ANSI/ASHRAE 90.2*a*, *b*, and *c*
Addenda to ANSI/ASHRAE Standard 90.2-1993

ASHRAE® STANDARD

Addenda to

Energy-Efficient Design of New Low-Rise Residential Buildings

Addendum 90.2*a* was approved by the ASHRAE Standards Committee February 1, 1995; by the ASHRAE Board of Directors February 2, 1995; and by the American National Standards Institute December 13, 1995. Addendum 90.2*b* was approved by the ASHRAE Standards Committee June 29, 1994; by the ASHRAE Board of Directors June 30, 1994; and by the American National Standards Institute December 13, 1995. Addendum 90.2*c* was approved by the ASHRAE Standards Committee January 29, 1997; by the ASHRAE Board of Directors January 30, 1997; and by the American National Standards Institute May 28, 1997.

This standard is under continuous maintenance procedures 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 ASHRAE's Internet Home Page, http://www.ashrae.org, or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. Email: orders @ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in U.S. and Canada).

ISSN 1041-2336

Approved American National Standard
ANSI

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.
1791 Tullie Circle, NE • Atlanta, GA 30329

ASHRAE Standard Project Committee 90.2P (Addenda 90.2*a* and 90.2*b*)
Cognizant TC: TC 9.6, Systems Energy Utilization
Project Committee Liaison: Sally A. Hooks

Frank J. Powell, *Chair**
William R. Strzepek, *Secretary**
Carl E. Adams*
George E. Barney
Floyd Barwig
Peter Harold Billing*
Lynn H. Bringhurst*
Mark Louis Bulger
T. Joseph Cardenas
Jefferey E. Christian*
Donald G. Colliver
Richard A. Davis
Earl A. Ferguson
David B. Goldstein*
Adam W. Hinge
Sally A. Hooks
Bion D. Howard*
Esher R. Kweller
Merle F. McBride*
Kenneth D. Mentzer*
Pay Payne
James A. Ranfone*
James S. Reiley
Ronald L. Ritschard
Henry T. Rutkowski*
Clifford D. Smith
Frank A. Stanonik
John M. Talbott
Adrian N. Tuluca
Martha G. Van Geem*
Donald Joseph Vild
Jose Villanueva
Francis Joseph Walter, Jr.
Allen C. Weidman
Bruce A. Wilcox*
John I. Woodworth
Hofu Wu

** Denotes members of voting status when the documents were approved for publication*

ASHRAE Standing Standard Project Committee 90.2 (Addendum 90.2*c*)
Project Committee Liaison: Mark C. Hegberg

David R. Conover, *Chair**
Harold L. Crowder, Jr., *Vice-Chair**
James C. Benney*
David C. Bixby
Maribeth Bradfield
Stephen G. Braun*
Paul W. Cabot*
David Dacquisto*
Randy G. Despain
Eric Ekstrom
David B. Goldstein
Walter T. Grondzik*
Kenneth W. Hedges
Billy G. Hinton, Jr.*
Jonathan Humble
Paul F. Hutchins, Jr.
Richard Kadulski
Mark E. Kelley, III*
Michael I. Kwart
Stephen Denny Kennedy*
Ted J. Kesik*
Todd A. Lash
Joseph A. Marsilii
Bernice A. Mattsson*
Richard A. Morris
Ronald G. Nickson*
Kenneth B. Nittler*
Bill Pennington*
Martin P. Petchul
John L. Peterson*
Wayne R. Reedy
Stephen V. Skalko*
Ann L. Stanton*
Bruce J. Swiecicki*
Z. Todd Taylor
Iain S. Walker*
Raymond J. Wojcieson*

** Denotes members of voting status when the document was approved for publication*

ASHRAE STANDARDS COMMITTEE 1993-94 (Addendum 90.2*b* approval)

Lee W. Burgett, *Chair*
Harry J. Sauer, Jr., *Vice-Chair*
M. Kent Anderson
Herman F. Behls
Larry O. Degelman
Allen J. Hanley
John K. Hodge
Peter J. Hoey
Sally A. Hooks
Ronald H. Howell
Daniel E. Kramer
James A. Ranfone
John M. Talbott
Michael W. Woodford
James E. Woods
Thomas P. Wutka
George S. Yamamoto
Grenville K. Yuill
John S. Blossom, *CO*
Michael E. Dillon, *ExO*

Jim L. Heldenbrand, *Manager of Standards*

ASHRAE STANDARDS COMMITTEE 1994-95 (Addendum 90.2*a* approval)

ASHRAE STANDARDS COMMITTEE 1996-97 (Addendum 90.2*c* approval)

SPECIAL NOTE

This American National Standard (ANS) is a national voluntary consensus standard developed under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (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 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,
d. permission to reprint portions of the Standard.

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.

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.

This foreword is not part of these addenda but is included for information purposes only.

Addenda 90.2a-1995 and 90.2b-1994 to ASHRAE/IESNA 90.1-1993 were written to update references, expand the metal stud correction factors, revise the fenestration trade-off equation, and add skylights to the fenestration trade-off equation. These changes were proposed primarily in response to commenters, to update references and to take advantage of current technological improvements.

Addendum 90.2a-1995 *updates the references and expands Table 5-1 to be consistent with* ASHRAE/IESNA Standard 90.1-1989.

Addendum 90.2b-1994 *revises the fenestration trade-off equation (Equation 5-12) to accommodate the addition of skylights. There is no change to the functional form or use of the equation. The principal change to the fenestration trade-off equation (Equation 5-12) is to revise the coefficients for the solar terms. Development of the original fenestration trade-off equation in 1986 was completed using Typical Meteorological Year (TMY) hourly weather data tapes with the DOE-2 program for 11 U.S. locations, and it only evaluated vertical glazing. In 1993, when skylights were evaluated, the Weather Year for Energy Calculation (WYEC) hourly tapes were used with the DOE-2 program. The solar values on the TMY tapes were different from the WYEC tapes. To ensure consistency in treatment of the vertical fenestration and skylights, all of the solar terms in this addendum were evaluated using the WYEC tapes. The skylight trade-off option was added to reflect its emergence as a prominent construction feature in many new residences.*

Note: Strikethrough indicates deletions; double underlines indicate additions, unless otherwise indicated.

ADDENDUM 90.2*a*

Change: 5.2.1.2 as indicated below:

5.2.1.2 To comply with the requirements of Section 5, calculation procedures and information contained in Chapters 19-27 of the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2) shall be used.

To comply with the requirements set forth in this section, other available measured thermal performance data for envelope sections, either from laboratory or field data or from engineering analyses, should be considered.

If laboratory or field test measurements are used for envelope heat transmission, they shall be obtained using one of the following test methods:

(a) Guarded hot plate: ASTM C177-~~85~~ 94 (Reference 11)

(b) Heat flow meter: ASTM C518-91 (Reference 12)

(c) Guarded hot box: ASTM C236-89 (Reference 13)

(d) Calibrated hot box: ASTM C976-90 (Reference 14)

All thermal properties (U, C, and R) that are used to determine compliance with this standard, whether calculated or measured, shall be based on a mean temperature of 75°F.

