ADDENDA

ANSI/ASHRAE Addendum f to
ANSI/ASHRAE Standard 55-2010

Thermal Environmental Conditions for Human Occupancy

Approved by the ASHRAE Standards Committee on October 2, 2012; by the ASHRAE Board of Directors on October 26, 2012; and by the American National Standards Institute on November 22, 2012.

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FOREWORD

This addendum removes informative language from the body of the standard and moves it to a new informative appendix. It includes some minor changes to requirements and states the requirements more clearly in normative language. In some cases, section numbering has been added or changed for greater clarity.

This addendum focuses primarily on Section 5.2.4, Local Thermal Discomfort, and Section 5.2.5, Temperature Variation with Time.

***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 f to Standard 55-2010

Revise Section 5.2.4 as shown. (Changes to Section 5.2.4 include those changes from published Addendum b to Standard 55-2010, available for free download from the ASHRAE Web site at www.ashrae.org/standards-research--technology/standards-addenda.)

5.2.4 Local Thermal Discomfort. ~~The local thermal 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 must be considered in determining conditions for acceptable thermal comfort. Requirements for these factors are specified in this section.~~

The requirements specified in this section shall be met only when representative occupants meet both of the following criteria:

a. have ~~apply to a lightly clothed person (with~~ clothing insulation ~~between 0.5 and~~ less than 0.7 clo~~)~~ and
b. are engaged in ~~near sedentary~~ physical activity ~~(~~with metabolic rates ~~between 1.0 and~~ below 1.3 met~~)~~.

***Note:** Because research is limited at clothing insulation above 0.7 clo, there are no requirements for consideration of local thermal discomfort above 0.7 clo. However, local discomfort effects may be present for occupants wearing more than 0.7 clo if their metabolic rate is below 1.3 met.*

For the purpose of compliance with this section, *representative occupants'* ankle level is 0.1 m (4 in.) above the floor and head level is 1.1 m (43 in.) for seated occupants and 1.7 m (67 in.) for standing occupants.

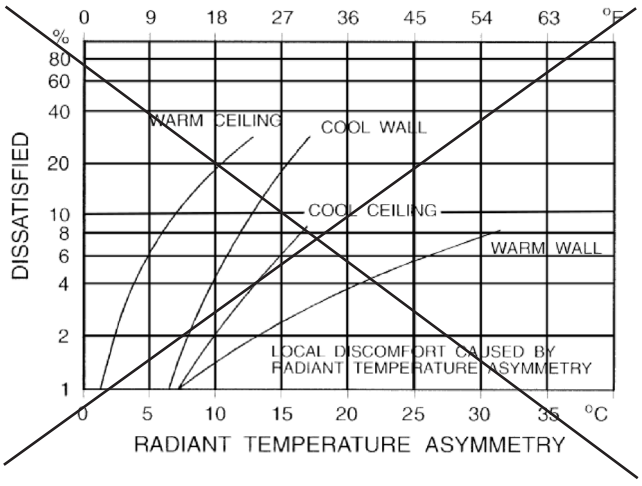
~~With higher metabolic rates and/or with more clothing insulation, people are less thermally sensitive and, consequently, the risk of local discomfort is lower. Thus, it is acceptable to use the requirements of this section for metabolic rates greater than 1.3 met and with clothing insulation greater than 0.7 clo, and they will be conservative. People are more sensitive to local discomfort when the whole body is cooler than neutral and less sensitive to local discomfort when the whole body is warmer than neutral. The requirements of this section are based on environmental temperatures near the center of the comfort zone. These requirements apply to the entire comfort zone, but they may be conservative for conditions near the upper temperature limits of the comfort zone and may underestimate acceptability at the lower temperature limits of the comfort zone.~~

~~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.~~

5.2.4.1 Radiant Temperature Asymmetry. ~~The thermal radiation field about the body may be nonuniform due to hot and cold surfaces and direct sunlight. This asymmetry may cause local discomfort and reduce the thermal acceptability of the space. In general, people are more sensitive to asymmetric radiation caused by a warm ceiling than that caused by hot and cold vertical surfaces. Figure 5.2.4.1 gives the predicted percentage of dissatisfied occupants as a function of the radiant temperature asymmetry caused by a warm ceiling, a cool wall, a cool ceiling, or a warm wall.~~

~~The limits for r~~Radiant temperature asymmetry ~~are specified~~ shall not exceed the values in Table 5.2.4.1. ~~Alternatively, it is acceptable to use Figure 5.2.4.1 in conjunction with the PD limits from Table 5.2.4 to determine the allowable radiant asymmetry.~~

