ADDENDA

ANSI/ASHRAE Addendum d to
ANSI/ASHRAE Standard 55-2013

Thermal Environmental Conditions for Human Occupancy

Approved by ASHRAE on May 29, 2015, and by the American National Standards Institute on June 1, 2015.

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. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards.

The latest edition of an ASHRAE Standard may be purchased on the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

 ISSN 1041-2336

Approved American National Standard
ANSI
www.ansi.org

SPECIAL NOTE

This American National Standard (ANS) is a national voluntary consensus Standard developed under the auspices of ASHRAE. *Consensus* is defined by the American National Standards Institute (ANSI), of which ASHRAE is a member and which has approved this Standard as an ANS, as "substantial agreement reached by directly and materially affected interest categories. This signifies the concurrence of more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that an effort be made toward their resolution." Compliance with this Standard is voluntary until and unless a legal jurisdiction makes compliance mandatory through legislation.

ASHRAE obtains consensus through participation of its national and international members, associated societies, and public review.

ASHRAE Standards are prepared by a Project Committee appointed specifically for the purpose of writing the Standard. The Project Committee Chair and Vice-Chair must be members of ASHRAE; while other committee members may or may not be ASHRAE members, all must be technically qualified in the subject area of the Standard. Every effort is made to balance the concerned interests on all Project Committees.

The Senior Manager of Standards of ASHRAE should be contacted for

a. interpretation of the contents of this Standard,
b. participation in the next review of the Standard,
c. offering constructive criticism for improving the Standard, or
d. permission to reprint portions of the Standard.

DISCLAIMER

ASHRAE uses its best efforts to promulgate Standards and Guidelines for the benefit of the public in light of available information and accepted industry practices. However, ASHRAE does not guarantee, certify, or assure the safety or performance of any products, components, or systems tested, installed, or operated in accordance with ASHRAE's Standards or Guidelines or that any tests conducted under its Standards or Guidelines will be nonhazardous or free from risk.

ASHRAE INDUSTRIAL ADVERTISING POLICY ON STANDARDS

ASHRAE Standards and Guidelines are established to assist industry and the public by offering a uniform method of testing for rating purposes, by suggesting safe practices in designing and installing equipment, by providing proper definitions of this equipment, and by providing other information that may serve to guide the industry. The creation of ASHRAE Standards and Guidelines is determined by the need for them, and conformance to them is completely voluntary.

In referring to this Standard or Guideline and in marking of equipment and in advertising, no claim shall be made, either stated or implied, that the product has been approved by ASHRAE.

(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

Addendum b to Standard 55-2013 changed the still-air threshold from 0.15 to 0.2 m/s (30 to 40 fpm) to align the compliance paths that previously had differing definitions of "still air." This addendum updates additional references and figures in the standard that were impacted by Addendum b. The air-speed limit to prevent draft sensation in cool environments is moved to Section 5.3.3.4, "Average Air Speed (V_a) without Occupant Control," to clarify how the limit fits into the other air-speed limits and Figure 5.3.3A, "Acceptable ranges of operative temperature (t_0) and average air speed (V_a) for the 1.0 and 0.5 clo comfort zones presented in figure 5.3.1, at humidity ratio 0.010." Normative Appendix C, "Procedure for Evaluating Cooling Effect of Elevated Air Speed Using SET" is also modified to state that the SET model cooling effect applies to both air and radiant temperature. Addendum b to Standard 55-2013 is published and available for free download from the ASHRAE website at https://www.ashrae.org/standards-research--technology/standards-addenda.

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 Standard 55-2013

Replace Figure 5.3.3A with the figure shown, and revise the figure caption as shown.