Change: 5.2.2.1.1 as indicated below:

5.2.2.1.1 Thermal Transmittance. The design thermal transmittance (U) of all envelope components above grade is the variable used to specify the requirements and demonstrate compliance. All design U-values are air to air, including interior and exterior air films. Calculation of design U-values shall be done in accordance with the procedures in Chapters 20, 22, and 27 of the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2) and account for thermal bridges and anomalies. For example:

(a) wood framing members and webs in masonry construction, see Chapter 20;

(b) metal framing members, see Chapter 22, "Zone Method of Calculation," or use Table 5-1;

(c) fenestration, see Chapter 27.

When more than one assembly is used in an envelope component, the design U-value for that envelope component shall be calculated using Equation 5-1.

$$U = \frac{U_1 \times A_1 + U_2 \times A_2 + \ldots + U_n \times A_n}{A} \qquad (5\text{-}1)$$

where

U = thermal transmittance of the envelope component, But/h·ft^{2}·°F;

A = area of the envelope component, ft^2;

$U_{1\text{-}n}$ = thermal transmittance of the individual component assemblies, Btu/h·ft^{2}·°F;

$A_{1\text{-}n}$ = area of the individual component assemblies, ft^2.

Change: 5.2.2.1.2 as indicated below:

5.2.2.1.2 Thermal Conductance. The thermal conductance (C) of all below-grade envelope components is the variable used to set the requirements and demonstrate compliance. All C-values are surface to surface, excluding air films and the adjacent ground. Calculation of C-values shall be done in accordance with the procedures in Chapters 20 and 22 of the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2) and account for thermal bridges and anomalies. For example:

(a) wood framing members and webs in masonry construction, see Chapter 20;

(b) metal framing members, see Chapter 22, "Zone Method of Calculation," or use Table 5-1.

Change: Table 5-1 as indicated below:

TABLE 5-1
Wall Sections with Metal Studs, Parallel Path Correction Factors

Size of Members	Gauge of Stud	Spacing of Framing, in.	Cavity Insulation R-Value	Correction Factor	Effective Framing/Cavity R-Values
2 × 4	18-16	16 o.c.	R-11	0.50	R-5.5
			R-13	0.46	R-6.0
			R-15	0.43	R-6.4
2 × 4	18-16	24 o.c.	R-11	0.60	R-6.6
			R-13	0.55	R-7.2
			R-15	0.52	R-7.8
2 × 6	18-16	16 o.c.	R-19	0.~~40~~37	R-7.1
			R-21	0.35	R-7.4
2 × 6	18-16	24 o.c.	R-19	0.45	R-8.6
			R-21	0.43	R-9.0
2 × 8	18-16	16 o.c.	R-25	0.31	R-7.8
2 × 8	18-16	24 o.c.	R-25	0.38	R-9.6

These factors can be applied to metal studs of this gauge or thinner.

When more than one assembly is used in an envelope component, the C-value for that envelope component shall be calculated using Equation 5-2.

$$C = \frac{C_1 \times A_1 + C_2 \times A_2 + \ldots + C_n \times A_n}{A} \qquad (5\text{-}2)$$

where

C = thermal conductance of the envelope component, Btu/h·ft^2·°F;

A = area of the envelope component, ft^2;

$C_{1\text{-}n}$ = thermal conductance of the individual component assemblies, Btu/h·ft^2·°F;

$A_{1\text{-}n}$ = area of the individual component assemblies, ft^2.

Change: 5.2.2.2.2 as indicated below:

5.2.2.2.2 Envelope Component U × A Term. When more than one assembly of ceilings, walls, fenestration, doors, or floors are used, the (U × A) term for that envelope component shall be calculated using Equation 5-7. All U-values are air-to-air, including interior and exterior air films. Calculation of U-values shall be done in accordance with the procedures in Chapters 20, 22, and 27 of the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2) and shall account for thermal bridges and anomalies. For example:

(a) wood framing members and webs in masonry construction, see Chapters 20 and 22;

(b) fenestration, see Chapter 27.

$$U \times A = (U_1 \times A_1) + (U_2 \times A_2) + \ldots + (U_n \times A_n) \qquad (5\text{-}7)$$

where

$U \times A$ = sum of the products of the thermal transmittances of the individual assemblies multiplied by the areas of the individual assemblies, Btu/h·°F;

$U_{1\text{-}n}$ = thermal transmittances of the individual assemblies for an envelope component, Btu/h·ft^2·°F;

$A_{1\text{-}n}$ = areas of the individual assemblies for an envelope component based on exterior dimensions, ft^2.

Change: 5.6.2.4 Access Hatches as indicated below:

5.6.2.4 Access Hatches. Openings from conditioned spaces into unconditioned spaces other than sliding doors (5.6.2.2) or swinging doors (5.6.2.3) shall be well sealed using weather stripping and shall be provided with positive means of closure. If such access ways are placed in insulated envelope subsystems, their level of insulation shall be equivalent to that of the section to which they are installed or shall be accounted for in the overall heat transfer value of the section using methods contained in the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2).

Change: 5.7.1 General as indicated below:

5.7.1. General. Water vapor retarders and moisture barriers shall be used to avoid moisture buildup and mold and mildew growth in energy-efficient, low air-leakage, space-conditioned buildings except as set forth below. Vapor retarders and moisture barriers shall be of a durable nature to resist tearing and breaking under normal construction conditions. For more information, refer to Chapters 20 and 21 of the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2).

Change: 5.7.2 Attic or Roof Sections as indicated below:

5.7.2 Attic or Roof Sections. For attic or roof sections or both, vapor retarders shall be used incorporating provisions of Chapter 21 of the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2).

Exception: The use of vapor retarders is neither required nor recommended in humid climates as defined in Section 3.

Change 5.7.3 Wall Sections as indicated below:

5.7.3 Wall Sections. Vapor retarders shall be installed on the conditioned space side of thermal insulations in walls so as not to conflict with provisions in Chapter 21 of the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2).

Exception: The use of vapor retarders is not required in humid climates. If vapor retarders are used, they should be on the exterior.

Change: 5.9.2 Calculation Procedure as follows:

5.9.2 Calculation Procedure. Calculations shall be done in accordance with Chapter 20 of the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2) as well as Equations 5-1 and 5-2. The fenestration area for each cardinal orientation shall be the sum of the fenestration areas oriented within 45° of each cardinal orientation. If more than one U-value, conductance, or shading coefficient for a component is proposed, area weighted values shall be used.

Change: 6.2.1 Calculation Procedures as indicated below:

6.2.1 Calculation Procedures. Heating and cooling design loads for the purpose of sizing systems shall be determined in accordance with one of the procedures described in the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2) or an acceptable procedure listed in Table 6-1. The design parameters in 6.2.2 shall apply for all load calculation methods. All thermal properties (U, C, and R) that are used to determine compliance with this standard, whether calculated or measured, shall be based on a mean temperature of 75°F.

