

What's New in ASHRAE's Standard on Comfort

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Eighty-seven years ago, the first thermal comfort standard determined the boundaries of comfort by seating unclothed subjects in front of fans.¹ Of course, research is more sophisticated now. In the 45 years since ASHRAE first published Standard 55, *Thermal Comfort Conditions*, the standard has incorporated the latest research in every edition.

In the 2010 version of Standard 55, *Thermal Environmental Conditions for Human Occupancy*, recent research helped inform significant changes required to improve and clarify the three distinct compliance paths established in Standard 55-2004. After summarizing some of the technical changes, this article explains these three compliance paths, highlights the differences between them, and summarizes the changes to each path.

Changes in the 2010 Version

Here is a brief description of some of the changes to the standard. For more information, visit www.ashrae.org/technology/page/132#55-2004 for the

addenda since 2004 that have been incorporated into the new version.

Standard 55-2010 includes extended provisions² for evaluating the impacts of elevated air speed. Elevated air movement increases the maximum operative temperature that occupants will find acceptable, so equivalent comfort can be maintained in a wider range of operative temperatures. Therefore, the use of elevated air speeds to widen the acceptable range of thermal conditions has been modified and expanded (Section 5.2.3). The standard had previously allowed modest increases in operative temperature beyond the PMV-PPD (Computer Model Method for General Indoor Ap-

plications [Computer Model Method] in Section 5.2) limits as a function of air speed and turbulence intensity. But field studies including recently published work show that occupants, especially when neutral or slightly warm, prefer higher air speeds than were previously allowed. In certain combinations of temperature ranges and personal factors, the preference for more air movement is greater than it is for less air movement. As a result, the standard provides a new method for expressing and selecting air speed limits, and alternatives for determining the boundaries of comfort at air speeds above 0.15 m/s (30 fpm).

With these changes, the standard continues to focus on defining the range of indoor thermal environmental conditions acceptable to a majority of occupants, while accommodating an increasing variety of design solutions intended to both provide comfort and to respect today's imperative for sustainable buildings.

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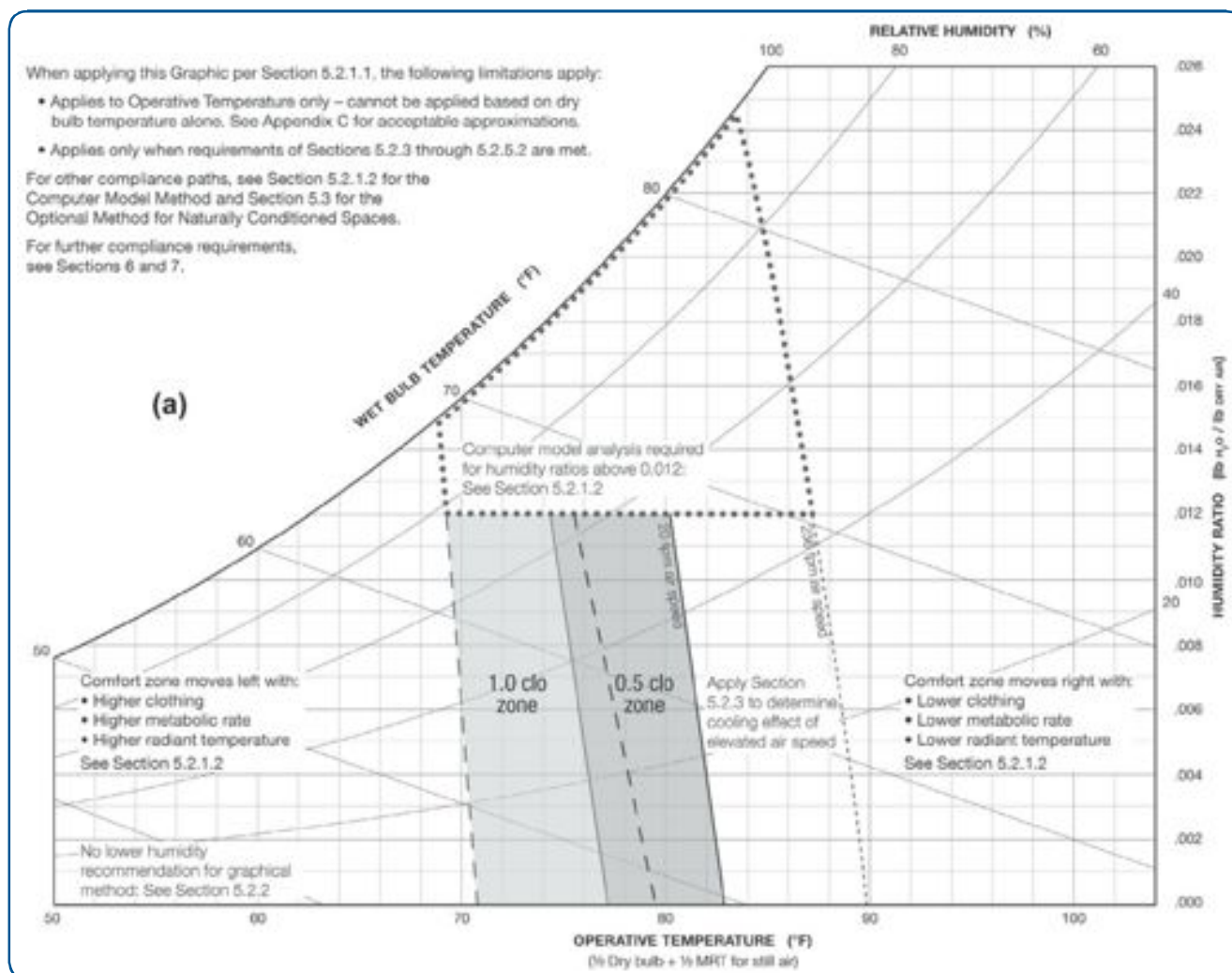