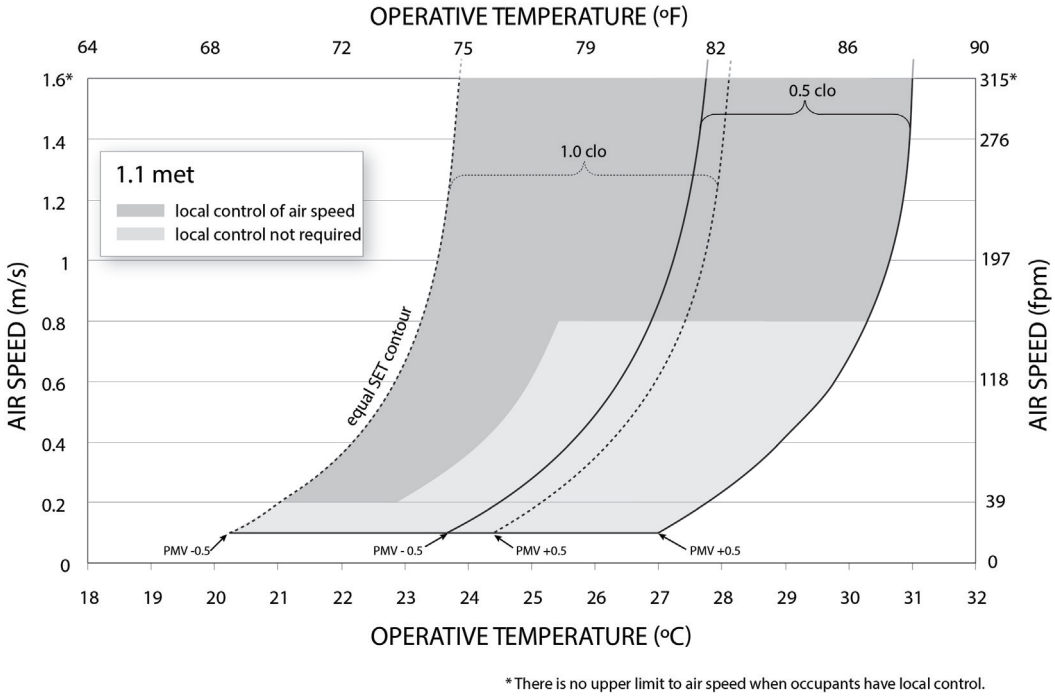

FIGURE 5.3.3A Acceptable ranges of operative temperature (t_o) and average air speed (V_a) for the 1.0 and 0.5 clo comfort zones presented in Figure 5.3.1, at humidity ratio 0.010.

Modify Figure 5.3.3B as shown.

