ANSI/ASHRAE/IES Addendum f to
ANSI/ASHRAE/IESNA Standard 90.1-2007

ASHRAE ADDENDA

Energy Standard for Buildings Except Low-Rise Residential Buildings

Approved by the ASHRAE Standards Committee on June 26, 2010; by the ASHRAE Board of Directors on June 30, 2010; by the IES Board of Directors on June 23, 2010; and by the American National Standards Institute on July 1, 2010.

These addenda were approved by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site (www.ashrae.org) or in paper form from the Manager of Standards.

The latest edition of an ASHRAE Standard may be purchased on the ASHRAE Web site (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

ISSN 1041-2336

Approved American National Standard
ANSI
www.ansi.org

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle NE, Atlanta, GA 30329
www.ashrae.org

ASHRAE STANDING STANDARD PROJECT COMMITTEE 90.1
Cognizant TC: TC 7.6, Systems Energy Utilization
SPLS Liaison: Doug Reindl · ASHRAE Staff Liaison: Steven C. Ferguson · IESNA Liaison: Rita M. Harrold

Mr Michael CA Schwedler*	Chair
Mr Mark M Hydeman*	Co-Vice Chair
Mr Stephen V Skalko, PE*	Co-Vice Chair
Ms Susan Isenhour Anderson*	Member
Mr Wagdy A Y Anis, FAIA*	Member
Mr Peter A Baselici*	Member
Mr Jeffrey G Boldt*	Member
Mr David J Branson*	Member
Mr Keith I Emerson*	Member
Mr Drake H Erbe*	Member
Mr James A Garrigus*	Member
Mr Jason John Glazer*	Member
Mr Pekka Hakkarainen*	Member
Mr Richard Heinisch*	Member
Mr Ned B Heminger*	Member
Mr John F Hogan, AIA, PE*	Member
Mr Hyman M Kaplan*	Member
Mr Michael D Lane, LC*	Member
Mr Richard Lord*	Member
Mr Ronald Majette*	Member
Dr Itzhak H Maor, PHD*	Member
Mr James Patrick McClendon*	Member
Mr Michael W Mehl*	Member
Mr Harry P Misuriello*	Member
Mr Frank T Morrison*	Member
Mr Timothy M Peglow*	Member
Mr Eric E Richman*	Member
Mr Leonard C Sciarra*	Member
Dr Maria Spinu*	Member
Mr Christian R Taber*	Member
Mr Michael Tillou*	Member
Ms Martha G VanGeem, PE*	Member
Mr Michael Waite*	Member
Mr Mchenry Wallace, Jr*	Member
Mr Richard D Watson*	Member
Mr Jerry W White, Jr*	Member
Mr Ron Burton*	Organizational
Mr Charles C Cottrell*	Organizational
Mr S Craig Drumheller*	Organizational
Mr Allan B. Fraser*	Organizational
Mr Ronald D Kurtz*	Organizational
Mr Steven Rosenstock, PE*	Organizational
Mr Frank A Stanonik*	Organizational
Mr Ernest A Conrad	Alternate Org
Mr Chad Groshart	Alternate Org
Dr Merle F McBride	Alternate Org
Mr Kenneth Sagan	Alternate Org
Mr Randall Blanchette	Subcommittee
Mr Donald M Brundage, PE	Subcommittee
Mr Brian David Hahnlen	Subcommittee
Ms Susanna S Hanson	Subcommittee
Mr Jonathan Humble	Subcommittee
Mr Raymond Frank McGowan	Subcommittee
Mr Michael I Rosenberg	Subcommittee
Ms Martha (Marty) Gail Salzberg	Subcommittee
Mr Jeffrey R Stein	Subcommittee
Mr Wayne Stoppelmoor	Subcommittee
Mr William J Talbert	Subcommittee
Mr Daniel J Walker, PE	Subcommittee

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

SPECIAL NOTE

This American National Standard (ANS) is a national voluntary consensus standard developed under the auspices of the Americ
iety of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). *Consensus* is defined by the American National Standa
itute (ANSI), of which ASHRAE is a member and which has approved this standard as an ANS, as "substantial agreement reached
ctly and materially affected interest categories. This signifies the concurrence of more than a simple majority, but not necessarily unanim
nsensus requires that all views and objections be considered, and that an effort be made toward their resolution." Compliance with t
ndard 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 Proj
nmittee Chair and Vice-Chair must be members of ASHRAE; while other committee members may or may not be ASHRAE members,
st be technically qualified in the subject area of the Standard. Every effort is made to balance the concerned interests on all Proj
nmittees.