Change: 6.2.2.1 Outdoor Design Conditions as indicated below:

6.2.2.1 Outdoor Design Conditions. Winter outdoor design conditions for the selected computational procedure shall be selected for listed locations from Chapter 24, Table 1, Column 5 (97.5% values) in the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2). Summer outdoor design conditions shall be selected for listed locations from Chapter 24, Table 1, Column 6 (2.5% values). Adjustments may be made to reflect local climates that differ from the ASHRAE tabulated temperatures or local weather experience may be used for locations not listed.

Change: 6.3.1.1 Sizing and Design as indicated below:

6.3.1.1 Sizing and Design. All air distribution systems shall be sized and designed in accordance with the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2) and the ACCA *Manual D* (Reference 33) or other procedures based on the following:

(a) Calculation of the supply air for each room shall be based on the greater of the heating load or sensible cooling load for that room.
(b) Duct size shall be determined by the supply air requirements of each room, the available static pressure, and the total equivalent length of the various duct runs.
(c) Friction loss data shall correspond to the type of material used in duct construction.
(d) All thermal properties (U, C, and R) that are used to determine compliance with this standard, whether calculated or measured, shall be based on a mean temperature of 75°F.

Change: 6.3.2.1 Sizing and Design as indicated below:

6.3.2.1 Sizing and Design. All piping shall be sized and designed in accordance with recognized engineering standards such as the Hydronic Institute's publication *I-B-R Installation Guide for Hydronic Heating Systems No. 200* (Reference 39) or ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2).

Change: 8.8.3.4.2 as indicated below:

8.8.3.4.2 Infiltration shall be calculated for both the proposed design and prescriptive design based on the effective leakage area (ELA) and site conditions for the proposed design plus an allowance for occupancy. The ELA shall be determined using methods described in Chapter 23 of the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2) or from standard test methods such as ANSI/ASTM E283-91 (Reference 18). The determination of the energy loss from infiltration shall be based upon the hourly calculation of specific infiltration as described in Chapter 23 of the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2) or an equivalent method. A constant of 0.15 ACH shall be added to the calculated leakage to account for occupancy-caused infiltration through door openings, exhaust fans, etc.

Change: Table 6-8 as indicated below:

TABLE 6-8
Minimum Cooling and Heating Efficiency Performance of Groundwater-Source Heat Pumps

Operating Model		Efficiency Rating	Minimum Efficiency Rating
Cooling	70°F entering water 50°F entering water	EER EER	11.0 11.5
Heating	70°F entering water 50°F entering water	COP COP	3.4 3.0

Performance for electrically powered equipment with capacity less than 65,000 Btu/h when rated in accordance with ARI Standard 325-~~85~~ 93 (Reference 44).

Change: Table 6-9 as indicated below:

TABLE 6-9
Minimum Cooling and Heating Efficiency Performance of Packaged Terminal Air Conditioners and Packaged Terminal Heat Pumps

Operating Mode		Efficiency Descriptor	Minimum Efficiency Rating
Cooling	95°F outdoor ambient 82°F outdoor ambient1	EER EER	See A below See B below
H2 Heating	47°F outdoor ambient	COP	See C below

A: $EER_A = 10 - [0.16 \times \text{capacity (in Btu/h)}/1000]$
B: $EER_B = 12.2 - [0.20 \times \text{capacity (in Btu/h)}/1000]$
C: $COP_C = 1.3 + (0.16 \times EERA)$
Performance for electrically powered equipment rated per ARI Standard ~~310~~ /380-~~90~~ 93 (Reference 4) ~~or ARI Standard 380-90 (Reference 5)~~. If the unit's capacity is less than 7,000 BTU/h, use 7,000 BTU/h in the calculations. If the unit's capacity is greater that 15,000 Btu/h, use 15,000 Btu/h in the calculations.
a. For equipment in which capacity reduction is provided and allowed by the controls.
b: For heat pumps rated in the heating mode per ARI STandard ~~310~~ /380 ~~90~~ 93 (Reference ~~5~~ 4)

Change: Table 6-9 as indicated below:

Change: 8.8.5.4 Transient Analysis Using Hourly Weather Data as indicated below:

8.8.5.4 Transient Analysis Using Hourly Weather Data. This method uses calculation techniques as specified in Chapter 28 of the ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals* (Reference 2). The method uses transfer functions, finite differences, or other methods to calculate the transient responses of the building to hourly weather data for a typical year. ASHRAE WYEC (Reference 53 and 54) or TMY weather (Reference 55) data sets or equivalent shall be used. If weather data for an entire year are not used, a statistically representative sample of at least 168 consecutive hours for each of four seasons of the year shall be used. Weather data may be adjusted to compensate for microclimatic differences between the building site and the weather station. Programs based upon this methodology that include algorithms for computing shading and other solar effects plus algorithms for computing the psychrometrics of air systems may be used to evaluate all building and equipment variables.

Change: the following references listed in Section 10 to update them as indicated below:

2. ~~1989~~ 1993 *ASHRAE Handbook—Fundamentals*, Inch Pound Edition

4. *ARI Standard ~~310~~/380-93 for Packaged Terminal Air-Conditioners and Heat Pumps*, Air-Conditioning and Refrigeration Institute, Arlington, VA 22209

5. ~~ARI Standard 380-90 for Packaged Terminal Heat Pumps, Air-Conditioning and Refrigeration Institute, Arlington, VA 22209~~

11. ASTM C 177 ~~85~~ 94, *Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus*, American Society for Testing and Materials, Philadelphia, PA 19103

44. *ARI Standard 325-~~85~~ 93 for Ground Water-Source Heat Pumps*, Air-Conditioning and Refrigeration Institute, Arlington, VA 22209

ADDENDUM 90.2*b*

Change: Delete the entire section 5.9.2.3 and replace it with the following:

5.9.2.3 Fenestration Load Change. The change in loads for all fenestration requirements shall be calculated using Equation 5-12.

