ADDENDA

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

Thermal Environmental Conditions for Human Occupancy

Approved by ASHRAE on November 18, 2014; and by the American National Standards Institute on December 1, 2014.

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FOREWORD

This addendum clarifies the three comfort calculation approaches in Section 5.3.3, "Elevated Air Speed," by providing a new applicability table (Table 5.3.1, "Applicability of Methods for Determining Acceptable Thermal Conditions in Occupied Spaces") and reorganizing Section 5.3.3 to cover an Elevated Air Speed Comfort Zone Method. In addition, the standard now explicitly states that when "average air speed" (V_a) is greater than 0.2 m/s (40 fpm), Section 5.3.3 shall be used to calculate the upper and lower bounds of the comfort zone. This requirement was not clearly stated previously.

Other changes include removal of the upper limit to air speed when occupants have control, and change of the draft limit to 0.2 m/s (40 fpm) to align with the still-air comfort zone in Figure 5.3.3B.

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 Standard 55-2013

Modify normative language and add a normative table to Section 5.3 as shown below. The remainder of Section 5.3 is unchanged.

5.3 General Method for Determining Acceptable Thermal Conditions in Occupied Spaces. Section 5.3 is permitted to be used to determine the requirements for thermal comfort in all occupied spaces within the scope of this standard. ~~The requirements of Sections 5.3.1 or 5.3.2, 5.3.4, and 5.3.5 must be met.~~

Acceptable thermal conditions shall be determined using one of the three methods shown in Table 5.3.1 and any applicable requirements of Sections 5.3.4 and 5.3.5.

Note: *Average air speed* and *average air temperature* have precise definitions in this standard. See Section 3 for all defined terms.

TABLE 5.3.1 Applicability of Methods for Determining Acceptable Thermal Conditions in Occupied Spaces

Average Air Speed, m/s (fpm)	Humidity Ratio	Met	Clo	Comfort Zone Method
<0.20 (40)	<0.012 kg·H_2O/kg dry air	1.0 to 1.3	0.5 to 1.0	Section 5.3.1, "Graphic Comfort Zone Method"
<0.20 (40)	All	1.0 to 2.0	0 to 1.5	Section 5.3.2, "Analytical Comfort Zone Method"
>0.20 (40)	All	1.0 to 2.0	0 to 1.5	Section 5.3.3, "Elevated Air Speed Comfort Zone Method"

Modify Section 5.3.3 as shown below.

5.3.3 Elevated Air Speed **Comfort Zone Method**~~. This section is permitted to be used to increase the maximum allowable operative temperature (t_o) and maximum allowable average air speed (V_a) determined from Sections 5.3.1 and 5.3.2, provided that the conditions described in Sections 5.3.3.1 and 5.3.3.2 are met.~~

~~The Standard Effective Temperature (SET) model in the *ASHRAE Thermal Comfort Tool*[4] is used to evaluate all cases of comfort under elevated air speed above 0.2 m/s (40fpm). Figure 5.3.3A represents two particular cases of equal skin heat loss contours computed by the SET model and shall be permitted as a compliance method for the conditions specified in the figure.~~

5.3.3.1 Applicability. It is permissible to apply the method in this section to all spaces within the scope of this standard where the occupants have activity levels that result in average metabolic rates between 1.0 and 2.0 met, clothing insulation (I_{cl}) between 0.0 and 1.5 clo, and average air speeds (V_a) greater than 0.20 m/s (40 fpm).

5.3.3.2 Methodology. The calculation method in Normative Appendix C is to be used with this method. This method uses the Analytical Comfort Zone Method in Section 5.3.2 combined with the Standard Effective Temperature (SET) method described in Appendix C.

Figure 5.3.3A represents two particular cases of the Elevated Air Speed Comfort Zone Method and shall be permitted as a method of compliance for the conditions specified on the figure. It is permissible to determine the acceptable operative temperature range by linear interpolation between the limits found for each zone in Figure 5.3.3A.

Alternative methods are permitted. If any other method is used, the user shall verify and document that the method used yields the same results. The *ASHRAE Thermal Comfort Tool*[4] is permitted to be used to comply with this section.

