



ADDENDA

**ANSI/ASHRAE Addendum b to
ANSI/ASHRAE Standard 55-2010**

Thermal Environmental Conditions for Human Occupancy

Approved by the ASHRAE Standards Committee on January 21, 2012; by the ASHRAE Board of Directors on January 25, 2012; and by the American National Standards Institute on January 26, 2012.

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FOREWORD

This addendum splits normative and informative language that appears in the body of the Standard, primarily in Section 4, "General Requirements"; Section 5.1, "Conditions that Provide Thermal Comfort, General Requirements"; and Section 5.2.1, "Graphic Comfort Zone Method for Typical Indoor Environments." Most of the informative language is moved to a new informative appendix.

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

Addendum b to 55-2010

[Revise the following text to Section 3 and add two new definitions as shown below:]

3. DEFINITIONS

environment, acceptable thermal: an environment that a substantial majority of the occupants would find thermally acceptable.

occupant, representative: an individual or composite or average of several individuals that is representative of the population occupying a space for 15 minutes or more.

zone, comfort: a two-dimensional range, often represented on a modified psychrometric chart, of operative temperature and humidity that is predicted to be an acceptable thermal environment at particular values of air speed, metabolic rate, and clothing insulation.

[Replace the current text in Section 4 as shown below:]

4. GENERAL REQUIREMENTS

Use of this standard is specific to the space being considered and the occupants of that space. Any application of this standard must specify the space to which it applies or the locations within that space to which it applies, if not to the entire space. Any application of this standard must identify the occupants (who must have a residency of more than 15 minutes in the space) to which it applies.

The activity and clothing of the occupants must be considered in applying this standard. When there are substantial differences in physical activity and/or clothing for occupants of a space, these differences must be considered.

In some cases it will not be possible to achieve an acceptable thermal environment for all occupants of a space due to individual differences, including activity and/or clothing. If

the requirements are not met for some known set of occupants, then these occupants must be identified.

The thermal environmental conditions required for comfort are determined according to Section 5.2 or Section 5.3 of this standard. Any application of this standard must clearly state which of these sections is used. Additionally, all requirements of the applicable Section, 5.2 or 5.3, must be met.

4.1 When information is required to be identified in this Standard, it shall be documented in accordance with and in addition to the requirements in Section 6.

4.2 Identify all the space types to which the Standard is being applied and any locations within a space to which it is not applied.

4.3 For each space type, at least one representative occupant shall be identified. If any known set of occupants is excluded from consideration, then these excluded occupants shall be identified.

4.4 For each representative occupant, the metabolic rate (M) in mets and the insulation (I) in clo shall be determined.

4.5 Section 5.2 in its entirety or Section 5.3 in its entirety shall be identified as the approach used in determining acceptable thermal environmental conditions.

[Revise the following text to Section 5.1 as shown below:]

5. CONDITIONS THAT PROVIDE THERMAL COMFORT

5.1 Introduction. Thermal comfort is that condition of mind that expresses satisfaction with the thermal environment. Because there are large variations, both physiologically and psychologically, from person to person, it is difficult to satisfy everyone in a space. The environmental conditions required for comfort are not the same for everyone. Extensive laboratory and field data have been collected that provide the necessary statistical data to define conditions that a specified percentage of occupants will find thermally comfortable. Section 5 of this standard is used to determine the thermal environmental conditions in a space that are necessary to achieve acceptance by a specified percentage of occupants of that space.

5.1 General Requirements. Section 5 of this standard shall be used to determine the acceptable thermal environmental conditions for each representative occupant of a space. The percentage of occupants of the space who are predicted to find it acceptable shall be specified.

The following ~~There are six primary factors that must~~ shall be addressed when defining conditions for thermal comfort. A number of other, secondary factors affect comfort in some circumstances. The six primary factors are listed below. Complete descriptions of these factors are presented in Section 5.4 and Normative Appendices A and B. acceptable thermal comfort.

1. Metabolic rate
2. Clothing insulation
3. Air temperature

4. Radiant temperature
5. Air speed
6. Humidity

It is possible for all six of these factors to vary with time. This standard only addresses thermal comfort in a steady state (with some limited specifications for temperature variations with time in Section 5.2.5). **Note:** As a result, people entering a space that meets the requirements of this standard may not immediately find the conditions comfortable if they have experienced different environmental conditions just prior to entering the space. The effect of prior exposure or activity may affect comfort perceptions for approximately one hour.