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, or

DISCLAIMER

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

ASHRAE INDUSTRIAL ADVERTISING POLICY ON STANDARDS

ASHRAE Standards and Guidelines are established to assist industry and the public by offering a uniform method of testing for rat
poses, by suggesting safe practices in designing and installing equipment, by providing proper definitions of this equipment, and by provid
er information that may serve to guide the industry. The creation of ASHRAE Standards and Guidelines is determined by the need for the
l 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 impli
the product has been approved by ASHRAE.

(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

FOREWORD

In response to continuous maintenance proposals this addendum expands the types of roofs shown by research to reduce the conduction loads through roofs into the conditioned space. This allows building design teams to select from a number of alternatives and reduce space loads, thereby reducing energy usage and cost.

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 90.1-2007

Revise the Standard as follows (I-P and SI units).

Add to definitions:

vegetative roof system: vegetation, growth media, drainage system, and waterproofing over a roof deck.

growth media: an engineered formulation of inorganic and organic materials including but not limited to heat-expanded clays, slates, shales, aggregate, sand, perlite, vermiculite and organic material including but not limited to compost worm castings, coir, peat, and other organic material.

5.5.3.1 Roofs

5.5.3.1.1 Roof Insulation. All *roofs* shall comply with the insulation values specified in Tables 5.5-1 through 5.5-8 ~~or shall comply with the insulation values specified in Section 5.5.3.1.1 and Table 5.5.3.1~~. Skylight curbs shall be insulated to the level of roofs with insulation entirely above deck or R-5.0 (R-0.9), whichever is less.

5.5.3.1.~~1~~2 ~~High Albedo Roofs~~ Roof Solar Reflectance and Thermal Emittance. ~~For~~ *roofs* in climate zones 1 through 3 shall have one of the following: ~~, other than *roofs* over ventilated attics or *roofs* over *semi-heated spaces* or *roofs* over *conditioned spaces* that are not *cooled spaces*, where the exterior surface has~~

a. a minimum three-year-aged solar reflectance of 0.55 when tested in accordance with ASTM C1549 or ASTM E1918, and in addition, a minimum three-year-aged thermal emittance of 0.75 when tested in accordance with ASTM C1371 or ASTM E408. ~~Where aged values are not available, the initial solar reflectance shall be adjusted to show compliance using the formula:~~

~~$$R_{aged} = 0.2 + 0.7 (R_{intial} - 0.2)$$~~

where:

~~R_{aged} = adjusted initial solar reflectance~~

~~R_{intial} = initial solar reflectance when tested in accordance with ASTM C1549or ASTM E1918, or~~

b. a minimum three-year-aged Solar Reflectance Index of 64 when determined in accordance with the Solar Reflectance Index method in ASTM E1980 using a convection coefficient of 2.1 BTU/h-ft^2 (12 W/m^2·K) ~~, or~~

c. increased roof insulation levels found in Table 5.5.3.1.2.

TABLE 5.5.3.1.2 Increased Roof Insulation Levels

Roofs	Non-Residential		Residential	
Opaque Elements	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Insulation Entirely Above Deck	U-0.030	R-33	U-0.029	R-34
Metal Buildings	U-0.028	R-35		

~~d. a solar reflectance of 0.70 when tested in accordance with ASTM C1549, ASTM E903, or ASTM E1918 and, in addition, a minimum thermal emittance of 0.75 when tested in accordance with ASTM C1371 or ASTM E408 or~~

~~a minimum Solar Reflective Index of 82 when determined in accordance with the Solar Reflectance Index method in ASTM E1980~~

Exceptions:

a. Ballasted Roofs with a minimum stone ballast of 17 lbs/ft^2 (74 kg/m^2) or 23 lbs/ft^2 pavers (117 kg/m^2).

a. *Vegetated* ~~Roofs~~ *Roof Systems* that contain ~~are either extensively and/or intensively vegetated, containing~~ a minimum thickness of ~~3~~2.5 inches (63.5~~76~~ mm) of growing medium and covering a minimum of 75% of the roof area with durable plantings.

a. *Roofs*, where a minimum of 75% of the roof area:

1. Is shaded during the peak sun angle on June 21st by permanent components or features of the building, or

1. Is covered by off-set photovoltaic arrays, building-integrated photovoltaic arrays, or solar air or water collectors, or

1. Is permitted to be interpolated using a combination of parts i and ii above.
   a. Steep sloped *roofs*
   a. Low sloped metal ~~Metal~~ building roofs in climate zones 2 and 3.
   a. *Roofs* over ventilated attics or *roofs* over *semi-heated spaces* or *roofs* over *conditioned spaces* that are not *cooled spaces.*
   b. Asphaltic membranes in climate zones 2 and 3.