~~***Notes:***~~

~~a. The SET model is available as part of the *ASHRAE Thermal Comfort Tool*,[4] as described in Informative Appendix G of this standard. Any other codings of the SET model must be validated against this code.~~

~~b.~~

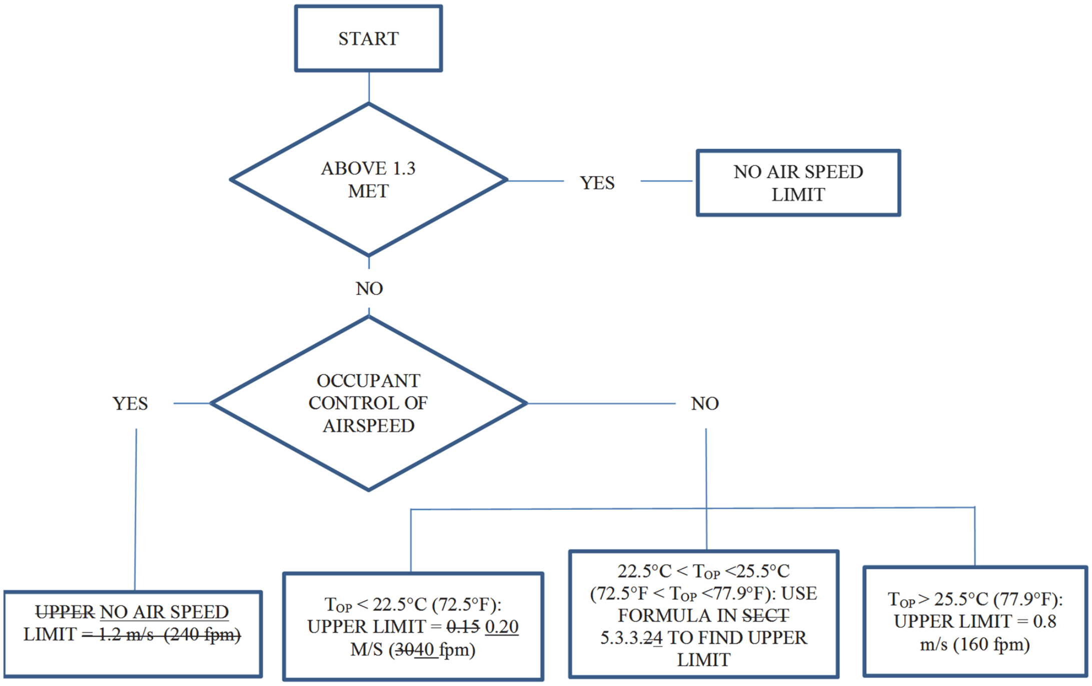

FIGURE 5.3.3B Flowchart for determining limits to airspeed inputs in ~~SET model~~ the Elevated Air Speed Comfort Zone Method.

Note: The flowchart in Figure 5.3.3B describes the steps for determining the ~~comfort under elevated air speed.~~ limits to airspeed inputs in SET model.

Renumber Section 5.3.3.1 and move behind new Section 5.3.3.2, and revise as shown below.

5.3.3.1~~3~~ ~~Limits to~~ Average Air Speed *(V_a)* with Occupant Control. ~~When control of local air speed is provided to occupants the maximum air speed shall be 1.2 m/s (240 fpm) for the SET model and Figure 5.3.3A.~~ Section 5.3.3.4 does not apply when the occupants have control over average air speed (V_a) meeting one of the following criteria:

~~When using either method, control shall be directly accessible to occupants and be provided either~~

a. one means of control for every six occupants or less ~~or fewer or~~

b. one means of control for every 84 m² (900 ft²) or less. ~~The range of control shall encompass air speeds suitable for sedentary occupants. The air speed should be adjustable continuously or in maximum steps of 0.25 m/s (50 fpm) as measured at the occupant's location.~~

~~***Note:*** These limits are shown by the fully bounded area for each clothing level in Figure 5.3.3A.~~

~~**Exception:**~~

c. In multi-occupant spaces where groups gather for shared activities, such as classrooms and conference rooms, at least one control shall be provided for each space, regardless of size. Multi-occupant spaces that can be subdivided by moveable walls shall have one control for each space subdivision.