Nonuniformity is addressed in Section 5.2.4. **Note:** Factors 2 through 6 may be nonuniform over an occupant's body, and this nonuniformity may be an important consideration in determining thermal comfort.

The vast majority of the available thermal comfort data pertains to sedentary or near sedentary physical activity levels typical of office work. This standard is intended primarily for these conditions. However, it is acceptable to use the standard to determine appropriate environmental conditions for moderately elevated activity. It does not apply to sleeping or bed rest. The body of available data does not contain significant information regarding the comfort requirements of children, the disabled, or the infirm. It is acceptable to apply the information in this standard to these types of occupants if it is applied judiciously to groups of occupants, such as those found in classroom situations.

Section 5.2 contains the methodology that shall be used for most applications. The conditions required for thermal comfort in spaces that are naturally conditioned are not necessarily the same as those conditions required for other indoor spaces. Field experiments have shown that in naturally conditioned spaces, where occupants have control of operable windows, the subjective notion of comfort is different because of different thermal experiences, availability of control, and resulting shifts in occupant expectations. Section 5.3 specifies criteria required for a space to be considered naturally conditioned. The methods of Section 5.3 may, as an option, be applied to spaces that meet these criteria. The methods of Section 5.3 may not be applied to other spaces.

Section 5.4 describes in some detail variables that must be clearly understood in order to use the methods of Section 5 effectively.

This standard requires these factors to be determined in a steady state. **Note:** It is possible for all six of these factors to vary with time.

Note: Complete descriptions of the six factors are presented in Section 5.4 and Normative Appendices A and B. The first two factors are characteristics of the occupant, and the remaining four factors are conditions of the thermal environment.

[Revise the following text to Section 5.2.1.1 as shown below:]

5.2.1.1 Graphic Comfort Zone Method for Typical Indoor Environments. It is permissible to apply the method

in this section Use of this method shall be limited to spaces where therepresentative occupants have activity levels that result inwith metabolic rates between 1.0 and 1.3 met, and where clothing is worn that providesinsulation between 0.5 and 1.0 clo of thermal insulation., in spaces with air speeds less than 0.2 m/s (40 ft/min).

Note: See Normative Appendix A for estimation of metabolic rates and Normative Appendix B for estimation of clothing insulation. Most office spaces fall within these limitations.

The range of operative temperatures presented in Figure 5.2.1.1 are for 80% occupant acceptability. This is based on a 10% dissatisfaction criterion for general (whole body) thermal comfort based on the PMV-PPD index, plus an additional 10% dissatisfaction that may occur on average from local (partial body) thermal discomfort. Normative Appendix D provides a list of inputs and outputs used in the PMV/PPD computer program to generate these graphs.

Figure 5.2.1.1 specifies the comfort zone for environments that meet the above criteria and where the air speeds are not greater than 0.20 m/s (40 ft/min). Two zones are shown—one for 0.5 clo of clothing insulation and one for 1.0 clo of insulation.

Note: These insulation levels are typical of clothing worn when the outdoor environment is warm and cool, respectively. It is permissible to determine the operative temperature range allowed for intermediate values of clothing insulation by linear interpolation between the limits for 0.5 and 1.0 clo, using the following relationships:

Comfort zones for intermediate values of clothing insulation shall be determined by linear interpolation between the limits for 0.5 and 1.0 clo using the following relationships:

$$T_{min, I_{cl}} = [(I_{cl} - 0.5 \text{ clo}) T_{min, 1.0 \text{ clo}} + (1.0 \text{ clo} - I_{cl}) T_{min, 0.5 \text{ clo}}] / 0.5 \text{ clo}$$

$$T_{max, I_{cl}} = [(I_{cl} - 0.5 \text{ clo}) T_{max, 1.0 \text{ clo}} + (1.0 \text{ clo} - I_{cl}) T_{max, 0.5 \text{ clo}}] / 0.5 \text{ clo}$$

where

$T_{max, I_{cl}}$ = upper operative temperature limit for clothing insulation I_{cl} ,

$T_{min, I_{cl}}$ = lower operative temperature limit for clothing insulation I_{cl} , and

I_{cl} = thermal insulation of the clothing in question, clo.

~~It is acceptable to use elevated~~Elevated air speeds to increase the upper operative temperature limit for the comfort zone if the criteria in certain circumstances. Section 5.2.3 describes these adjustments and specifies the criteria required for such adjustmentsare met.