$$\begin{aligned} LC_f = {} & Area_m \text{ x } U_m - Area_p \times U_p) \times (20 \times HDD65_c + 0.24 \times CDH74_c \\ & - 2440) + Area_m \times SC_m) \times (-9.775 \times HDD65_c + 1.3 \times CDH74_c \\ & + 14{,}350) - (A_{v,n} \text{ x } SC_{v,n}) \times (-4.8 \times HDD65_c + 0.8 \times CDH74_c \\ & + 10{,}500) - (A_{v,s} \times SC_{v,s}) \times (-15.9 \times HDD65_c + 1.3 \times CDH74_c \\ & + 11{,}600) - (A_{v,e} \times SC_{v,e}) \times (-9.8 \times HDD65_c + 1.6 \times CDH74_c \\ & + 15{,}100) - (A_{v,w} \times SC_{v,w}) \times (-8.6 \times HDD65_c + 1.5 \times CDH74_c \\ & + 20{,}200) - (A_{s,n} \times SC_{s,n}) \times (0.145 \times HDD65_c \times Tilt - 16.6 \\ & \times HDD65_c - 672 \times Tilt - 0.056 \times CDH74_c \times Tilt + 5.9 \\ & \times CDH74_c + 70{,}300) - (A_{s,s} \times SC_{s,s}) \times (0.047 \times HDD65_c \\ & \times Tilt - 23.9 \times HDD65_c - 694 \times Tilt - 0.052 \times CDH74_c \times Tilt \\ & + 6.9 \times CDH74_c + 82{,}900) - (A_{s,e} \times SC_{s,e}) \times (0.106 \times HDD65_c \\ & \times Tilt - 21.1 \times HDD65_c - 619 \times Tilt - 0.048 \times CDH74_c \times Tilt \\ & + 6.4 \times CDH74_c + 73{,}900) - (A_{s,w} \times SC_{s,w}) \times (0.117 \times HDD65_c \\ & \times Tilt - 20.3 \times HDD65_c - 579 \times Tilt - 0.049 \times CDH74_c \times Tilt + 6.4 \\ & \times CDH74_c + 77{,}100) \end{aligned} \tag{5-12}$$

where

LC_f = load change, fenestration, Btu

$Area_m$ = smaller of $Area_p$ or 18% of the building conditioned floor area, ft^2

$Area_p$ = total fenestration area in proposed design, ft^2

$A_{v,n}$, $A_{v,s}$, $A_{v,e}$, $A_{v,w}$ = fenestration area in exterior walls in proposed design for each orientation, ft^2

SC_m = mandatory base shading coefficient as specified by the prescriptive requirements

$SC_{v,n}$, $SC_{v,s}$, $SC_{v,e}$, $SC_{v,w}$ = shading coefficients of fenestration in exterior walls for proposed design by orientation. When used in combination with standard window treatments of draperies, blinds, sheers, or some combination, the shading coefficient of the glazing may be reduced by 0.3 to obtain the proposed shading coefficient for the trade-off calculations. The shading coefficient for a fenestration assembly shall be based on the same area used to determine the thermal transmittance. This means that the frame and glazing portions shall be area weighted.

$Tilt$ = angle of skylight from horizontal, degrees

$A_{s,n}$ = area of skylight in north orientation, ft^2

$A_{s,s}$ = area of skylight in south orientation, ft^2

$A_{s,e}$ = area of skylight in east orientation, ft^2

$A_{s,w}$ = area of skylight in west orientation, ft^2

$SC_{s,n}$ = shading coefficient of skylight in north orientation

$SC_{s,s}$ = shading coefficient of skylight in south orientation

$SC_{s,e}$ = shading coefficient of skylight in east orientation

$SC_{s,w}$ = shading coefficient of skylight in west orientation

Any changes made to the fenestration area in exterior walls shall be accompanied by corresponding changes in the opaque exterior wall area such that the area of all exterior walls remains a constant value for a particular house design. The change in loads for the opaque exterior wall area change shall be calculated using Equation 5-13.

$$LC_w = U_w \times (A_{w,o} - A_{w,a}) \times (HLF_w \times HDD65_c + CLF_w \times CDH74_c) \tag{5-13}$$

where

LC_w = load change, opaque exterior wall, Btu

U_w = thermal transmittance of opaque exterior wall in proposed design, Btu/h·ft^2·°F)

$A_{w,o}$ = exterior opaque wall area of proposed design with original fenestration area, ft^2

$A_{w,a}$ = exterior opaque wall area of proposed design with adjusted fenestration area, ft^2

HLF_w = heating load factor for exterior opaque walls from Table 5-7

CLF_w = cooling load factor for exterior opaque walls from Table 5-7

Any changes made to the fenestration area in ceilings shall be accompanied by corresponding changes in the opaque ceiling area such that the area of all exterior ceilings remains a constant value for a particular house design. The change in loads for the opaque ceiling area change shall be calculated using Equation 5-14.

$$LC_c = U_c \times (A_{c,o} - A_{c,a}) \times (HLF_c \times HDD65_c + CLF_c \times CDH74_c) \tag{5-14}$$

where

LC_c = load change, opaque ceiling, Btu

U_c = thermal transmittance of ceiling in proposed design, Btu/(h·ft^2·°F)

$A_{c,o}$ = ceiling area of proposed design with original fenestration area, ft^2

$A_{c,a}$ = ceiling area of proposed design with adjusted fenestration area, ft^2

HLF_c = heating load factor for ceilings from Table 5-7.

CLF_c = cooling load factor for ceilings from Table 5-7.

This foreword is not part of this addendum but is included for information purposes only.

FOREWORD

Standing Standards Project Committee (SSPC) 90.2R has developed Addendum 90.2c to ANSI/ASHRAE Standard 90.2-1993. *This addendum addresses the issues listed below and is a sincere attempt by the SSPC to correct and enhance certain provisions in the standard.*

Addendum 90.2c:

- *clarifies certain provisions of the standard related to the application of the thermal envelope criteria in the standard;*
- *clarifies and enhances certain provisions related to heat traps and hot water piping insulation and deletes shower flow requirements that are addressed by preemptive federal law;*
- *provides enhancements to the provisions for heating and air-conditioning equipment and systems, most notably revising the acceptable processes for documenting and verifying equipment efficiency; and*
- *revises certain requirements related to the calculation of thermal properties of building envelope components.*

Note: Unless otherwise indicated, strikethrough indicates deletions; double underlines indicate additions.

ADDENDUM 90.2*c*

Change 3.3 as indicated below:

fenestration: all light-transmitting ~~envelope component~~ assemblies in a building ~~wall or ceiling~~ envelope, ~~used for light transmittance, ventilation, entry, or exit~~ including the glazing material, sash, frame, and permanently affixed external or internal shading devices, where such component assemblies enclose conditioned space.

heat trap: a device or arrangement of the piping entering and leaving a water heater, constructed to counteract the convective forces of the heated water (thermosyphoning) during standby periods.

unitary cooling and heating equipment: one or more factory-made units that normally include an evaporator or cooling coil or a compressor and condenser combination and may include a heating function as well. ~~Where such equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together.~~

unitary heat pump: one or more factory-made units that normally include an indoor conditioning coil, compressor(s), and outdoor coil or refrigerant-to-water heat exchanger, including means to provide both heating and cooling functions.~~When such equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together.~~[6,7]

zone: a separately controlled heated or cooled space in a residential building.

Change 5.2.1.2 as indicated below:

5.2.1.2 Compliance Procedures. To comply with the requirements of Section 5, calculation procedures and information contained in chapters 20 through 27 of the *1993 ASHRAE Handbook—Fundamentals*[2] shall be used.