~~the insulation value for the roof shall comply with the values in Table 5.5.3.1.~~ The values for ~~initial and/or~~ three-year-aged solar reflectance and ~~initial and/or~~ three-year-aged thermal emittance shall be determined by a laboratory accredited by a nationally recognized accreditation organization, such as the Cool Roof Rating Council CRRC-1 Product Rating Program, and shall be labeled and certified by the manufacturer.

Delete table 5.5.3.1

Revise Section 12 as follows: I-P (SI units)

ASTM e1918-~~97~~2006.
~~ASTM E903~~

Revise Table 11.3.1 as follows:

Revise Normative Appendix G, Table G3.1 as follows:

TABLE 11.3.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost Budget

No.	Proposed Building Design (Column A) Design Energy Cost (DEC)	Budget Building Design (Column B) Energy Cost Budget (ECB)
	5. Building Envelope	
	All components of the building envelope in the *proposed building design* shall be modeled as shown on architectural drawings or as installed for *existing building* envelopes. **Exceptions:** The following building elements are permitted to differ from architectural drawings. a. Any envelope assembly that covers less than 5% of the total area of that assembly type (e.g., exterior walls) need not be separately described. If not separately described, the area of an envelope assembly must be added to the area of the adjacent assembly of that same type. b. Exterior surfaces whose azimuth orientation and tilt differ by no more than 45 degrees and are otherwise the same may be described as either a single surface or by using multipliers. c. The exterior roof surface shall be modeled using the ages solar *reflecance* and thermal *emittance* determined in accordance with Section 5.5.3.1.2(a). ~~For exterior roofs~~ Where aged test data is unavailable, ~~other than roofs with ventilated attics,~~ the roof surface ~~may~~ shall be modeled with a solar *reflectance* of ~~0.45~~ 0.30 ~~if the reflectance of the *proposed design* roof is greater than 0.70 and its emittance is greater than 0.75. The reflectance and emittance shall be tested in accordance with the Exception to Section 5.5.3.1. All other roof surfaces shall be modeled with a reflectance of 0.3~~ and a thermal *emittance* of 0.90. d. Manually operated fenestration shading devices such as blinds or shades shall not be modeled. Permanent shading devices such as fins, overhangs, and lightshelves shall be modeled.	The *budget building design* shall have identical *conditioned floor area* and identical exterior dimensions and orientations as the *proposed building design*, except as noted in (a), (b), and (c) in this clause. a. Opaque assemblies such as roof, floors, doors, and walls shall be modeled as having the same *heat capacity* as the *proposed building design* but with the minimum U-factor required in Section 5.5 for new buildings or *additions* and Section 5.1.3 for *alterations*. b. Roof Solar *Reflectance* and Thermal *Emittance*. ~~albedo—All~~ The exterior *roof* surfaces shall be modeled with a ~~reflectivity of 0.3~~ solar *reflectance* and thermal *emittance* as required in Section 5.5.3.1.2(a). All other roofs, including *roofs* exempted from the requirements in Section 5.5.3.1.2, shall be modeled the same as the proposed design. c. Fenestration—No shading projections are to be modeled; fenestration shall be assumed to be flush with the exterior wall or roof. If the fenestration area for new buildings or *additions* exceeds the maximum allowed by Section 5.5.4.2, the area shall be reduced proportionally along each exposure until the limit set in Section 5.5.4.2 is met. Fenestration U-factor shall be the minimum required for the climate, and the SHGC shall be the maximum allowed for the climate and orientation. The fenestration model for envelope *alterations* shall reflect the limitations on area, U-factor, and SHGC as described in Section 5.1.3. **Exception:** When trade-offs are made between an *addition* and an *existing building* as described in the Exception to Section 4.2.1.2, the envelope assumptions for the *existing building* in the *budget building design* shall reflect existing conditions prior to any revisions that are part of this permit.

