ADDENDA

ANSI/ASHRAE Addendum d 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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 ISSN 1041-2336

Approved American National Standard
ANSI
www.ansi.org

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FOREWORD

This addendum removes informative language related to the use of Section 5.3 for occupant-controlled naturally conditioned spaces (sometimes called the adaptive comfort method) from the body of the standard and moves it to an informative appendix. It also states the requirements more clearly in normative language. In some cases, paragraph numbering has been added or modified for greater clarity.

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 d to 55-2010

[Modify Section 3 Definitions as follows.]

3. DEFINITIONS

***local thermal discomfort*: t**he discomfort caused by a vertical air temperature difference between the feet and the head, by an asymmetric radiant field, by local convective cooling (draft), or by contact with a hot or cold floor.

naturally conditioned spaces, occupant controlled: those spaces where the thermal conditions of the space are regulated primarily by ~~the opening and closing of windows by the occupants~~occupant-controlled openings in the envelope.

occupant controlled openings: Openings such as windows or vents that are directly controlled by the occupants of a space. Such openings may be manually controlled or controlled through the use of electrical or mechanical actuators under direct occupant control.

[Modify Section 4.5 of published Addendum b to Standard 55-2010. Addendum b is available for free download from the ASHRAE website at http://www.ashrae.org/standards-research--technology/standards-addenda.]

4.5 The thermal environmental conditions required for comfort are determined according to Section 5 of this standard.~~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.~~

[Modify Section 5.1 of published Addendum b to Standard 55-2010. Addendum b is available for free download from the ASHRAE website at http://www.ashrae.org/standards-research--technology/standards-addenda.]

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 shall be addressed when defining conditions for acceptable thermal comfort.

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

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.

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. Section 5.2 shall be permitted to be used in any space and Section 5.3 shall be permitted to be used only in those spaces that meet the applicability criteria in Section 5.3.1.

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

[Modify Section 5.3 of published Addendum c to Standard 55-2010. Addendum c is available for free download from the ASHRAE website at http://www.ashrae.org/standards-research--technology/standards-addenda.]

5.3 ~~Optional Method for~~ Determining Acceptable Thermal Conditions in Occupant-Controlled Naturally Conditioned Spaces. ~~For the purposes of this standard, occupant-controlled naturally conditioned spaces are those spaces where the thermal conditions of the space are regulated primarily by the occupants through opening and closing of windows. Field experiments have shown that occupants' thermal responses in such spaces depend in part on the outdoor climate and may differ from thermal responses in buildings with centralized HVAC systems primarily because of the different thermal experiences, changes in clothing, availability of control, and shifts in occupant expectations. This optional method is intended for such spaces.~~

5.3.1 Applicability. This method defines acceptable thermal environments only for occupant-controlled naturally conditioned spaces that meet all of the following criteria:

5.3.1.1 ~~In order for this optional method to apply, the space in question must be equipped with operable windows that open to the outdoors and can be readily opened and adjusted by the occupants of the space.~~ There is~~must be~~ no mechanical cooling system ~~for the space~~ (e.g., refrigerated air conditioning, radiant cooling, or desiccant cooling) installed. ~~It is permissible to use mechanical ventilation with unconditioned air, but opening and closing of windows must be the~~

~~primary means of regulating the thermal conditions in the space. It is permissible for the space to be provided with a heating system, but this optional method does not apply when the~~ No heating system is in operation.

5.3.1.2 ~~It applies only to spaces where the o~~Occupants are engaged in near-sedentary physical activities, with metabolic rates ranging from 1.0 to 1.3 met. See Normative Appendix A for estimation of metabolic rates.

5.3.1.3 ~~This optional method applies only to spaces where the o~~Occupants are free to adapt their clothing to the indoor and/or outdoor thermal conditions within a range at least as wide as 0.5–1.0 clo. See Normative Appendix B for estimation of clothing insulation.