To comply with the requirements set forth in this section, other available measured thermal performance data for envelope sections, either from laboratory or field data or from engineering analyses, should be considered.

If laboratory or field test measurements are used ~~for envelope heat transmission~~ to determine thermal properties, they shall be obtained using one of the following ~~test methods~~:

For Envelope Components Other Than Fenestration

(a) guarded hot plate: ASTM C177-~~94~~ 93,[11]

(b) heat flowmeter: ASTM C518 91,[12]

(c) guarded hot box: ASTM C236-89,[13] or

(d) calibrated hot box: ASTM C976-90.[14]

For Fenestration

(e) procedure for determining product thermal properties: NFRC 100-91[64]

All thermal properties (U, C, and R) that are used to determine compliance with this standard, whether calculated or measured, shall be based on a mean temperature of 75°F.

Change the third paragraph of 5.9.1 as indicated below:

5.9 Envelope Trade-Off Procedure

5.9.1 Scope. This subsection allows the use of building envelope components that do not meet the requirements of 5.3 or 5.5. This subsection shall be used to determine the fenestration area. It provides that the added heating and cooling loads imposed thereby are compensated for by the load savings from other envelope components that exceed the prescriptive requirements.

Calculations shall be done using the load factors and equations from this subsection only. Trade-offs shall be allowed only for items listed in Table 5-7 and, except for fenestration, only for the area or length actually included in the proposed building. No credit is allowed for changes from one component type to another, such as from masonry walls to frame walls. Fenestration, however, has prescriptive requirements for U-values and shading coefficients, all of which may be traded in this procedure.

The procedures in this subsection are appropriate for simple envelope trade-off calculations in typical residential buildings. This subsection shall not be used for buildings with more than 32% of the total floor area in fenestration. Designers are encouraged to use the procedures in Section 8 for more accurate analysis of constructions not covered here, ~~such as skylights,~~ and for more flexibility than is permitted by this section.

Change 5.9.2.2 and Equation 5-11 as indicated below:

5.9.2.2 Component Load Change. The load change for each component that deviates from the requirements shall be calculated using Equation 5-11, except for fenestration. To calculate the load change for fenestration, see 5.9.2.3. For slab edge insulation, U-values for the prescriptive and proposed designs shall be calculated as

$$U = 1/(1+R)$$

where

R = insulation thermal resistance

$$LC_j = (U_{jm} - U_{jp}) \times Size_j \times (HLF_j \times HDD65_c + CLF_j \times CDH74_c) \qquad (6)$$

where

LC_j = load change for component j (Btu)
$HDD65_c$ = heating degree-days, base 65°F, of the city or location being evaluated, as specified in Section 9
$CDH74_c$ = cooling degree-hours, base 74°F, of the city or location being evaluated, as specified in Section 9
U_{jm} = mandatory thermal transmittance or conductance of component j as specified by the prescriptive requirements (Btu/h·ft^2·°F)
U_{jp} = thermal transmittance or conductance of component j in proposed design (Btu/h·ft^2·°F)
$Size_j$ = area or length of component j (ft^2 or ft)
HLF_j = heating load factor for component j (from Table 5-7)
CLF_j = cooling load factor for component j (from Table 5-7)

Change 5.9.2.3 as indicated below, including changes to text and some terms for Equation 5-12 and replacement of Equations 5-13 and 5-14:

5.9.2.3 Fenestration Load Change. The change in loads for ~~all~~ deviations from the prescriptive fenestration requirements shall be calculated using Equation 5-12.

Change the terms SC_m, SC_n, SC_e, SC_s, and SC_w in Equation 5-12 as indicated below:

$$\begin{aligned}LC_f = {} & (Area_m \times U_m - Area_p \times U_p) \times (20 \times HDD65_c + 0.24 \times CDH74_c - 2440) + (Area_m \times SC_m) \times (-9.775 \\ & \times HDD65_c + 1.3 \times CDH74_c + 14{,}850) - (A_{v,n} \times SC_{v,n}) \times (-4.8 \times HDD65_c + 0.8 \times CDH74_c \\ & + 10{,}500) - (A_{v,s} \times SC_{v,s}) \times (-15.9 \times HDD65_c + 1.3 \times CDH74_c + 11{,}600) - (A_{v,e} \times SC_{v,e}) \\ & \times (-9.8 \times HDD65_c + 1.6 \times CDH74_c + 15{,}100) - (A_{v,w} \times SC_{v,w}) \times (-8.6 \times HDD65_c + 1.5 \\ & \times CDH74_c + 20{,}200) - (A_{s,n} \times SC_{s,n}) \times (0.145 \times HDD65_c \times Tilt - 16.6 \times HDD65_c - 672 \times Tilt \\ & - 0.056 \times CDH74_c \times Tilt + 5.9 \times CDH74_c + 70{,}300) - (A_{s,s} \times SC_{s,s}) \times (0.047 \times HDD65_c \\ & \times Tilt - 23.9 \times HDD65_c - 694 \times Tilt - 0.052 \times CDH74_c \times Tilt + 6.9 \times CDH74_c + 82{,}900) \\ & - (A_{s,e} \times SC_{s,e}) \times (0.106 \times HDD65_c \times Tilt - 21.1 \times HDD65_c - 619 \times Tilt - 0.048 \times CDH74_c \\ & \times Tilt + 6.4 \times CDH74_c + 73{,}900) - (A_{s,w} \times SC_{s,w}) \times (0.117 \times HDD65_c \times Tilt - 20.3 \\ & \times HDD65_c - 579 \times Tilt - 0.049 \times CDH74_c \times Tilt + 6.4 \times CDH74_c + 77{,}100)\end{aligned} \qquad (5\text{-}12)$$

where

LC_f = load change, fenestration, Btu
$Area_m$ = smaller of $Area_p$ or 18% of the building conditioned floor area, ft^2
$Area_p$ = total fenestration area in proposed design, ft^2
$A_{v,n}$, $A_{v,s}$, $A_{v,e}$, $A_{v,w}$ = fenestration area in exterior walls in proposed design for each orientation, ft^2
SC_m = ~~mandatory base shading coefficient as specified by the prescriptive requirement~~ the shading coefficient as specified by the prescriptive requirements or the actual shading coefficient if it is not greater than the prescriptive requirements.
$SC_{v,s}$, $SC_{v,w}$, $SC_{v,n}$, $SC_{v,e}$ = shading coefficients of fenestration in exterior walls for proposed design by orientation. When used in combination with standard window treatments of draperies, blinds, sheers, or some combination, the shading coefficient of the glazing may be reduced by ~~0.3~~ 30% of its value without internal shading to obtain the proposed shading coefficient for the trade-off calculations. The shading coefficient for a fenestration assembly shall be based on the same area used to determine the thermal transmittance. This means that the frame and glazing portions shall be area weighted.
$Tilt$ = angle of skylight from horizontal, degrees
$A_{s,n}$ = area of skylight in north orientation, ft^2
$A_{s,s}$ = area of skylight in south orientation, ft^2
$A_{s,e}$ = area of skylight in east orientation, ft^2
$A_{s,w}$ = area of skylight in west orientation, ft^2
$SC_{s,n}$ = shading coefficient of skylight in north orientation
$SC_{s,s}$ = shading coefficient of skylight in south orientation
$SC_{s,e}$ = shading coefficient of skylight in east orientation
$SC_{s,w}$ = shading coefficient of skylight in west orientation