5.2.4.2 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~~



~~Figure 5.2.4.1 Local thermal discomfort caused by radiant asymmetry.~~

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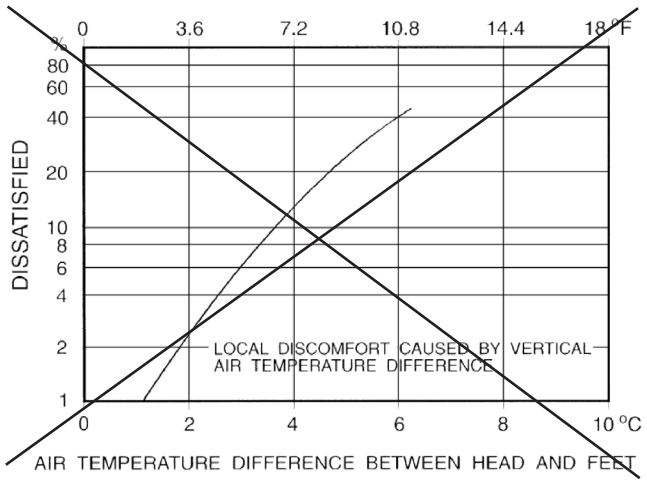
~~TABLE 5.2.4 Percentage Dissatisfied (PD) Due to Local Discomfort from Draft or Other Sources~~

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

TABLE 5.2.4.1 Allowable Radiant Temperature Asymmetry

Radiant Temperature Asymmetry °C (°F)			
~~Warm~~ Ceiling Warmer than Floor	~~Cool~~ Wall Cooler than Air	~~Cool~~ Ceiling Cooler than Floor	~~Warm~~ Wall Warmer than Air
<5 (9.0)	<10 (18.0)	<14 (25.2)	<23 (41.4)



~~Figure 5.2.4.3 Local thermal discomfort caused by vertical temperature differences.~~

~~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~~.

At operative temperatures below 22.5°C (72.5°F), air speeds caused by the building, its fenestration, and its HVAC system shall ~~within the comfort envelope of ±0.5 PMV should~~ not exceed 0.15 m/s (30 fpm) ~~as measured~~ at any ~~single~~ height ~~surrounding the body~~ from the ankle to the head. This limit does ~~applies to air movement caused by the building, its fenestration, and its HVAC system and~~ not require consideration of ~~to~~ air movement produced by office equipment or occupants.

Exception: Higher air speeds that are permitted by ~~It is acceptable for 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 5.2.3.

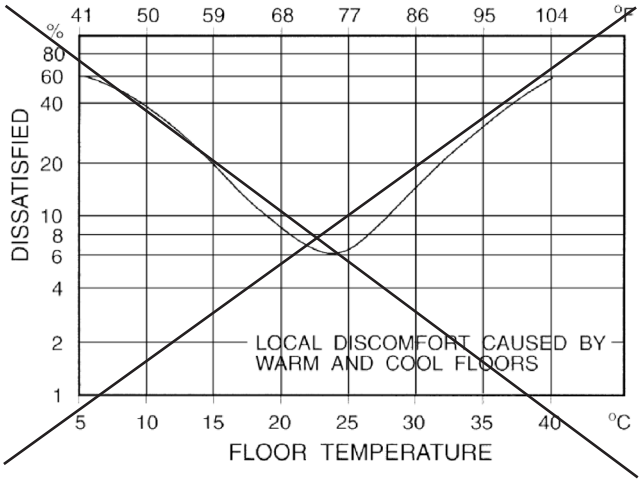
5.2.4.3 Vertical Air Temperature Difference. ~~Thermal stratification that results in the air temperature at the head level being warmer than at the ankle level may cause thermal~~

~~TABLE 5.2.4.3 Allowable Vertical Air Temperature Difference Between Head and Ankles~~

~~Vertical Air Temperature Difference, °C (°F)~~
~~<3 (<5.4)~~

~~TABLE 5.2.4.4 Allowable Range of the Floor Temperature~~

~~Range of Surface Temperature of the Floor, °C (°F)~~
~~19–29 (66.2–84.2)~~



~~Figure 5.2.4.4 Local discomfort caused by warm and cool floors.~~

~~discomfort. This section specifies allowable differences between the a~~Air temperature difference between~~at~~ head level and ~~the air temperature at~~ ankle level shall not exceed 3°C (5.4°F). ~~Figure 5.2.4.3 gives the predicted percentage of dissatisfied occupants as a function of 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.~~