5.3.1.4 The ***prevailing mean outdoor temperature*** is greater than 10°C (50°F) and less than 33.5°C (92.3°F),

5.3.2 Methodology

5.3.2.1 ~~For spaces that meet these criteria, determine the~~The allowable indoor operative temperatures shall be determined from Figure 5.3 using the 80% acceptability limits. ***Note:*** the 90% acceptability limits are included for information only (see Informative Appendix X for further guidance). ~~for any day in question using the ***prevailing mean outdoor air temperature*** determined in accordance with all of the following:~~

~~**5.3.2.1** It shall be based on no fewer than 7 and no more than 30 sequential days prior to the day in question.~~

~~**5.3.2.2** It shall be a simple arithmetic mean of all of the ***mean daily outdoor air temperatures*** of all the sequential days in 5.3.2.1.~~

~~**Exception to 5.3.2.2:** Weighting methods are permitted provided that the weighting curve continually decreases towards the more distant days such that the weight applied to a day is between 0.6 and 0.9 of that applied to the subsequent day. For this option the upper limit on the number of days in the sequence does not apply.~~

~~**5.3.2.3** ***Mean daily outdoor air temperature*** for each of the sequential days in 5.3.2.1 shall be the simple arithmetic mean of all the outdoor dry-bulb temperature observations for the 24 hour day. The quantity of measurements shall be no less than two and in that case shall be the minimum and maximum for the day. When using three or more measurements, the time periods shall be evenly spaced.~~

~~**5.3.2.4** Observations in 5.3.2 shall be from the nearest approved meteorological station, public or private, or TMY (Typical Meteorological Year) weather file.~~

~~**Exception to 5.3.2.1, 5.3.2.2, 5.3.2.3:** When weather data to calculate the ***prevailing mean outdoor air temperature*** are not available, it is permitted to use as the prevailing mean the published meteorological monthly means for each calendar month. It is permitted to interpolate between monthly means.~~

~~**5.3.3** This figure includes two sets of operative temperature limits—one for 80% acceptability and one for 90% acceptability. The 80% acceptability limits are for typical applications and shall be used when other information is not available. It is acceptable to use the 90% acceptability limits when a higher standard of thermal comfort is desired. Figure 5.3 is based on an adaptive model of thermal comfort that is derived from a global database of 21,000 measurements taken primarily in office buildings.~~

5.3.2.2 It shall be permitted to use the following ~~The~~ equations, which correspond~~ing~~ to the acceptable operative temperature ranges in Figure 5.3 ~~are~~:

Upper 80% acceptability limit (°C) = 0.31 (~~*prevailing mean outdoor air temperature*~~)$t_{pma(out)}$ + 21.3
Upper 80% acceptability limit (°F) = 0.31 (~~*prevailing mean outdoor air temperature*~~) $t_{pma(out)}$ + 60.5

~~Upper 90% acceptability limit (°C) = 0.31 (*prevailing mean outdoor air temperature*) + 20.3~~
~~Upper 90% acceptability limit (°F) = 0.31 (*prevailing mean outdoor air temperature*) + 58.7~~

Lower 80% acceptability limit (°C) = 0.31 (~~*prevailing mean outdoor air temperature*~~) $t_{pma(out)}$ + 14.3
Lower 80% acceptability limit (°F) = 0.31 (~~*prevailing mean outdoor air temperature*~~) $t_{pma(out)}$ + 47.9

~~Lower 90% acceptability limit (°C) = 0.31 (*prevailing mean outdoor air temperature*) + 15.3~~
~~Lower 90% acceptability limit (°F) = 0.31 (*prevailing mean outdoor air temperature*) + 49.7~~

~~**5.3.4** The allowable operative temperature limits in Figure 5.3 may not be extrapolated to outdoor temperatures above and below the end points of the curves in this figure. If the *prevailing mean outdoor air temperature* is less than 10°C (50°F) or greater than 33.5°C (92.3°F), this option may not be used, and no specific guidance for naturally conditioned spaces is included in this standard.~~

~~Figure 5.3 accounts for local thermal discomfort effects in typical buildings, so it is not necessary to address these factors when using this option. If there is reason to believe that local thermal comfort is a problem, it is acceptable to apply the criteria in Section 5.2.4.~~

~~Figure 5.3 also accounts for people's clothing adaptation in naturally conditioned spaces by relating the acceptable range of indoor temperatures to the outdoor climate, so it is not necessary to estimate the clothing values for the space.~~

~~No humidity or air-speed limits are required when this option is used.~~

5.3.2.3 The following effects are already accounted for in Figure 5.3; therefore, it is not required that they be separately evaluated: local thermal discomfort, clothing level, metabolic rate, humidity, and air speed.