Revise the text as indicated below:

~~Any changes made to the fenestration area in exterior walls shall be accomplished by corresponding changes in the opaque exterior wall area such that the area of all exterior walls remains a constant value for a particular house design. The change in loads for the opaque exterior wall area change shall be calculated using Equation 5-13.~~

For buildings with skylights and with more than 18% but not more than 32% of building conditioned floor area in fenestration, the fenestration area above 18% (the "excess fenestration") shall be considered to have replaced opaque exterior ceiling area up to the area of skylights that are present in the proposed design. The change in loads for the opaque ceiling area replaced by excess fenestration shall be calculated using Equation 5-13.

Delete the current Equation 5-13 and replace it with the following:

$$LC_c = U_c \times (A_{c,1} - A_{c,2}) \times (HLF_c \times HDD65 + CLF_c \times CDH74) \quad (5\text{-}13)$$

where

LC_c = load change, opaque ceiling, Btu

U_c = thermal transmittance of ceiling in proposed design, Btu/(h·ft^2·°F)

$A_{c,1}$ = ceiling area of proposed design without excess fenestration

$A_{c,2}$ = ceiling area of proposed design with excess fenestration

HLF_c = heating load factor for ceilings from Table 5-7

CLF_c = cooling load factor for ceilings from Table 5-7

HDD65 = heating degree-days, base 65°F, of the city or location being evaluated, as specified in Section 9

CDH74 = cooling degree-hours, base 74°F, of the city or location being evaluated, as specified in Section 9

Continue the text revision as indicated below:

~~Any changes made to the fenestration area in ceilings shall be accomplished by corresponding changes in the opaque ceiling area such that the area of all exterior ceilings remains a constant value for a particular house design. The change in loads for the opaque ceiling area change shall be calculated using Equation 5-14~~.

Any excess fenestration not considered to have replaced opaque exterior ceiling area pursuant to Equation 5-13 shall be considered to have replaced opaque exterior wall area. The change in loads for the opaque exterior wall area replaced by excess fenestration shall be calculated using Equation 5-14.

Delete the current Equation 5-14 and replace it with the following:

$$LC_w = U_w \times (A_{w,1} - A_{w,2}) \times (HLF_w \times HDD65 + CLF_w \times CDH74) \quad (5\text{-}14)$$

where

LC_w = load change, opaque exterior wall, Btu

U_w = thermal transmittance of opaque exterior wall in proposed design, Btu/(h·ft^2·°F)

$A_{w,1}$ = exterior opaque wall area of proposed design without excess fenestration

$A_{w,2}$ = exterior opaque wall area of proposed design with excess fenestration

HLF_w = heating load factor for exterior opaque walls from Table 5-7

CLF_w = cooling load factor for exterior opaque walls from Table 5-7

HDD65= heating degree-days, base 65°F, of the city or location being evaluated, as specified in Section 9

CDH74= cooling degree-hours, base 74°F, of the city or location being evaluated, as specified in Section 9

Change 6.3.1.2 as indicated below:

6.3.1.2 Installation. All ductwork shall be constructed, erected, and sealed in accordance with the following:

(a) Sheet Metal and Air Conditioning Contractors National Association (SMACNA) *Installation Standards for Residential Heating and Air-Conditioning Systems*, 6th ed.[34]

(b) NAIMA *Fibrous Glass Duct Construction Standards*, AH116, 1993[35]

(c) *SMACNA HVAC Duct Construction Standards, Metal and Flexible*, 1st ed.[36]

(d) *SMACNA HVAC Duct Leakage Test Manual*, 1985[37]

(e) ADC *Flexible Duct Performance and Installation Standards*[65]

(f) UL 181A-91, *Closure Systems for Use with Rigid Air Ducts and Connectors*[66]

(g) SMACNA, *Fibrous Glass Duct Construction Standards*, 6th edition[67]

Change 6.3.4.3 as indicated below:

6.3.4.3 Low-Density Radiant Ceiling System. These systems shall be installed within the ceiling assemblies only (insulated in accordance with Section 5) and shall be controlled by a thermostat located on an interior wall. Ceiling cable installations shall have heat-conducting plaster applied in accordance with the manufacturer's installation instructions. The plaster shall be applied over the cable prior to the finish coat or bottom layer of gypsum board to conduct heat to the conditioned space.

Change 6.4.1 as indicated below:

6.4.1 Performance Data for HVAC Equipment ~~and System Components~~

6.4.1.1 Equipment. ~~Rated Combinations~~ ~~Suppliers of HVAC system equipment and system components shall furnish upon request by prospective purchasers,~~ System designers shall obtain ~~or contractors~~ the input(s), output(s), and value of the appropriate energy descriptor ~~of all such HVAC products from~~ shown in Tables 6-5 through 6-11 from suppliers of HVAC equipment. These shall be based on equipment ~~or components~~ in new condition to enable determination of its compliance with this standard. Manufacturers' recommended maintenance instructions shall be furnished with the equipment. The manufacturer of electric resistance heating equipment shall furnish upon request by prospective purchasers, designers, or contractors the full-load energy input over the range of voltages at which the equipment is intended to operate.

6.4.1.2 Nonrated Combinations. Where elements such as indoor or outdoor coil combinations not rated by the manufacturer are used as part of the heating or cooling system (or both), it shall be the function of the system designer to determine compliance with these requirements using data provided by the component suppliers.

6.4.1.3 Heating and Cooling Equipment Selection. Selection of heating and cooling equipment shall be based on manufacturer's performance data. Qualification for the equipment selected shall be submitted to the building official upon request.

~~**Criteria.** Cooling equipment selections shall be based on information that provides, or that can be extrapolated from the manufacturer's performance data, sensible and latent cooling capacity for the following conditions~~:

~~(a) air-source condensing unit operating at the summer design temperature or water-cooled condensing unit operating at the design water temperature,~~

~~(b) indoor fan operating at the design airflow rate, and~~

~~(c) indoor coil operating at the entering air condition (dry- and wet-bulb temperatures) that corresponds to the cooling design condition. If mechanical ventilation is not used, the entering condition corresponds to the indoor design values that were used for the cooling load calculation. If mechanical ventilation is used, the entering dry- and wet-bulb temperatures must be adjusted for the effect of ventilation air (usually a percent of outdoor air)~~.