~~The air speed control must extend to still air 0.2 m/s (40 fpm) as measured at the occupant's location and be adjustable continuously or in maximum steps of 0.25 m/s (50 fpm) as measured at the occupant's location.~~

~~**Exception:** Above activity levels of 1.3 met, the 1.2 m/s (240 fpm) limit does not apply.~~

Renumber Section 5.3.3.2 and revise as shown below.

5.3.3.2~~4~~ ~~Limits to~~ 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~~1~~, 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) below 22.5°C (72.5°F), the limit to average air speed (V_a) shall be 0.15 m/s (30 fpm).~~

b~~c~~. For operative temperatures (t_o) between 22.5°C and 25.5°C (72.5°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 ~~the curve~~ shown between the dark and light shaded areas ~~in Figure 5.3.3.A~~. It is acceptable to approximate the curve in Figure 5.3.3A in I-P and SI units by using the following equation:

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

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

Notes:

<u>a.</u> These limits are shown by the light gray area in Figure 5.3.3A

<u>b.</u> <u>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.</u>

~~**Exception:** Above activity levels of 1.3 met, the limits in Section 5.3.3.2 do not apply when using the SET model and Figure 5.3.3A.~~

Modify Section 5.3.4.3 as shown below.

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 <u>0.20</u> ~~0.15~~ m/s (<u>40</u> ~~30~~ fpm). This limit does not require consideration of air movement produced by office equipment or occupants.

Exceptions: Higher average air speeds *(V_a)* that are permitted by Section 5.3.3.

Modify Section 6.2 as shown below. The remainder of Section 6.2 is unchanged.

6.2 Documentation. The method and design conditions appropriate for the intended use of the building shall be selected and documented as follows.

Note: Some of the requirements in items (a) through (g) below may not be applicable to naturally conditioned buildings.

a. The method of design compliance shall be stated for each space and/or system: Graphic Comfort Zone Method (Section 5.3.1), Analytical Comfort Zone Method (Section 5.3.2), <u>Elevated Air Speed Comfort Zone Method (Section 5.3.3),</u> or the use of Section 5.4 for Occupant-Controlled Naturally Conditioned Spaces.

[…]

Modify Section 7.2.2 as shown below.

7.2.2 Prediction of Comfort from Environmental Measurements

7.2.2.1 Mechanically Conditioned Spaces. Use Section 5.3.1.2 to determine the PMV-based comfort zone for the occupants' expected clothing and metabolic rate. The modeled clothing and activity levels of the occupants must be as observed or as expected for the use of the indoor space in question. Use Section 5.3.3 to adjust the comfort zone<u>'s lower and upper operative temperature limits</u> ~~boundaries~~ for elevated air movement. Occupied zone conditions must also conform to requirements for avoiding local thermal discomfort (as specified in Section 5.3.4) and to limits to rate of temperature change over time, as specified in Section 5.3.5.

Parameters to be measured and/or recorded include the following:

a. Occupant metabolic rate (met) and clothing (clo) observations
b. Air temperature (t_a) and humidity
c. Mean radiant temperature ($\bar{t}_r$), unless it can be otherwise demonstrated that, within the space, $\bar{t}_r$ is within 1°C (2°F) of t_a
d. Air speed, unless it can be otherwise demonstrated that, within the space, average air speed *(V_a)* meets the requirements of Section 5.3.3

7.2.2.2 Naturally Conditioned Spaces. Section 5.4 prescribes the use of the adaptive model for determining the comfort zone boundaries. The air movement extensions to <u>the</u> comfort zone<u>'s lower and upper operative temperature limits</u> ~~boundaries~~ (<u>Table 5.4.2.4</u> ~~Figure 5.3.3B~~) shall be used when elevated air movement is present.

Parameters to be measured include the following:

a. Indoor air temperature and mean radiant temperature
b. Outdoor air temperature

Modify Informative Appendix F as shown below. The remainder of Informative Appendix F is unchanged.