5.3.2.4 If $t_0 > 25°C$ (77°F), then it shall be permitted to increase ~~Figure 5.3 includes the effects of people's indoor air speed adaptation in warm climates, up to 0.3 m/s (59 fpm) in operative temperatures warmer than 25°C (77°F). In naturally conditioned spaces where air speeds within the occupied zone exceed 0.3 m/s (59 fpm),~~ the upper acceptability temperature limits in Figure 5.3 ~~are increased~~ by the corresponding Δt_0 in Table 5.3~~, which is based on equal SET values as illustrated in Section 5.2.3.2~~. ~~For example, increasing air speed within the~~

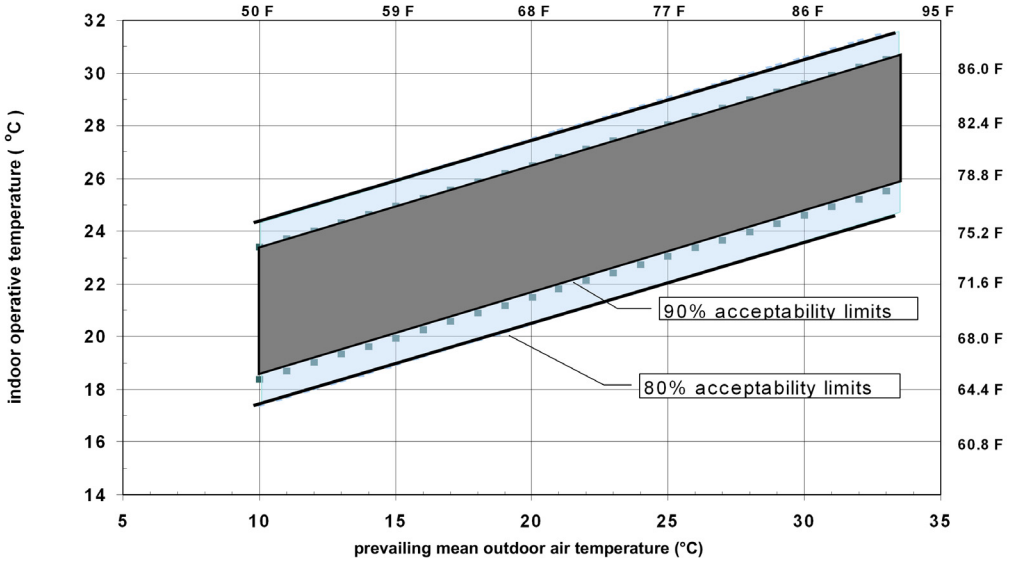

Figure 5.3 Acceptable operative temperature ranges for naturally conditioned spaces (80% bounds are normative, 90% bounds are informative).

~~occupied zone from 0.3 m/s (59 fpm) to 0.6 m/s (118 fpm) increases the upper acceptable temperature limits in Figure 5.3 by a Δt_0 of 1.2°C (2.2°F). These adjustments to the upper acceptability temperature limits apply only at t_0 >25°C (77°F)~~

TABLE 5.3 Increases in Acceptable Operative Temperature Limits (Δt_0) in Naturally Conditioned Spaces ~~the Adaptive Comfort Standard~~ (Figure 5.3) Resulting from Increasing Air Speed above 0.3 m/s (59 fpm)

Air Speed, 0.6 m/s (118 fpm)	Air Speed, 0.9 m/s (177 fpm)	Air Speed, 1.2 m/s (236 fpm)
1.2°C (2.2°F)	1.8°C (3.2°F)	2.2°C (4.0°F)

~~in which the occupants are engaged in near sedentary physical activity (with metabolic rates between 1.0 met and 1.3 met).~~

[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 X— OCCUPANT-CONTROLLED NATURALLY CONDITIONED SPACES

For the purposes of this standard, occupant-controlled naturally conditioned spaces are those spaces where the thermal conditions of the space are regulated primarily by the occupants through opening and closing of openings in the envelope. Field experiments have shown that occupants' thermal responses in such spaces depend in part on the outdoor climate and may differ from thermal responses in buildings with centralized HVAC systems primarily because of the different thermal experiences, changes in clothing, availability of control, and shifts in occupant expectations. This optional method is intended for such spaces.