~~**6.4.1.4 Heat Pump Heating Selection Criteria.** The manufacturer shall provide (as a minimum) the inputs and outputs at 17°F and 47°F outdoor air temperatures for air-source units and the inputs and outputs at entering water temperatures of 70°F and 50°F for water-source units.~~

Change 6.4.2.1 as indicated below:

6.4.2.1 Fossil Fuel Fired Heating Equipment. ~~The design load shall be calculated in accordance with 6.2.1.~~ The capacity of the equipment selected shall not ~~exceed 170%~~ be less than ~~of~~ the design load calculated in accordance with 6.2.1.

> ~~**Exception**: For power burner and induced-draft burner fossil fuel heating equipment, there is no capacity requirement.~~

Change 6.5.1 as indicated below:

6.5.1 Temperature Control. Each single-zone system or each zone within a multi-zone system shall be provided with at least one thermostat for the regulation of temperature. Each thermostat shall be capable of being set by adjustment or selection of sensors as follows.

(a) Where used to control heating, cooling, or both, it shall be capable of being set from 55°F to 85°F and shall be capable of operating the system's heating and cooling. The thermostat, control system, or both shall have an adjustable dead band, the range of which includes a setting of 10°F, when automatic changeover is provided.

(b) Where wall-mounted temperature controls are used, they shall be mounted on an inside wall.

Change 6.5.4.1 as indicated below:

6.5.4.1 Electric Resistance. ~~The~~ Heat pumps shall be installed with a control to prevent electric auxiliary heater operation when the outdoor temperature is above the design balance point (e.g., an outdoor air temperature sensing thermostat). The design balance point is that outdoor temperature at which refrigeration cycle heating capacity is equal to the building load. However, electric auxiliary heater operation is permitted during defrost. Electric auxiliary heater operation is also permitted during recovery from setback when the control specified in 6.5.1.1.3 is used. Where manual controls are provided for activating the supplementary heat source on an emergency basis, an indicator shall be provided to show the control status.

Delete 7.4.1 as indicated below:

~~**7.4.1 Shower Discharge Rate** Showers shall limit the maximum water discharge to 3.0 gal/min when tested in accordance with ANSI/ASME A112.18.1M-1989.~~[46]

Change 7.8 as indicated below:

7.8 Heat Traps. Water heaters serving non-circulating systems that are not equipped with integral heat traps and have vertical pipe risers connected to the top of the water heater shall be installed with heat traps on both the inlet and outlets. The heat trap shall be installed as close as possible to the inlet and outlet fittings.

> ~~**Exception**: For circulating systems, heat traps are not required.~~

> **Exception:** Hot water piping meeting 7.2.2.1.

~~Note: A heat trap may take the form of a 180° loop in the piping; an arrangement of pipe fittings, such as elbows, connected so that the inlet and outlet piping makes vertically upward runs just before turning downward to connect to the water heater's inlet and outlet fittings; a commercially available heat trap; or any other type that effectively restricts the natural tendency of hot water to rise in the vertical pipe during periods of standby. When the water heater outlet is directly horizontal out of the tank or is piped with an elbow on the vertical outlet and then downward, this piping arrangement itself is effectively a heat trap and a separate heat trap is not then required.~~

Change 8.8.2 as indicated below:

8.8.2 Internal Thermal Mass. Both the prescriptive design and proposed design shall have the same occupancy thermal mass (furniture and contents). The value shall be 8 lb/ft^2 of the conditioned floor area. This is based on 2-in. wood with a specific heat of 0.39 Btu/lb·°F and a conductivity of 1.0 Btu·in/(h·ft^2°F). To account for structural mass (such as partition walls), a value of 5.0 lb/ft^2 of the conditioned floor area shall be used for the prescriptive design. This is based on the thermal properties of 1/2-in. gypsum board. The proposed design with non-standard construction features may use a different structural mass assumption if detailed calculations are documented. Calculation methods that assume massless exterior walls and a combined interior thermal mass node shall use 3.5 Btu/~~ft²~~ °F per square foot of conditioned floor area total mass in the prescriptive design and in the proposed design unless additional structural thermal mass is documented in the proposed design.

Change 8.8.3.2 as indicated below:

8.8.3.2 Window ~~Management~~ Internal Shading. Fenestration shall be ~~internally shaded by nonwhite draperies in both the prescriptive design and proposed design even if no draperies are shown on the plan. This drapery, when closed, shall reduce the shading coefficient of the fenestration to 70% of its value without drapery~~ assumed to be internally shaded for both the prescriptive and the proposed design cooling load calculations. Such shading shall be assumed to reduce the fenestration shading coefficient by 30% of its value without internal shading but shall have no effect on window U-value. Credit may be taken for higher performance shading and insulation systems in the proposed design. All operable shading and drapes shall be closed when the air conditioner is running to meet a cooling load and at night but shall be open during the rest of the day.

Change 8.8.3.3 as indicated below:

8.8.3.3 Natural Ventilation. Both the proposed design and the prescriptive design shall utilize occupant-managed natural ventilation to maintain the indoor comfort whenever the outdoor air condition allows the indoor cooling setpoint temperature to be maintained at a relative humidity of 70% or less. Natural ventilation strategies shall be used to reduce indoor temperature below the cooling setpoint when this is advantageous. Both the proposed design and the prescriptive design shall use the same control strategy for natural ventilation. The free vent area for the prescriptive design shall be 10% of the glazing area uniformly distributed. To account for screens, other obstructions, and occupant behavior, the maximum free vent area in the proposed design shall be ~~20% of the operable sash area~~ 50% of the maximum clear opening or vent area reported by the manufacturer.

Change 8.8.3.4.2 as indicated below:

8.8.3.4.2 Infiltration shall be calculated for both proposed design and prescriptive design based on the effective leakage area (ELA) and site conditions for the proposed design plus an allowance for occupancy. The ELA shall be determined using methods described in Chapter 23 of the *1993 ASHRAE Handbook—Fundamentals,*[2] *ANSI/ASHRAE 119-88 (RA94),*[68] using a standard pressure of 4 Pa, or from standard test methods such as ANSI/ASTM E283-91.[18] The determination of the energy loss from infiltration shall be based upon the hourly calculation of specific infiltration as described in Chapter 23 of the *1993 ASHRAE Handbook—Fundamentals,*[2] ANSI/ASHRAE 119,[68] or an equivalent method. A constant of 0.15 ACH shall be added to the calculated leakage to account for occupancy-caused infiltration through door openings, exhaust fans, etc.

Change 8.8.3.4.3 as indicated below:

8.8.3.4.3 The infiltration of the proposed design shall be calculated according to 8.8.3.4.2 based on an assumed ELA ~~including~~ at 4 Pa plus an allowance of 0.15 ACH for occupancy effects. The infiltration rate in the prescriptive design shall be a constant 0.5 ACH. Every building shall be measured after completion using ASTM E779-87[51] or an equivalent to verify that the actual ELA is less than or equal to that assumed in the calculation. Compliance is not achieved until this test is successfully completed.