INFORMATIVE APPENDIX F ~~ANALYTICAL AND GRAPHIC~~ COMFORT ZONE METHODS

F1. DETERMINING ACCEPTABLE THERMAL CONDITIONS IN OCCUPIED SPACES

[…]

F2. GRAPHICAL COMFORT ZONE METHOD

Use of this method is limited to representative occupants with metabolic rates between 1.0 and 1.3 met and clothing insulation between 0.5 and 1.0 clo in spaces with air speeds less than 0.2 m/s (40 fpm). Spaces with air distribution systems that are engineered such that HVAC-system-supplied air streams do not enter the occupied zone will seldom have averaged air speeds that exceed 0.2 m/s (40 fpm). See Chapter 21 of *ASHRAE Handbook—Fundamentals* for guidance on selecting air distribution systems.

Figure 5.3.1 in the Graphical Comfort Zone Method section shows the comfort zone for environments that meet the above criteria. Two zones are shown—one for 0.5 clo of clothing insulation and one for 1.0 clo of insulation. These insulation levels are typical of clothing worn when the outdoor environment is warm and cool, respectively.

Comfort zones for intermediate values of clothing insulation are determined by linear interpolation between the limits for 0.5 and 1.0 clo, using the relationships shown in this standard.

Elevated air speeds increase the <u>lower and</u> upper operative temperature (t_o) limit for the comfort zone if the criteria in ~~the elevated air speed section~~ <u>Section 5.3.3</u> are met.

F3. ANALYTICAL COMFORT ZONE METHOD

[…]

<u>F4. ELEVATED AIR SPEED COMFORT ZONE METHOD</u>

The outer boundary curves in Figure 5.3.3A shift toward the left or right depending on clo and met level. An increase of 0.1 clo or 0.1 met corresponds approximately to a 0.8°C (1.4°F) or 0.5°C (0.9°F) reduction in operative temperature (t_0); a decrease of 0.1 clo or 0.1 met corresponds approximately to a 0.8°C (1.4°F) or 0.5°C (0.9°F) increase in operative temperature.

F5~~F~~4. HUMIDITY LIMITS

[…]

Change previously Informative Appendix G to Normative Appendix C and modify it as shown below. Renumber other Appendices accordingly.

~~**(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 the right to appeal at ASHRAE or ANSI.)**~~

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

~~INFORMATIVE~~ NORMATIVE APPENDIX ~~G~~C PROCEDURE FOR EVALUATING COOLING EFFECT OF ELEVATED AIR SPEED USING SET

C1. CALCULATION OVERVIEW

Section 5.3 ~~specifies~~ 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.

~~*ASHRAE Handbook—Fundamentals*[3] defines SET as the equivalent air temperature of an isothermal environment at 50% rh in which a subject, wearing clothing standardized for the activity concerned, has the same heat stress (skin temperature) and thermoregulatory strain (skin wettedness) as in the actual environment.~~

~~SET is calculated by a thermophysiological simulation of the human body. The SET model reduces any combination of real environmental and personal variables into the temperature of the imaginary standard environment. The standard environment enables air speed effects on thermal comfort to be related across a wide range of air temperatures, radiant temperatures, and humidities.~~

For a given set of environmental and personal variables, including an elevated average air speed and an average air temperature *(t_a)*, the SET is first calculated. Then the average air speed *(V_a)* is replaced by still air (0.15 m/s [30 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 ~~termed the "adjusted average air temperature." The difference in the two average air temperatures is the cooling effect of the average air speed *(V_a)*.~~

~~The~~used to calculate PMV ~~adjusted for an environment with elevated average air speed is calculated using the adjusted average air temperature and still air (0.15 m/s [(30 fpm])~~.