Figure 2: The new Graphic Comfort Zone Method, Figure 5.2.1.1 in Standard 55-2010 (IP version shown).

paths, and indeed in much of the standard, the graphic represents *operative temperature*.

The standard in certain cases allows air or space temperature to be used as an approximation for operative temperature, but only in spaces where mean radiant temperature does not unduly depart from air temperature. Appendix C of the standard provides more detail on when this simplifying approximation is justifiable. In today's architecture with abundant glazing, this simplifying assumption may not always apply. So, the building and its systems must be able to provide *operative temperatures* in the ranges shown, at and between the warmer and colder outdoor design conditions applicable to the project.

The upper limits for humidity with this simple Graphic Comfort Zone Method are more strict than with the other compliance paths. An upper limit of 0.012 humidity ratio applies, which gives us the "flat top" of the comfort zone in *Figure 1*. For the "summer" comfort zone based on lightweight clothing towards the right side of the figure, this represents relative humidities between 67% and 56%. Bear in mind that,

with respect to humidity, ANSI/ASHRAE Standard 62 is more restrictive than Standard 55, which does not deal with IAQ nor the impact to building materials and envelopes.

Additionally, as is now stated in the graphic, the requirements of Sections 5.2.3 through 5.2.5.2 must be met. Though previously true, these requirements were often ignored in design processes and documentation evaluated by the committee. These sections require that, in addition to being able to achieve operative temperatures within the applicable comfort zone, designs claiming compliance with Standard 55-2010 must also address specific limits and provisions for evaluating the impacts of elevated air speed (§5.2.3), as well as the following causes of local thermal discomfort:

- Radiant temperature asymmetry (§5.2.4.1);
- Draft (§5.2.4.2);
- Vertical air temperature difference (§5.2.4.3); and
- Floor surface temperature (§5.2.4.4).

Perhaps most often overlooked, are requirements limiting temperature variations with time: cyclic variations (§5.2.5.1) and drifts or ramps (§5.2.5.2). As stated previously, the elevat-

The maximum permissible operative temperature increases dramatically from traditional still-air comfort zones. Two important notes: the permissible air speeds for cooler temperatures without local occupant control *have not changed*, and for a certain elevated air speed the lower limit on temperature increases as well, not just the upper limit.

The standard clarifies that the upper humidity limit shown on the psychrometric chart in the graphical method only applies to the Graphic Comfort Zone Method for Typical Indoor Environments (Graphic Comfort Zone Method). Higher humidity limits are allowed if evaluated with the Computer Model Method, and no limits are imposed on the Adaptive Method.

Revised requirements and calculation methods apply when increased air movement is used to maintain comfort in warm conditions. Standard Effective Temperature (SET) is re-introduced into the standard as the calculation basis for determining the cooling effect of air movement. This calculation method has been simplified with the removal of turbulence intensity and draft risk calculations and the personal control limitations have been relaxed based on the results of new research. This change is expected to give clear requirements for application of ceiling and other in-room fans for comfort cooling.

