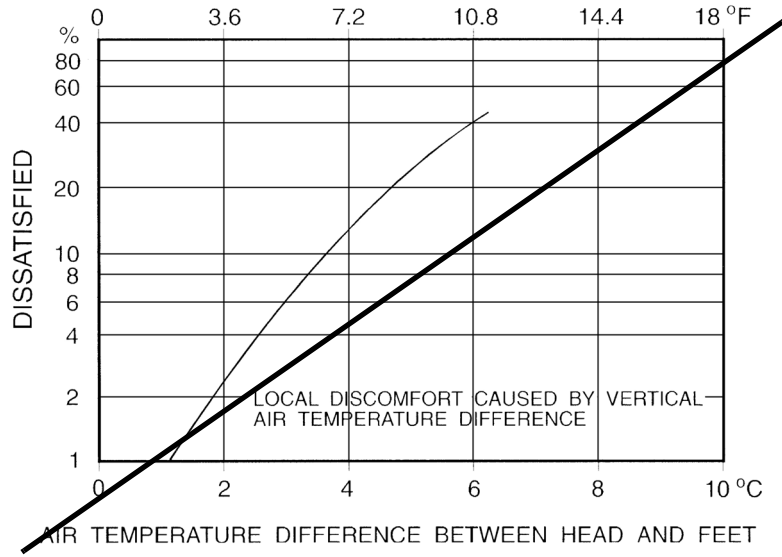


Figure I-3 Local thermal discomfort caused by vertical temperature differences.

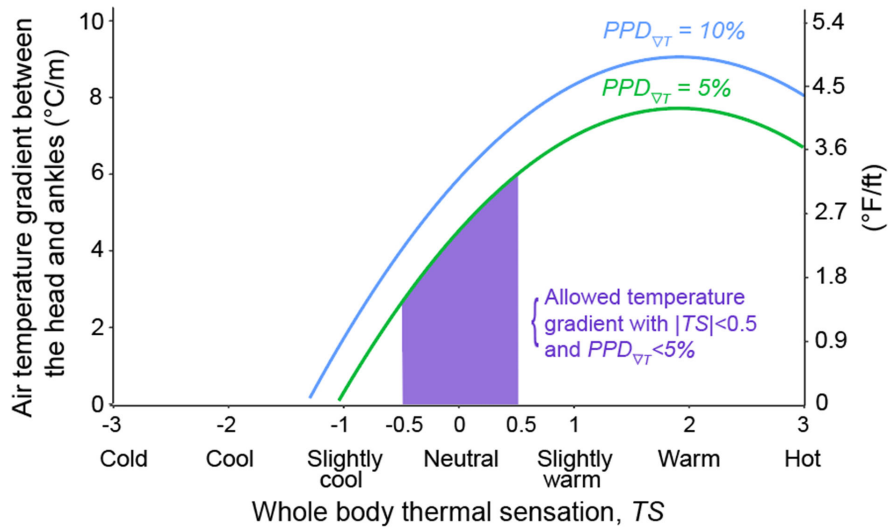


Figure I-3 Vertical air temperature gradient limit between the head and ankles as a function of whole body thermal sensation and the predicted percentage dissatisfied with vertical air temperature gradient (PPD_{vT}).

Modify Informative Appendix M as shown. The remainder of Appendix M is unchanged.

Liu, S., S. Schiavon, A. Kabanshi, W. Nazaroff. 2016. Predicted percentage of dissatisfied with ankle draft. *Indoor Air* 27(4):852–62. doi: doi.org/10.1111/ina.12364. www.escholarship.org/uc/item/9076254n

Liu, S., Z. Wang, S. Schiavon, Y. He, M. Luo, H. Zhang, E. Arens. 2020. Predicted percentage of dissatisfied with vertical air temperature gradient. *Energy and Buildings* P.110085. doi: doi.org/10.1016/j.enbuild.2020.110085. www.escholarship.org/uc/item/0s76t57k.

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