~~This process can be performed manually using the *ASHRAE Thermal Comfort Tool* or similar software as follows:~~

a. Enter the average air temperature *(t_a)*, radiant temperature, relative humidity, clo value, and met rate.
b. Set the ~~your elevated~~ average air speed (V_a) ~~in the range from above 0.15 to 3 m/s (30 to 590 fpm)~~.
c. Note the calculated value for SET in the output data.
d. Reduce the average air speed *(V_a)* to 0.15 m/s (30 fpm).
e. Reduce the average air temperature *(t_a)* in small increments until the SET is equal to the value noted in Step ~~3~~(c).
f. This air temperature value is the adjusted average air temperature.
g. The PMV adjusted for elevated average air speed is calculated using the following inputs:
    1. Adjusted average air temperature from Step ~~6~~(f)
    2. Average air speed *(V_a)* of 0.15 m/s (30 fpm)
    3. Original relative humidity
    4. Original mean radiant temperature (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 ν_{elev} is the elevated average air speed such that $\nu_{elev} > 0.15$ m/s (30 fpm). Let $\nu_{still} = 0.15$ m/s (30 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}, we assert that it satisfies the following:

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

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}, an iterative root-finding method such as the bisection or secant method may be employed. The root of the function $f(t)$ satisfies the definition of t_{adj}:

$$f(t) = \text{SET}(t_{db}, \nu_{elev}, *) - \text{SET}(t, \nu_{still}, *) \qquad \text{~~(G-2)~~(C-2)}$$

The adjusted PMV is given by

$$\text{PMV}_{adj} = \text{SET}(t_{adj}, \nu_{still}, *) \qquad \text{~~(G-3)~~(C-3)}$$

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.

Example:

Input settings at elevated average air speed:

t_a	$\bar{t}_r$	V_a	RH	Met	Clo
28°C (82.4°F)	28°C (82.4°F)	0.15 m/s (29.5 fpm)	50	1.3	0.8
SET= 29.9°C (85.8°F)					

Input settings at reduced average air speed:

t_a	$\bar{t}_r$	V_a	RH	Met	Clo
28°C (82.4°F)	28°C (82.4°F)	0.15 m/s (29.5 fpm)	50	1.3	0.8
SET= 29.9°C (85.8°F)					

Input settings after search for adjusted average air temperature:

t_a	$\bar{t}_r$	V_a	RH	Met	Clo
22.5°C (74°F)	28°C (82.4°F)	0.15 m/s (29.5 fpm)	50	1.3	0.8
SET= 27.5°C (81.5°F)					

The adjusted average air temperature is 22.5°C (74°F). The PMV result for the final input settings is

PMV = 0.63

If the *ASHRAE Thermal Comfort Tool* is not available, it is possible to use the Graphical Method in Figure 5.3.3A, approximating the effect of clothing or activity changes as follows: The outer boundary curves in Figure 5.3.3A shift toward the left or right depending on clo and met level. An increase of 0.1 clo or 0.1 met corresponds approximately to a 0.8°C (1.4°F) or 0.5°C (0.9°F) reduction in operative temperature (t_o); a decrease of 0.1 clo or 0.1 met corresponds approximately to a 0.8°C (1.4°F) or 0.5°C (0.9°F) increase in operative temperature.

Average air speed (V_a) as defined in this standard is averaged at three heights. The averaging may be weighted by the designer to account for the following: The *SET* thermophysiological model described in Section 5.3.3 and Informative Appendix G is based on the assumption that the body is exposed to a uniform air speed. However, spaces with passive or active systems that provide strongly nonuniform air velocity fields cause skin heat losses that cannot be simply related to those of uniform velocity fields. Therefore, the designer shall decide the proper averaging for air speed for use in the Graphical Method (Figure 5.3.3) and Informative Appendix G. The proper averaging shall include air speeds incident on unclothed body parts (e.g., head) that have greater cooling effect and potential for local discomfort than unclothed parts.

G1. COMPUTER PROGRAM FOR CALCULATION OF SET

C3. VALIDATION TABLE FOR SET CALCULATION

Software implementations and other methods of SET calculation shall be validated against Table C1.

For additional technical information and an I-P version of the equations in this appendix, refer to the *ASHRAE Thermal Comfort* Tool.[4] The Thermal Comfort Tool allows for I-P inputs and outputs, but the algorithm is implemented in SI units. Documentation for the SET model is Fountain and Huizenga (1995). (See Informative Appendix L, "Bibliography and Informative References.")

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.

Move Table G1-1 to New Section C3.