[Add the following sentence to the third paragraph of Section 5.2.4 as shown below.]

5.2.4 Local Thermal Discomfort.

[...]

Table 5.2.4 specifies the expected percent dissatisfied (PD) for each source of local thermal discomfort described in

Sections 5.2.4.1 through 5.2.4.4. The criteria for all sources of local thermal discomfort must be met simultaneously at the levels specified for an environment to meet the requirements of this standard. The expected percent dissatisfied (PD) for each source of local thermal discomfort described in Sections 5.2.4.1 through 5.2.4.4 shall be specified.

[Add the following new informative appendix.]

(This appendix 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 a right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX X1— CONDITIONS THAT PROVIDE THERMAL COMFORT

Introduction. Thermal comfort is that condition of mind that expresses satisfaction with the thermal environment. Because there are large variations, physiologically and psychologically, from person to person, it is difficult to satisfy everyone in a space. The environmental conditions required for comfort are not the same for everyone. Extensive laboratory and field data have been collected that provide the necessary statistical data to define conditions that a specified percentage of occupants will find thermally comfortable.

The operative temperature and humidity shown on the psychrometric chart in Figure 5.2.1.1 (graphical method) are for 80% occupant acceptability. This is based on a 10% dissatisfaction criterion for general (whole body) thermal comfort based on the PMV-PPD index, plus an additional 10% dissatisfaction that may occur on average from local (partial body) thermal discomfort (see below). Normative Appendix D provides a list of inputs and outputs used in the PMV/PPD computer program to generate these graphs.

Thermal Comfort Factors. Six primary factors must be addressed when defining conditions for thermal comfort. A number of other, secondary factors affect comfort in some circumstances. The six primary factors are listed below.

1. Metabolic rate
2. Clothing insulation
3. Air temperature
4. Radiant temperature
5. Air speed
6. Humidity

The first two factors are characteristics of the occupants, and the remaining four factors are conditions of the thermal environment. Detailed descriptions of these factors are presented in Section 5.4 and Normative Appendices A and B.

These must be clearly understood in order to use the methods of Section 5 effectively.

Variation among Occupants. For each occupant, the activity level, represented as metabolic rate (M) in mets and the clothing worn by the occupants, represented as insulation (I) in clo must be considered in applying this standard. When there are substantial differences in physical activity and/or clothing for occupants of a space, these differences must be considered.

In some cases it will not be possible to achieve an acceptable thermal environment for all occupants of a space due to individual differences, including activity and/or clothing. If the requirements are not met for some known set of occupants, then the Standard requires that these occupants be identified.

Temporal Variation. It is possible for all six of these factors to vary with time. This standard only addresses thermal comfort in a steady state (with some limited specifications for temperature variations with time in Section 5.2.5). **Note:** As a result, people entering a space that meets the requirements of this standard may not immediately find the conditions comfortable if they have experienced different environmental conditions just prior to entering the space. The effect of prior exposure or activity may affect comfort perceptions for approximately one hour.

Local Thermal Discomfort. Nonuniformity is addressed in Section 5.2.4. **Note:** Factors 2 through 6 may be nonuniform over an occupant's body, and this nonuniformity may be an important consideration in determining thermal comfort.

Variation in Activity Level. The vast majority of the available thermal comfort data pertains to sedentary or near-sedentary physical activity levels typical of office work. This standard is intended primarily for these conditions. However, it is acceptable to use the standard to determine appropriate environmental conditions for moderately elevated activity. It does not apply to sleeping or bed rest. The body of available data does not contain significant information regarding the comfort requirements of children, the disabled, or the infirm. It is acceptable to apply the information in this standard to these types of occupants if it is applied judiciously to groups of occupants, such as those found in classroom situations.

Naturally Conditioned Spaces. Section 5.2 contains the methodology that shall be used for most applications. The conditions required for thermal comfort in spaces that are naturally conditioned are not necessarily the same as those conditions required for other indoor spaces. Field experiments have shown that in naturally conditioned spaces, where occupants have control of operable windows, the subjective notion of comfort is different because of different thermal experiences, availability of control, and resulting shifts in occupant expectations. Section 5.3 specifies criteria required for a space to be considered naturally conditioned. The methods of Section 5.3 may, as an option, be applied to spaces that meet these criteria. The methods of Section 5.3 may not be applied to other spaces.

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