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

No.	Proposed Building Performance	Baseline Building Performance
	5. Building Envelope	

TABLE G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance

All components of the *building envelope* in the *proposed design* shall be modeled as shown on architectural drawings or as built for existing building envelopes. **Exceptions:** The following building elements are permitted to differ from architectural drawings. a. All uninsulated assemblies (e.g., projecting balconies, perimeter edges of intermediate floor stabs, concrete floor beams over parking garages, roof parapet) shall be separately modeled using either of the following techniques: 1. Separate model of each of these assemblies within the energy simulation model. 2. Separate calculation of the U-factor for each of these assemblies. The U-factors of these assemblies are then averaged with larger adjacent surfaces using an area-weighted average method. This average U-factor is modeled within the energy simulation model. Any other envelope assembly that covers less than 5% of the total area of that assembly type (e.g., exterior walls) need not be separately described provided that it is similar to an assembly being modeled. If not separately described, the area of an envelope assembly shall be added to the area of an assembly of that same type with the same orientation and thermal properties. b. Exterior surfaces whose azimuth orientation and tilt differ by less than 45 degrees and are otherwise the same may be described as either a single surface or by using multipliers. c. The exterior *roof* surface shall be modeled using the aged solar *reflectance* and thermal *emittance* determined in accordance with Section 5.5.3.1.2(a). ~~For exterior roofs~~Where aged test data is unavailable, the roof surface may be modeled with a solar *reflectance* of ~~0.45~~ 0.30 ~~if the reflectance of the *proposed design* roof is greater than 0.70 and its emittance is greater than 0.75 or has a minimum SRI of 82. Reflectance values shall be based on testing in accordance with ASTM C1549, ASTM E903, or ASTM E1918, and emittance values shall be based on testing in accordance with ASTM C1371 or ASTM E408, and SRI shall be based on ASTM E1980 calculated at medium wind speed. All other roof surfaces shall be modeled with a reflectance of 0.30~~ and a thermal *emittance* of 0.90. d. Manual fenestration shading devices such as blinds or shades shall not be modeled. Automatically controlled fenestration shades or blinds may be modeled. Permanent shading devices such as fins, overhangs, and light shelves may be modeled.	Equivalent dimensions shall be assumed for each exterior envelope component type as in the *proposed design*; i.e., the total gross area of exterior walls shall be the same in the *proposed* and *baseline building designs*. The same shall be true for the areas of roofs, floors, and doors, and the exposed perimeters of concrete slabs on grade shall also be the same in the *proposed* and *baseline building designs*. The following additional requirements shall apply to the modeling of the *baseline building design*: a. **Orientation.** The *baseline building performance* shall be generated by simulating the building with its actual orientation and again after rotating the entire building 90, 180, and 270 degrees, then averaging the results. The building shall be modeled so that it does not shade itself. b. **Opaque Assemblies.** Opaque assemblies used for new buildings or *additions* shall conform with the following common, lightweight assembly types and shall match the appropriate assembly maximum U-factors in Tables 5.5-1 through 5.5-8: • Roofs—Insulation entirely above deck • *Above-grade walls*—Steel-framed • Floors—Steel-joist • Opaque door types shall match the proposed design and conform to the U-factor requirements from the same tables. • Slab-on-grade floors shall match the F-factor for unheated slabs from the same tables. Opaque assemblies used for *alterations* shall conform with Section 5.1.3. c. **Vertical Fenestration.** Vertical fenestration areas for new buildings and *additions* shall equal that in the *proposed design* or 40% of gross above-grade wall area, whichever is smaller, and shall be distributed on each face of the building in the same proportions in the *proposed design*. Fenestration U-factors shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. Fenestration SHGC shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. All vertical glazing shall be assumed to be flush with the exterior wall, and no shading projections shall be modeled. Manual window shading devices such as blinds or shades shall not be modeled. The fenestration areas for envelope *alterations* shall reflect the limitations on area, U-factor, and SHGC as described in Section 5.1.3. d. **Skylights and Glazed Smoke Vents.** Skylight area shall be equal to that in the proposed building design or 5% of the gross roof area that is part of the *building envelope*, whichever is smaller. If the skylight area of the proposed building design is greater than 5% of the gross roof area, baseline skylight area shall be decreased by an identical percentage in all roof components in which skylights are located to reach the 5% skylight-to-roof ratio. Skylight orientation and tilt shall be the same as in the proposed building design. Skylight U-factor and SHGC properties shall match the appropriate requirements in Tables 5.5-1 through 5.5-8. e. **Roof Solar *Reflectance* and Thermal *Emittance*. ~~albedo.~~** ~~All~~ The exterior *roof* surfaces shall be modeled with a ~~reflectivity of 0.3~~ solar *reflectance* and thermal *emittance* as required in Section 5.5.3.1.2(a). All other roofs, including *roofs* exempted from the requirements in Section 5.5.3.1.2, shall be modeled using a solar *reflectance* of 0.30 and a thermal *emittance* of 0.90. f. **Existing Buildings.** For existing *building envelopes*, the *baseline building design* shall reflect existing conditions prior to any revisions that are part of the scope of work being evaluated.

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.