TABLE G1-1 TABLE C1 Validation Table for SET Computer Model Calculation

Temperature		MRT		Velocity		RH	Met	Clo	SET	
°C	°F	°C	°F	m/s	fpm	%			°C	°F
25	77	25	77	0.15	29.5	50	1	0.5	23.9	75.0
0	32	25	77	0.15	29.5	50	1	0.5	12.3	54.1
10	50	25	77	0.15	29.5	50	1	0.5	17	62.6
15	59	25	77	0.15	29.5	50	1	0.5	19.3	66.7
20	68	25	77	0.15	29.5	50	1	0.5	21.6	70.9
30	86	25	77	0.15	29.5	50	1	0.5	26.2	79.2
40	104	25	77	0.15	29.5	50	1	0.5	33.6	92.5
25	77	25	77	0.15	29.5	10	1	0.5	23.3	73.9
25	77	25	77	0.15	29.5	90	1	0.5	24.4	75.9

~~TABLE G1-1~~ TABLE C1 Validation Table for SET ~~Computer Model~~ Calculation *(Continued)*

Temperature		MRT		Velocity		RH	Met	Clo	SET	
°C	°F	°C	°F	m/s	fpm	%			°C	°F
25	77	25	77	0.1	19.7	50	1	0.5	24	75.2
25	77	25	77	0.6	118.1	50	1	0.5	21.4	70.5
25	77	25	77	1.1	216.5	50	1	0.5	20.4	68.7
25	77	25	77	3	590.6	50	1	0.5	18.8	65.8
25	77	10	50	0.15	29.5	50	1	0.5	15.2	59.4
25	77	40	104	0.15	29.5	50	1	0.5	31.9	89.4
25	77	25	77	0.15	29.5	50	1	0.1	20.7	69.3
25	77	25	77	0.15	29.5	50	1	1	27.2	81.0
25	77	25	77	0.15	29.5	50	1	2	32.6	90.7
25	77	25	77	0.15	29.5	50	1	4	38	100.4
25	77	25	77	0.15	29.5	50	0.8	0.5	23.3	73.9
25	77	25	77	0.15	29.5	50	2	0.5	29.8	85.6
25	77	25	77	0.15	29.5	50	4	0.5	35.9	96.6