~~It is permissible to determine the allowable differences in air temperature from the ankle level to the head level from Table 5.2.4.3. Alternatively, it is acceptable to use Figure 5.2.4.3 in conjunction with the PD limit for vertical temperature differences in Table 5.2.4 to determine the allowable differences in air temperature from the ankle level to the head level.~~

5.2.4.4 Floor Surface Temperature. When *representative occupants* are seated with feet in contact with the floor, ~~Occupants may feel uncomfortable due to contact with~~ floor surfaces temperatures within the *occupied zone* shall be 19–29°C (66.2–84.2°F). ~~that are too warm or too cool. The temperature of the floor, rather than the material of the floor covering, is the most important factor for foot thermal comfort for~~

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people wearing shoes. Figure 5.2.4.4 gives the predicted percentage of dissatisfied occupants as a function of floor temperature. The criteria in this section are based on people wearing lightweight indoor shoes. It is acceptable to use these criteria for people wearing heavier footgear, but they may be conservative. This standard does not address the floor temperature required for people not wearing shoes, nor does it address acceptable floor temperatures when people sit on the floor.

The limits for floor temperature are specified in Table 5.2.4.4. Alternatively, it is acceptable to use Figure 5.2.4.4 conjunction with the PD limit from Table 5.2.4 to determine the allowable floor temperature range.

Revise Section 5.2.5 as shown.

5.2.5 Temperature Variations with Time. Fluctuations in the air temperature and/or mean radiant temperature may affect the thermal comfort of occupants. Those fluctuations under the direct control of the individual occupant do not have a negative impact on thermal comfort, and the requirements of this section do not apply to these fluctuations. FThe fluctuations requirements of this section shall be met when they are that occur due to factors not under the direct control of the individual occupant (e.g., cycling from thermostatic control) may have a negative effect on comfort, and the requirements of this section apply to these fluctuations. Fluctuations that occupants experience as a result of moving between locations with different environmental conditions are allowed as long as the conditions at all of these locations are within the comfort zone for these moving occupants.

5.2.5.1 Cyclic Variations. Cyclic variations refer to those situations where the in operative temperature repeatedly rises and falls, and thethat have a period of these variations is not greater than 15 minutes. If the period of the fluctuation cycle exceeds 15 minutes, the variation is treated as a drift or ramp in operative temperature, and the requirements of Section 5.2.5.2 apply. In some situations, variations with a period not greater than 15 minutes are superimposed on variations with a longer period. In these situations, the requirements of Section 5.2.5.1 apply to the component of the variation with a period not greater than 15 minutes, and the requirements of Section 5.2.5.2 apply to the component of the variation with a period greater than 15 minutes.

Table 5.2.5.1 specifies the maximum allowable shall have a peak-to-peak amplitude no greater than 1.1°C (2.0°F). cyclic variation in operative temperature.

5.2.5.2 Drifts or Ramps. Temperature drifts and ramps are The requirements of this section apply only to monotonic, noncyclic changes in operative temperature and . The requirements of this section also apply to cyclic variations with a period greater than 15 minutes. Generally, drifts refer to passive temperature changes of the enclosed space, and ramps refer to actively controlled temperature changes. The requirements of this section are the same for drifts and ramps.

Table 5.2.5.2 specifies the maximum Cchanges in operative temperature allowed during a period of time. For any given time period,shall not exceed the most restrictive requirements from Table 5.2.5.2 apply. For example, the operative temperature may not change more than 2.2°C (4.0°F) during a 1.0 h period, and it also may not change more than 1.1°C (2.0°F) during any 0.25 h period within that 1.0 h period. If variations are created as a result of control or adjustments by the user, higher values may be acceptable.

TABLE 5.2.5.1 Allowable Cyclic Operative Temperature Variation

Allowable Peak-to-Peak Variation in Operative Temperature, °C (°F)
1.1 (2.0)

TABLE 5.2.5.2 Limits on Temperature Drifts and Ramps

Time Period, h	0.25	0.5	1	2	4
Maximum Operative Temperature Change Allowed, °C (°F)	1.1 (2.0)	1.7 (3.0)	2.2 (4.0)	2.8 (5.0)	3.3 (6.0)

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 XX

XX1. LOCAL THERMAL DISCOMFORT

Avoiding local thermal discomfort, whether 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, is essential to providing acceptable thermal comfort.