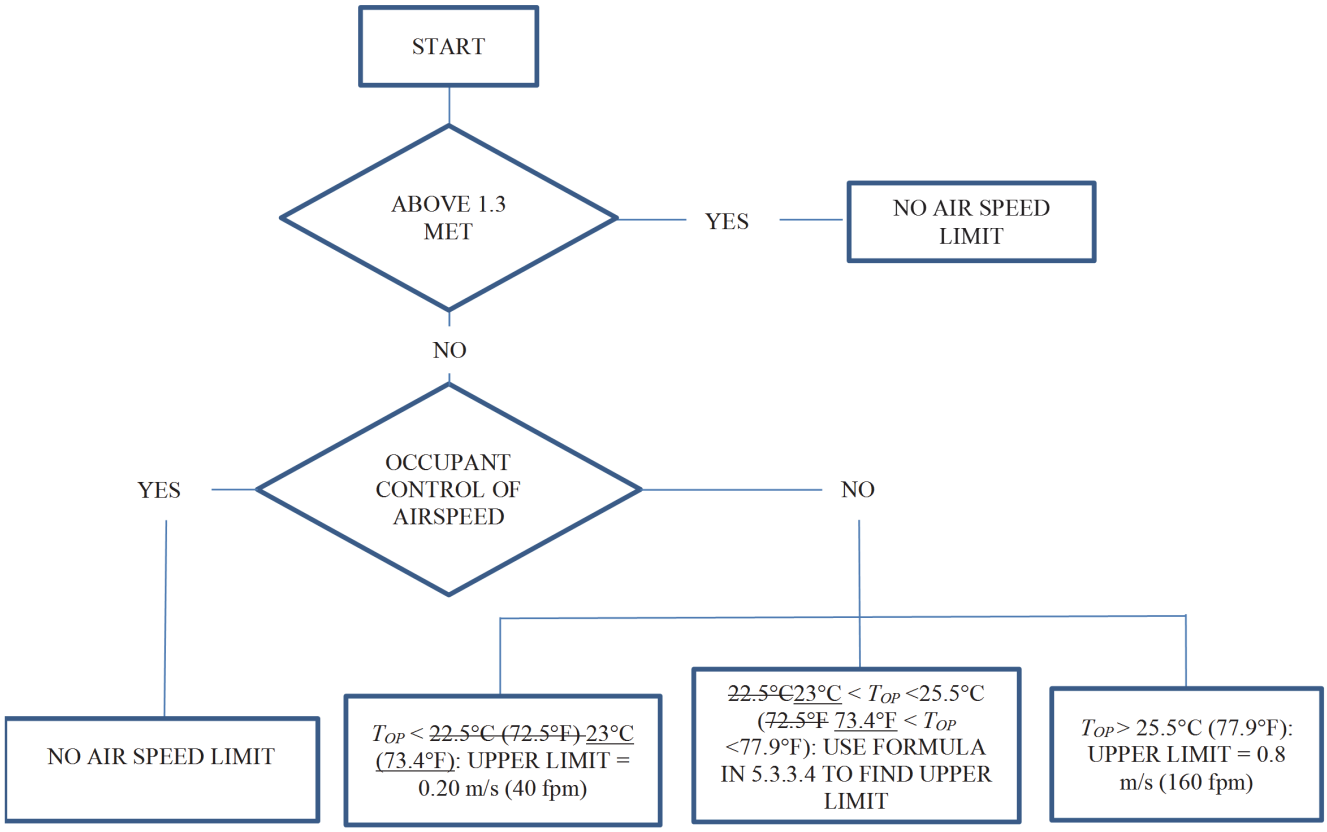

FIGURE 5.3.3B Flowchart for determining limits to airspeed inputs in the Elevated Air Speed Comfort Zone Method.

Revise Section 5.3.3.4 as shown.

5.3.3.4 Average Air Speed (V_a) without Occupant Control. If occupants do not have control over the local air speed meeting the requirements of Section 5.3.3.3, the following limits apply to the SET model and Figure 5.3.3A.

a. For operative temperatures (t_o) above 25.5°C (77.9°F), the upper limit to average air speed *(V_a)* shall be 0.8 m/s (160 fpm).
b. For operative temperatures (t_o) between ~~22.5~~23.0°C and 25.5°C (~~72.5~~73.4°F and 77.9°F), the upper limit to average air speed (V_a) shall follow an equal SET contour as described in Normative Appendix C. In Figure 5.3.3A this curve is shown between the dark and light shaded areas. It is acceptable to approximate the curve in Figure 5.3.3A in I-P and SI units by using the following equation:

$$V = 50.49 - 4.4047\ t_a + 0.096425(t_a)^2 \text{ (m/s, °C)}$$

$$V = 31375.7 - 857.295\ t_a + 5.86288(t_a)^2 \text{ (fpm, °F)}$$

c. For operative temperatures (t_o) below 23.0°C (73.4°F), the limit to average air speed *(V_a)* shall be 0.2 m/s (40 fpm).

Exceptions to Section 5.3.3.4(c):

1. Representative occupants with clothing insulation (I_{cl}) greater than 0.7 clo
2. Representative occupants with metabolic rates above 1.3 met

Notes: ~~a.~~These limits are shown by the light gray area in Figure 5.3.3A.

~~b. Section 5.3.4.3 has further requirements for operative temperatures (t_o) below 22.5°C (72.5°F) at particular levels of clo and met.~~

Delete Section 5.3.4.3 as shown.

~~**5.3.4.3 Draft.** At operative temperatures (t_o) below 22.5°C (72.5°F), average air speed *(V_a)* caused by the building, its fenestration, and its HVAC system shall not exceed 0.20 m/s (40 fpm). This limit does not require consideration of air movement produced by office equipment or occupants.~~

~~**Exception:** Higher average air speeds *(V_a)* that are permitted by Section 5.3.3~~

Revise Normative Appendix C, Sections C1 and C2, as shown. The remainder of Appendix C is unchanged.