Change 8.8.5.4 as indicated below:

8.8.5.4 Transient Analysis Using Hourly Weather Data. This method uses calculation techniques as specified in chapter 28 of the *1993 ASHRAE Handbook—Fundamentals.*[2] The method uses transfer functions, finite differences, or other methods to calculate the transient responses of the building to hourly weather data for a typical year. ASHRAE WYEC[53,54] or TMY weather[55] data sets or the equivalent shall be used. If weather data for an entire year are not used, ~~a statistically representative sample of at least 168 consecutive hours for each season of the year shall be used~~ the weather data used must represent the full range of climatic variation for the full year in the chosen location. Weather data may be adjusted to compensate for microclimatic differences between the building site and the weather station. Programs based on this methodology that include algorithms for computing shading and other solar effects plus algorithms for computing the psychrometries of air systems may be used to evaluate all building and equipment variables.

Change the following reference in Section 10:

ASTM C 177 ~~94~~ 93, *Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus*, American Society for Testing and Materials, Philadelphia, PA 19103

Add the following references to Section 10:

64. NFRC 100-91, *Procedure for Determining Fenestration Product Thermal Properties*. Silver Spring, MD: National Fenestration Rating Council, 1991.

65. ADC. *Flexible Duct Performance and Installation Standards*. Fort Worth, TX: Air Diffusion Council.

66. UL 181A-91, *Closure Systems for Use with Rigid Air Ducts and Air Connectors*. Northbrook, IL: Underwriters Laboratories, Inc., 1991

67. SMACNA, *Fibrous Glass Duct Construction Standard*, 6th edition. Chantilly, VA: Sheet Metal and Air Conditioning Contractors National Association, Inc., 1992.

68. *ANSI/ASHRAE 119-1988 (RA 1994), Air Leakage Performance for Detached Single-Family Residential Buildings*. Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1994.

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 effects 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 transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

NOTICE

INSTRUCTIONS FOR SUBMITTING A PROPOSED CHANGE TO THIS STANDARD UNDER CONTINUOUS MAINTENANCE

This standard is maintained under continuous maintenance procedures 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. SSPC consideration will be given to proposed changes according to the following schedule:

Deadline for receipt of proposed changes	SSPC will consider proposed changes at next
February 20	**ASHRAE Annual Meeting (normally June)**

Proposed changes must be submitted to the Manager of Standards (MOS) in the latest published format available from the MOS. However, the MOS may accept proposed changes in an earlier published format, if the MOS concludes that the differences are immaterial to the proposed changes. If the MOS concludes that the current form must be utilized, the proposer may be given up to 20 additional days to resubmit the proposed changes in the current format.

Specific changes in text or values are required and must be substantiated. The Manager of Standards will return to the submitter any change proposals that do not meet these requirements. Supplemental background documents to support changes submitted may be included.

FORM FOR SUBMITTAL OF PROPOSED CHANGE TO ASHRAE STANDARD UNDER CONTINUOUS MAINTENANCE

(Please type)

1. Submitter: ____
(name—type)

Affiliation: ____

Address: ______________________ City: ______________ State: _______ Zip: ________

Telephone: _________________ __ Fax: ________________ E-Mail: ______________________

I hereby grant the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) the non-exclusive royalty rights, including non-exclusive royalty rights in copyright, in my proposals and I understand that I acquire no rights in publication of this standard in which my proposal in this or other similar analogous form is used. I hereby attest that I have the authority and am empowered to grant this copyright release.

Author's Signature: ____ Date: _______________

NOTE: Use a separate form for each comment, completing each section (including Sections 1 and 2) to facilitate processing.

2. Number and Year of Standard:

3. Clause (i.e., Section), Subclause or Paragraph Number, and Page Number:

4. I Propose To: [ ] Change to read as shown [ ] Delete and substitute as shown
(check one) [ ] Add new text as shown [ ] Delete without substitution

---

(Indicate the proposed change by showing a strikeout line through material to be deleted and underlining material to be added. After showing the text to be changed, insert a horizontal line and state the purpose, reason, and substantiation for the proposed change. Use additional pages if necessary.)

5. Proposed Change:

6. Purpose, Reason, and Substantiation Statements:
(Be brief; provide abstracts of lengthy substantiation; full text should be enclosed for reference on request by project committee members.)

[ ] Check if additional pages are attached. Number of additional pages: ______

NOTE: Use separate form for each comment. Submittals (MS Word 7 preferred) may be attached to e-mail (preferable), submitted on diskettes, uploaded to ASHRAE's ftp site, or submitted in paper form by mail or fax to ASHRAE, Manager of Standards, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305.
E-mail: change.proposal@ashrae.org. Ftp server address: ftp.ashrae.org, directory: *change.proposal.* Fax: 404-321-5478

ELECTRONIC PREPARATION/SUBMISSION OF FORM FOR PROPOSING CHANGES

An electronic version of each change, which must comply with the instructions in the Notice and the Form, is the preferred form of submittal to ASHRAE Headquarters at the address shown below. The electronic format facilitates both paper-based and computer-based processing. Submittal in paper form is acceptable. The following instructions apply to change proposals submitted in electronic form.

Use the appropriate file format for your word processor and save the file in either Microsoft Word 7 (preferred) or higher or WordPerfect 5.1 for DOS format. Please save each change proposal file with a different name (example, prop001.doc, prop002.doc, etc., for Word files—prop001.wpm, prop002.wpm, etc., for WordPerfect files). If supplemental background documents to support changes submitted are included, it is preferred that they also be in electronic form as wordprocessed or scanned documents.

Electronic change proposals may be submitted either as files (MS Word 6 preferred) attached to an e-mail (uuencode preferred), files uploaded to an ftp site, or on 3.5” floppy disk. ASHRAE will accept the following as equivalent tot he signature required on the change submittal form to convey non-exclusive copyright:

Files attached to e-mail:	Electronic signature on change submittal form (as a picture; *.tif, or *.wpg), or e-mail address.
Files on disk or uploaded to ftp site:	Electronic signature on change submittal form (as a picture; *.tif, or *.wpg), listing of the submitter’s e-mail address on the change submittal form, or a letter with submitter’s signature accompanying the disk or sent by facsimile (single letter may cover all of proponent’s proposed changes).

Submit e-mail, ftp file, or disks containing change proposal files to:
Manager of Standards
ASHRAE
1791 Tullie Circle, NE
Atlanta, GA 30329-2305
E-mail: *change.proposal@ashrae.org*
Ftp server address: *ftp.ashrae.org*, logon to anonymous ftp in directory: *change.proposal*.
(Alternatively, mail paper versions to ASHRAE address or Fax: 404-321-5478.)

The form and instructions for electronic submittal to ASHRAE’s ftp site or as attachments to e-mail may be obtained from the Standards section of ASHRAE’s Home Page, *http://www.ashrae.org*, or by contacting a Standards Secretary, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. Phone: 404-636-8400. Fax: 404-321-5478.
Email: *standards.section@ashrae.org*.