In order for this optional method to apply, the space in question must be equipped with operable openings to the outdoors and can be readily opened and adjusted by the occupants of the space.

It is permissible to use mechanical ventilation with unconditioned air, but opening and closing of windows must be the primary means of regulating the thermal conditions in the space. It is permissible for the space to be provided with a heating or cooling system, but this optional method does not apply when the heating or cooling system is in operation. It applies only to spaces where the occupants are engaged in near-sedentary physical activities, with metabolic rates ranging from 1.0 to 1.3 met. See Normative Appendix A for estimation of metabolic rates. This optional method applies only to spaces where the occupants are free to adapt their clothing to the indoor and/or outdoor thermal conditions. The permitted range of acceptable clothing must be at least as broad as 0.5 to 1.0 clo. Table X1 shows example clothing ensembles that achieve 0.5 clo or lower.

For spaces that meet these criteria, it is acceptable to determine the allowable indoor operative temperatures from Figure 5.3. This figure includes two sets of operative temperature limits—one for 80% acceptability and one for 90% acceptability. The 80% acceptability limits are for typical applications. It is acceptable to use the 90% acceptability limits when a higher standard of thermal comfort is desired.

TABLE X1 Example Clothing Ensembles

Garment Description	I_{clu}(clo)	Garment Description	I_{clu}(clo)
Sample Woman's Ensemble		Sample Man's Ensemble	
Bra	0.01	Men's briefs	0.04
Panties	0.03	Shoes	0.02
Pantyhose/stockings	0.02	Calf-length socks	0.03
Shoes	0.02	Short-sleeve dress shirt	0.19
Short-sleeve dress shirt	0.19	Straight trousers (thin)	0.15
Skirt (knee length thin)	0.14	Net, metal or wooden sided arm chair	0.00
Net, metal or wooden sided arm chair	0.00	Total	0.43
Total	0.41		

Figure 5.3 is based on an adaptive model of thermal comfort that is derived from a global database of 21,000 measurements taken primarily in office buildings.

The allowable operative temperature limits in Figure 5.3 may not be extrapolated to outdoor temperatures above and below the end points of the curves in this figure. If the prevailing mean outdoor temperature is less than 10°C (50°F) or greater than 33.5°C (92.3°F), this option may not be used, and no specific guidance for such conditions is included in this standard.

Figure 5.3 accounts for local thermal discomfort effects in typical buildings, so it is not necessary to address these factors when using this option. If there is reason to believe that local thermal comfort is a problem, it is acceptable to apply the criteria in Section 5.2.4.

Figure 5.3 also accounts for people's clothing adaptation in naturally conditioned spaces by relating the acceptable range of indoor temperatures to the outdoor climate, so it is not necessary to estimate the clothing values for the space. No humidity or air-speed limits are required when this option is used.

Figure 5.3 includes the effects of people's indoor air speed adaptation in warm climates, up to 0.3 m/s (59 fpm) in operative temperatures warmer than 25°C (77°F). In naturally conditioned spaces where air speeds within the occupied zone exceed 0.3 m/s (59 fpm), the upper acceptability temperature limits in Figure 5.3 are increased by the corresponding Δt_0 in Table 5.3, which is based on equal SET values as illustrated in Section 5.2.3.2. For example, increasing air speed within the occupied zone from 0.3 m/s (59 fpm) to 0.6 m/s (118 fpm) increases the upper acceptable temperature limits in Figure 5.3 by a Δt_0 of 1.2°C (2.2°F). These adjustments to the upper acceptability temperature limits apply only at $t_0 > 25$°C (77°F) in which the occupants are engaged in near sedentary physical activity (with metabolic rates between 1.0 met and 1.3 met).

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.