C1. CALCULATION OVERVIEW

Section 5.3 requires that the Elevated Air Speed Comfort Zone Method be used when average air speed *(V_a)* is greater than 0.20 m/s (40 fpm). The SET model shall be used to account for the cooling effect of air speeds greater than the maximum allowed in the Graphic Comfort Zone or Analytical Comfort Zone methods. This Appendix describes the calculation procedures for the Elevated Air Speed Comfort Zone Method.

For a given set of environmental and personal variables, including an elevated average air speed ~~and,~~ an average air temperature *(t_a)*, and a mean radiant temperature ($\bar{t}_r$), the SET is first calculated. Then the average air speed *(V_a)* is replaced by still air (~~0.15~~0.1 m/s [~~30~~20 fpm]), and ~~a second average air temperature is found that yields the same SET as in the first calculation. The second average air temperature is used to calculate PMV~~ the average air temperature and radiant temperature are adjusted according to the cooling effect. The cooling effect (CE) of the elevated airspeed is the value that, when subtracted equally from both the average air temperature and the mean radiant temperature, yields the same SET under still air as in the first SET calculation under elevated airspeed. The PMV adjusted for an environment with elevated average air speed is calculated using the adjusted average air temperature, the adjusted radiant temperature, and still air (0.1 m/s [20 fpm]).

a. Enter the average air temperature *(t_a)*, radiant temperature, relative humidity, clo value, and met rate.
b. Set the average air speed (V_a).
c. Note the calculated value for SET in the output data.
d. Reduce the average air speed *(V_a)* to ~~0.15~~0.1 m/s (~~30~~20 fpm).
e. Reduce the average air temperature *(t_a)* and radiant temperature (t_r) equally in small increments until the SET is equal to the value noted in Step (c).
f. ~~This air temperature value is the adjusted average air temperature.~~ The cooling effect (CE) is the quantity by which the average air temperature and radiant temperature have been reduced. The resulting air temperature value is the adjusted average air temperature, and the resulting radiant temperature is the adjusted mean radiant temperature.
g. The PMV adjusted for elevated average air speed is calculated using the following inputs:
   1. Adjusted average air temperature from Step (f)
   2. Adjusted mean radiant temperature from Step (f)
   ~~2~~3. Average air speed *(V_a)* of ~~0.15~~0.1 m/s (~~30~~20 fpm)
   ~~3~~4. Original relative humidity
   ~~4. Original mean radiant temperature ($\bar{t}_r$)~~
   5. Original clo value
   6. Original met rate.

C2. CALCULATION PROCEDURE

The following is a formal description of this process that can be automated.

Suppose t_a is the average air temperature and v_{elev} is the elevated average air speed such that $v_{elev} >$ ~~0.15~~0.1 m/s (~~30~~20 fpm). Let v_{still} = ~~0.15~~0.1 m/s (~~30~~20 fpm). Consider functions PMV and SET, which take six parameters, which we will denote with the shorthand PMV (.,*) and SET (.,*). The variables of importance will be listed explicitly, while the parameters that are invariant will be denoted with the "*" shorthand. The variables we will refer to explicitly are the average air temperature (t_a), mean radiant temperature (t_r), average air speed (V_a), and relative humidity (RH).

~~To define the adjusted average air temperature t_{adj}~~ To define the cooling effect, CE, we assert that it satisfies the following:

~~$$\text{SET}(t_{db}, v_{elev}, *) = \text{SET}(t_{adj}, v_{still}, *) \qquad \text{(C-1)}$$~~

$$\mathrm{SET}(t_a, t_r, v_{elev}, *) = \mathrm{SET}(t_a - \mathrm{CE}, t_r - \mathrm{CE}, v_{still}, *) \quad \text{(C-1)}$$

That is, the adjusted average air temperature yields the same SET given still air as the actual air temperature does at elevated average air speed. In order to determine ~~t_{adj}~~ the cooling effect, an iterative root-finding method, such as the bisection or secant method, may be employed. The root of the parameterized function ~~$f(t)$~~ $f(\mathrm{ce})$ is the cooling effect (CE). ~~satisfies the definition of t_{adj}~~:

~~$$f(t) = \mathrm{SET}(t_{db}, v_{elev}, *) - \mathrm{SET}(t, v_{still}, *) \quad \text{(C-2)}$$~~

$$f(\mathrm{ce}) = \mathrm{SET}(t_a, t_r, v_{elev}, *) - \mathrm{SET}(t_a - \mathrm{ce}, t_r - \mathrm{ce}, v_{still}, *) \quad \text{(C-2)}$$

The adjusted PMV is given by

~~$$\mathrm{PMV}_{adj} = \mathrm{SET}(t_{adj}, v_{still}, *) \quad \text{(C-3)}$$~~

$$\mathrm{PMV}_{adj} = \mathrm{PMV}(t_a - \mathrm{CE}, t_r - \mathrm{CE}, v_{still}, *) \quad \text{(C-3)}$$

Note: For the use of SET in ASHRAE Standard 55, the function for self-generated air speed as a function of met rate has been removed.

Modify Informative Appendix H Section H3 as shown.

H3. DRAFT

Draft is unwanted local cooling of the body caused by air movement. It is most prevalent when the whole body thermal sensation is cool (below neutral). Draft sensation depends on the air speed, the air temperature, the activity, and the clothing. Sensitivity to draft is greatest where the skin is not covered by clothing, especially the head region comprising the head, neck, and shoulders and the leg region comprising the ankles, feet, and legs.

Use of elevated air speed to extend the thermal comfort range is appropriate when occupants are slightly warm, as set forth in Section 5.3.3. When occupants are neutral to slightly cool, such as under certain combinations of met rate and clo value with operative temperatures (t_o) below ~~22.5~~23.0°C (~~72.5~~73.4°F), average air speeds within the comfort envelope of ±0.5 PMV should not exceed 0.20 m/s (40 fpm). This draft limit applies to air movement caused by the building, its fenestration, and its HVAC system and not to air movement produced by office equipment or occupants. This standard allows average air speed to exceed this draft limit if it is under the occupants' local control and it is within the elevated air speed comfort envelope described in Section 5.3.3.

Modify Informative Appendix H Table H1 as shown.

TABLE H1 Expected Percent Dissatisfied Due to Sources of Local Discomfort ~~from Draft or Other Sources~~

Draft	Vertical Air Temperature Difference	Warm or Cool Floors	Radiant Asymmetry
<20%	<5%	<10%	<5%

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.

ASHRAE · 1791 Tullie Circle NE · Atlanta, GA 30329 · www.ashrae.org

About ASHRAE

ASHRAE, founded in 1894, is a global society advancing human well-being through sustainable technology for the built environment. The Society and its members focus on building systems, energy efficiency, indoor air quality, refrigeration, and sustainability. Through research, Standards writing, publishing, certification and continuing education, ASHRAE shapes tomorrow's built environment today.

For more information or to become a member of ASHRAE, visit www.ashrae.org.

To stay current with this and other ASHRAE Standards and Guidelines, visit www.ashrae.org/standards.

Visit the ASHRAE Bookstore

ASHRAE offers its Standards and Guidelines in print, as immediately downloadable PDFs, on CD-ROM, and via ASHRAE Digital Collections, which provides online access with automatic updates as well as historical versions of publications. Selected Standards and Guidelines are also offered in redline versions that indicate the changes made between the active Standard or Guideline and its previous version. For more information, visit the Standards and Guidelines section of the ASHRAE Bookstore at www.ashrae.org/bookstore.

IMPORTANT NOTICES ABOUT THIS STANDARD

To ensure that you have all of the approved addenda, errata, and interpretations for this Standard, visit www.ashrae.org/standards to download them free of charge.

Addenda, errata, and interpretations for ASHRAE Standards and Guidelines are no longer distributed with copies of the Standards and Guidelines. ASHRAE provides these addenda, errata, and interpretations only in electronic form to promote more sustainable use of resources.

5/15