C4. COMPUTER PROGRAM FOR CALCULATION OF SET

The following code is one implementation of the SET calculation using JavaScript in SI units:

```
FindSaturatedVaporPressureTorr = function(T) {
    //Helper function for pierceSET calculates Saturated Vapor Pressure (Torr) at Temperature T (°C)
        return Math.exp(18.6686 - 4030.183/(T + 235.0));
}
pierceSET = function(TA, TR, VEL, RH, MET, CLO, WME, PATM) {
  //Input variables – TA (air temperature): °C, TR (mean radiant temperature): °C, VEL (air velocity): m/s,
  //RH (relative humidity): %, MET: met unit, CLO: clo unit, WME (external work): W/m2, PATM (atmospheric pressure): kPa
  var KCLO = 0.25;
  var BODYWEIGHT = 69.9;                          //kg
  var BODYSURFACEAREA = 1.8258;                   //m2
  var METFACTOR = 58.2;                           //W/m2
  var SBC = 0.000000056697;                       //Stefan-Boltzmann constant (W/m2K4)
  var CSW = 170.0;
  var CDIL = 120.0;
  var CSTR = 0.5;
  var LTIME = 60.0;

  var VaporPressure = RH * FindSaturatedVaporPressureTorr(TA)/100.0;
  var AirVelocity = Math.max(VEL, 0.1);
  var TempSkinNeutral = 33.7;
  var TempCoreNeutral = 36.49;
  var TempBodyNeutral = 36.49;
  var SkinBloodFlowNeutral = 6.3;
  var TempSkin = TempSkinNeutral;                 //Initial values
  var TempCore = TempCoreNeutral;
  var SkinBloodFlow = SkinBloodFlowNeutral;
  var MSHIV = 0.0;
  var ALFA = 0.1;
  var ESK = 0.1 * MET;
  var PressureInAtmospheres = PATM * 0.009869;
  var RCL = 0.155 * CLO;
  var FACL = 1.0 + 0.15 * CLO;
```

```
var LR = 2.2/PressureInAtmospheres;                                  //Lewis Relation is 2.2 at sea level
var RM = MET * METFACTOR;
var M = MET * METFACTOR;
if (CLO <= 0) {
   var WCRIT = 0.38 * Math.pow(AirVelocity, –0.29);
   var ICL = 1.0;
} else {
   var WCRIT = 0.59 * Math.pow(AirVelocity, –0.08);
   var ICL = 0.45;
}
   var CHC = 3.0 * Math.pow(PressureInAtmospheres, 0.53);
   var CHCV = 8.600001 * Math.pow((AirVelocity * PressureInAtmospheres), 0.53);
   var CHC = Math.max(CHC, CHCV);
   var CHR = 4.7;
   var CTC = CHR + CHC;
   var RA = 1.0/(FACL * CTC);                                        //Resistance of air layer to dry heat transfer
   var TOP = (CHR * TR + CHC * TA)/CTC;
   var TCL = TOP + (TempSkin – TOP)/(CTC * (RA + RCL));
   //TCL and CHR are solved iteratively using: H(Tsk – TOP) = CTC(TCL – TOP),
   //where H = 1/(RA + RCL) and RA = 1/FACL*CTC
   var TCL_OLD = TCL;
   var flag = true;
   var DRY, HFCS, ERES, CRES, SCR, SSK, TCSK, TCCR, DTSK, DTCR, TB, SKSIG, WARMS, COLDS, CRSIG, WARMC,
       COLDC, BDSIG, WARMB, COLDB, REGSW, ERSW, REA, RECL, EMAX, PRSW, PWET, EDIF, ESK;
   for (var TIM = 1; TIM <= LTIME; TIM++) {                          //Begin iteration
       do {
           if (flag) {
              TCL_OLD = TCL;
              CHR = 4.0 * SBC * Math.pow(((TCL + TR)/2.0 + 273.15), 3.0) * 0.72;
              CTC = CHR + CHC;
              RA = 1.0/(FACL * CTC);                                 //Resistance of air layer to dry heat transfer
              TOP = (CHR * TR + CHC * TA)/CTC;
           }
           TCL = (RA * TempSkin + RCL * TOP)/(RA + RCL);
           flag = true;
        } while (Math.abs(TCL – TCL_OLD) > 0.01);
        flag = false;
        DRY = (TempSkin – TOP)/(RA + RCL);
        HFCS = (TempCore – TempSkin) * (5.28 + 1.163 * SkinBloodFlow);
        ERES = 0.0023 * M * (44.0 – VaporPressure);
        CRES = 0.0014 * M * (34.0 – TA);
        SCR = M – HFCS – ERES – CRES – WME;
        SSK = HFCS – DRY – ESK;
        TCSK = 0.97 * ALFA * BODYWEIGHT;
        TCCR = 0.97 * (1 – ALFA) * BODYWEIGHT;
        DTSK = (SSK * BODYSURFACEAREA)/(TCSK * 60.0);                //°C/min
        DTCR = SCR * BODYSURFACEAREA/(TCCR * 60.0);                  //°C/min
        TempSkin = TempSkin + DTSK;
        TempCore = TempCore + DTCR;
        TB = ALFA * TempSkin + (1 – ALFA) * TempCore;
        SKSIG = TempSkin – TempSkinNeutral;