Section 6, Compliance, contains new mandatory minimum requirements for analysis and documentation of a design to show that it meets the requirements in the standard. Informative Appendix G expands on Section 6, Compliance, by providing a compliance form for documentation of design compliance. This form is the basis for the U.S. Green Building Council LEED template for documenting compliance with the requirements of the Thermal Comfort design credit in the New Construction (NC) rating system's Indoor Environmental Quality Credit 7.1.

A new general satisfaction survey has been added to Section 7.5.2.1 as a method to evaluate thermal comfort in occupied spaces. The previous survey in the 2004 version of the standard was meant for evaluating comfort at a point in time (e.g., “how do you feel right now?”), and the new survey is meant to evaluate the overall comfort of a space (e.g., “how do you feel in general?”). Addition of a general satisfaction survey aligns Standard 55 with current practice for survey based post-occupancy evaluations (POEs).

Editorial changes have been made throughout the standard to clarify requirements. Wherever possible, the use of informative language in the standard is avoided.

Compliance Paths & Methods in Standard 55-2010

As with the 2004 standard, there are three primary compliance paths in Standard 55-2010: the Graphic Comfort Zone Method, the Computer Model Method, and the Optional Method for Determining Acceptable Thermal Condi-

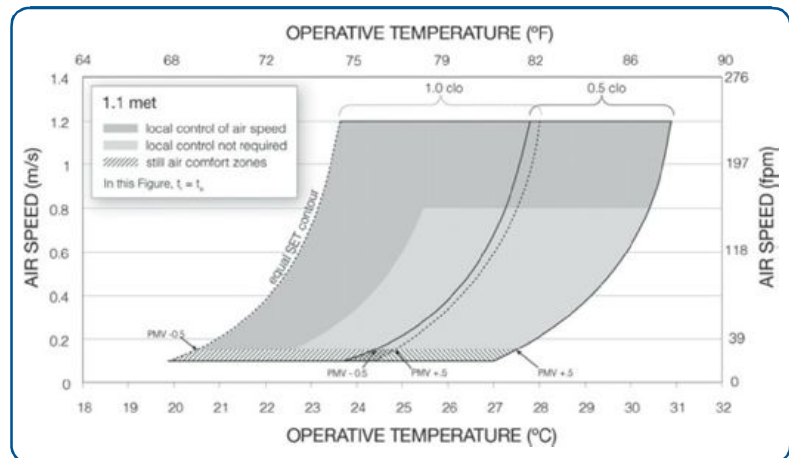


Figure 1: Acceptable range of operative temperature and air speeds for the comfort zone shown in Figure 2, at humidity ratio 0.010 (Standard 55-2010).

tions in Naturally Conditioned Spaces (Adaptive Method). The Graphic Comfort Zone Method is the simplest, the time-honored Graphic Method based on the (in?)famous thermal comfort chart. It is based on the Computer Model Method, but minimizes calculations. It includes a “comfort zone” graphic in the standard that applies to projects where the assumptions and limitations stated in the method apply.

The second method is the Computer Model Method, which requires calculations that allow—and require—the use of project specific inputs. This method applies to some projects or spaces not suited for the graphic comfort zone method. The third method is the Adaptive Method introduced in 2004 to extend the applicability of the standard to naturally ventilated spaces. This approach is for use in naturally ventilated spaces without mechanical cooling, and applies to times when no heating system is in use. In such projects and conditions, it better describes the range of thermal conditions that provide comfort as occupants “adapt” to changing outdoor conditions.

Graphic Comfort Zone Method

In the past, I attended many ASHRAE chapter programs that incorporated a scanned version of the tiny chart that appeared in earlier versions of the standard. This was invariably presented with misinformation or missing information about the related requirements of the standard. Unfortunately, an evaluation of compliance documentation examples collected and reviewed by the committee in recent years shows similar oversimplification of design for compliance with Standard 55. To help improve compliance with the Graphic Comfort Zone Method and *all* of its requirements, the committee has made significant editorial improvements to the comfort zone graphic.

Today, the improved and enlarged comfort zone graphic (Figure 1) in the 2010 standard better represents the several conditions and opportunities related to this compliance method. Foremost, this graphic *cannot be applied based on dry-bulb temperature alone!* As is true in all three compliance

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