The requirements specified in Section 5.2.4 of this standard apply directly to a lightly clothed person (with clothing insulation between 0.5 and 0.7 clo) engaged in near sedentary physical activity (with metabolic rates between 1.0 and 1.3 met). With higher metabolic rates and/or with more clothing insulation, people are less thermally sensitive and, consequently, the risk of local discomfort is lower. Thus, it is acceptable to use the requirements of Section 5.2.4 for metabolic rates greater than 1.3 met and with clothing insulation greater than 0.7 clo, since they will be conservative. People are more sensitive to local discomfort when the whole body is cooler than neutral and less sensitive to local discomfort when the whole body is warmer than neutral. The requirements of Section 5.2.4 of this standard are based on environmental temperatures near the center of the comfort zone. These

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TABLE XX-1 Expected Percent Dissatisfied Due to Local Discomfort from Draft or Other Sources

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

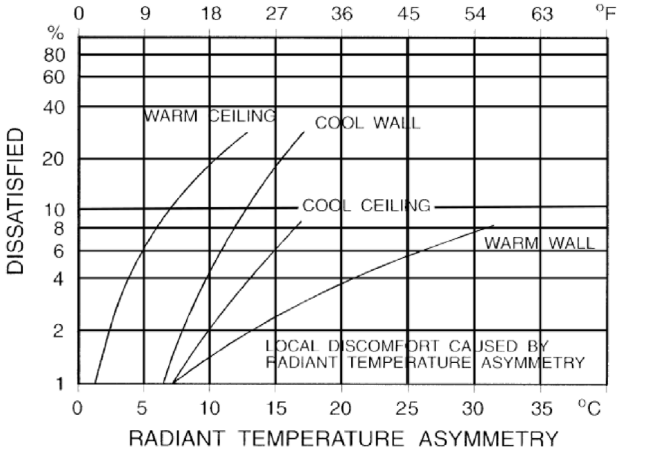

Figure XX-1 Local thermal discomfort caused by radiant asymmetry.

requirements apply to the entire comfort zone, but they may be conservative for conditions near the upper temperature limits of the comfort zone and may underestimate discomfort at the lower temperature limits of the comfort zone.

Table XX-1 shows the expected percent dissatisfied 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 should be met simultaneously at the levels specified for an environment to meet the requirements of Section 5.4 of this standard. The expected percent dissatisfied for each source of local thermal discomfort described in Sections 5.2.4.1 through 5.2.4.4 should be specified.

XX2. RADIANT TEMPERATURE ASYMMETRY

The thermal radiation field about the body may be nonuniform due to hot and cold surfaces and direct sunlight. This asymmetry may cause local discomfort and reduce the thermal acceptability of the space. In general, people are more sensitive to asymmetric radiation caused by a warm ceiling than that caused by hot and cold vertical surfaces. Figure 5.2.4.1 gives the expected percentage of occupants dissatisfied due to radiant temperature asymmetry caused by a warm ceiling, a cool wall, a cool ceiling, or a warm wall.

The allowable radiant asymmetry limits are based on Figure XX-1 and assume that a maximum of 5% of occupants are dissatisfied by radiant asymmetry.

XX3. 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 5.2.3. When occupants are neutral to slightly cool, such as under certain combinations of met rate and clo value with operative temperatures below 22.5°C (72.5°F), air speeds within the comfort envelope of ±0.5 PMV should not exceed 0.15 m/s (30 fpm) as measured at any single height surrounding the body. 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 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 5.2.3.

XX4. VERTICAL AIR TEMPERATURE DIFFERENCE

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 5.2.4.3 of this standard specifies allowable differences between the air temperature at head level and the air temperature at ankle level. Figure XX-2 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 XX-2 and assumes that a maximum of 5% of occupants are dissatisfied by the vertical air stratification.

XX5. FLOOR SURFACE TEMPERATURE

Occupants may feel uncomfortable due to contact with floor surfaces that are too warm or too cool. The temperature of the floor, rather than the material of the floor covering, is the most important factor for foot thermal comfort for people wearing shoes. Figure XX-3 gives the expected percentage of occupants who are dissatisfied due to floor temperature based on people wearing lightweight indoor shoes. Thus, it is acceptable to use these criteria for people wearing heavier footgear since they will be conservative. This standard does not address the floor temperature required for people not wearing shoes, nor does it address acceptable floor temperatures when people sit on the floor.

The limit for floor temperature is based on Figure XX-3 and assumes that a maximum of 10% of occupants are dissatisfied by warm or cold floors.