        WARMS = (SKSIG > 0) * SKSIG;
        COLDS = ((–1.0 * SKSIG) > 0) * (–1.0 * SKSIG);
        CRSIG = (TempCore – TempCoreNeutral);
        WARMC = (CRSIG > 0) * CRSIG;
        COLDC = ((–1.0 * CRSIG) > 0) * (–1.0 * CRSIG);
        BDSIG = TB – TempBodyNeutral;
        WARMB = (BDSIG > 0) * BDSIG;
```

```
        SkinBloodFlow = (SkinBloodFlowNeutral + CDIL * WARMC)/(1 + CSTR * COLDS);
        SkinBloodFlow = Math.max(0.5, Math.min(90.0, SkinBloodFlow));
        REGSW = CSW * WARMB * Math.exp(WARMS/10.7);
        REGSW = Math.min(REGSW, 500.0);
        var ERSW = 0.68 * REGSW;
        var REA = 1.0/(LR * FACL * CHC);                    //Evaporative resistance of air layer
        var RECL = RCL/(LR * ICL);                          //Evaporative resistance of clothing (icl=.45)
        var EMAX = (FindSaturatedVaporPressureTorr(TempSkin) – VaporPressure)/(REA + RECL);
        var PRSW = ERSW/EMAX;
        var PWET = 0.06 + 0.94 * PRSW;
        var EDIF = PWET * EMAX – ERSW;
        var ESK = ERSW + EDIF;
        if (PWET > WCRIT) {
          PWET = WCRIT;
          PRSW = WCRIT/0.94;
          ERSW = PRSW * EMAX;
          EDIF = 0.06 * (1.0 – PRSW) * EMAX;
          ESK = ERSW + EDIF;
        }
        if (EMAX < 0) {
          EDIF = 0;
          ERSW = 0;
          PWET = WCRIT;
          PRSW = WCRIT;
          ESK = EMAX;
        }
        ESK = ERSW + EDIF;
        MSHIV = 19.4 * COLDS * COLDC;
        M = RM + MSHIV;
        ALFA = 0.0417737 + 0.7451833/(SkinBloodFlow + 0.585417);
      }                                                     //End iteration

    var HSK = DRY + ESK;                                    //Total heat loss from skin
    var RN = M – WME;                                       //Net metabolic heat production
    var ECOMF = 0.42 * (RN – (1 * METFACTOR));
    if (ECOMF < 0.0) ECOMF = 0.0;                           //From Fanger
    EMAX = EMAX * WCRIT;
    var W = PWET;
    var PSSK = FindSaturatedVaporPressureTorr(TempSkin);
    var CHRS = CHR;                                         //Definition of ASHRAE standard environment
                                                            //... denoted "S"
    if (MET < 0.85) {
    var CHCS = 3.0;
    } else {
        var CHCS = 5.66 * Math.pow(((MET – 0.85)), 0.39);
        CHCS = Math.max(CHCS, 3.0);
      }
    var CTCS = CHCS + CHRS;
    var RCLOS = 1.52/((MET – WME/METFACTOR) + 0.6944) – 0.1835;
    var RCLS = 0.155 * RCLOS;
    var FACLS = 1.0 + KCLO * RCLOS;
    var FCLS = 1.0/(1.0 + 0.155 * FACLS * CTCS * RCLOS);
    var IMS = 0.45;
    var ICLS = IMS * CHCS/CTCS * (1 – FCLS)/(CHCS/CTCS – FCLS * IMS);
    var RAS = 1.0/(FACLS * CTCS);
    var REAS = 1.0/(LR * FACLS * CHCS);
    var RECLS = RCLS/(LR * ICLS);
    var HD_S = 1.0/(RAS + RCLS);
```

```
var HE_S = 1.0/(REAS + RECLS);

//SET determined using Newton's iterative solution
var DELTA = .0001;
var dx = 100.0;
var SET, ERR1, ERR2;
var SET_OLD = TempSkin – HSK/HD_S;                    //Lower bound for SET
while (Math.abs(dx) > .01) {
    ERR1 = (HSK – HD_S * (TempSkin – SET_OLD) – W * HE_S * (PSSK – 0.5 *
    FindSaturatedVaporPressureTorr(SET_OLD)));
    ERR2 = (HSK – HD_S * (TempSkin – (SET_OLD + DELTA)) – W * HE_S * (PSSK – 0.5 *
    FindSaturatedVaporPressureTorr((SET_OLD + DELTA))));
     SET = SET_OLD – DELTA * ERR1/(ERR2 – ERR1);
     dx = SET – SET_OLD;
     SET_OLD = SET;
  }
  return SET;
}
```

Modify Informative Appendix H as shown below. The remainder of Informative Appendix H is unchanged.

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°C (72.5°F), average air speeds within the comfort envelope of ±0.5 PMV should not exceed 0.20 ~~0.15~~ m/s (40 ~~30~~ fpm). This 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 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.

[. . .]

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.

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