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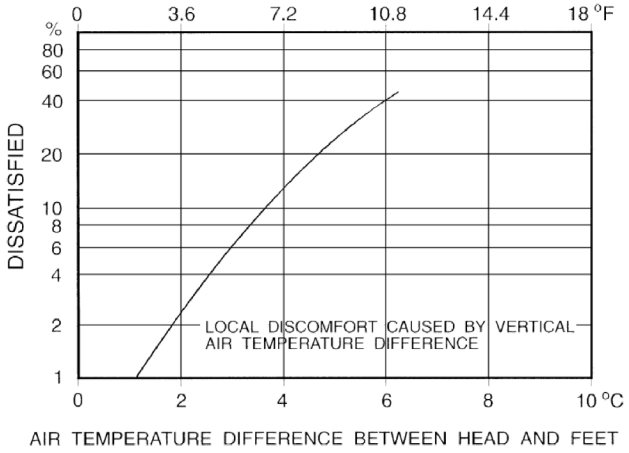

Figure XX-2 Local thermal discomfort caused by vertical temperature differences.

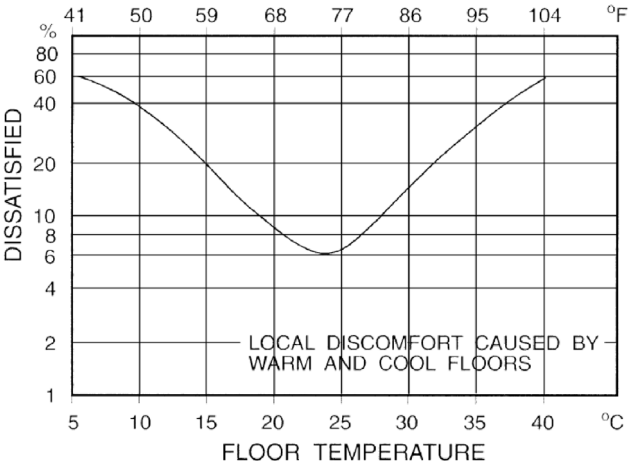

Figure XX-3 Local discomfort caused by warm and cool floors.

XX6. TEMPERATURE VARIATIONS WITH TIME

Fluctuations in the air temperature and/or mean radiant temperature may affect the thermal comfort of occupants. Those fluctuations under the direct control of the individual occupant do not have a negative impact on thermal comfort, and the requirements of this standard do not apply to these fluctuations. Fluctuations that occur due to factors not under the direct control of the individual occupant (e.g., cycling from thermostatic control) may have a negative effect on comfort, and the requirements of this standard apply to these fluctuations. Fluctuations that occupants experience as a result of moving between locations with different environmental conditions are allowed by Section 5 of this standard as long as the conditions at all of these locations are within the comfort zone for these moving occupants.

XX7. CYCLIC VARIATIONS

Cyclic variations refer to those situations where the operative temperature repeatedly rises and falls, and the period of these variations is not greater than 15 minutes. If the period of the fluctuation cycle exceeds 15 minutes, the variation is treated as a drift or ramp in operative temperature and the requirements of Section 5.2.5.2 apply. In some situations, variations with a period not greater than 15 minutes are superimposed on variations with a longer period. In these situations, the requirements of Section 5.2.5.1 apply to the component of the variation with a period not greater than 15 minutes, and the requirements of Section 5.2.5.2 apply to the component of the variation with a period greater than 15 minutes.

XX8. DRIFTS OR RAMPS

Temperature drifts and ramps are monotonic, noncyclic changes in operative temperature. The requirements of Section 5.2.5.2 also apply to cyclic variations with a period greater than 15 minutes. Generally, drifts refer to passive temperature changes of the enclosed space, and ramps refer to actively controlled temperature changes. The requirements of Section 5.2.5.2 are the same for both drifts and ramps.

Section 5.2.5.2 specifies the maximum change in operative temperature allowed during a period of time. For any given time period, the most restrictive requirements from Table 5.2.5.2 apply. For example, the operative temperature may not change more than 2.2°C (4.0°F) during a 1.0 h period, and it also may not change more than 1.1°C (2.0°F) during any 0.25 h period within that 1.0 h period. If the user creates variations as a result of control or adjustments, higher values may be acceptable.

These local thermal comfort criteria were developed in order to keep the expected percent of occupants who are dissatisfied due to all of these local discomfort factors at or below 10%. The operative temperature ranges required in the standard were developed in order to keep the predicted percent dissatisfied of occupants due to operative temperature only, without factoring in local thermal factors. When both local discomfort factors and operative temperature considerations are combined, the goal of this standard to standardize thermal conditions acceptable to a substantial majority of occupants (80%) is achieved. This is especially true if there is some overlap between those who are dissatisfied due to local factors and those who are dissatisfied due to operative temperature.

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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.