ADDENDA

ANSI/ASHRAE/IES Addendum s to
ANSI/ASHRAE/IES Standard 90.1-2019

Energy Standard for Buildings Except Low-Rise Residential Buildings

Approved by ASHRAE and the American National Standards Institute on February 26, 2021, and by the Illuminating Engineering Society on February 18, 2021.

This addendum was 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. Instructions for how to submit a change can be found on the ASHRAE® website (https://www.ashrae.org/continuous-maintenance).

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FOREWORD

*Addendum s removes the use of solar reflectance index (SRI) for walls and replaces it with the more accurate and relevant term—*solar reflectance *(SRI is still used when referring to roofs). The proposal also adds requirements for south-, east-, and west-facing walls to have a minimum solar reflectance of 0.30 in Climate Zone 0.*

a. *Thermal emittance values do not vary much for opaque, nonmetallic surfaces. A minimum value of 0.75 is sufficient and can be demonstrated by published values or testing. The default value in Appendix G is 0.90. The main reason to have 0.75 backstop is to avoid shiny bare metal, which can become hot.*
b. *For solar reflectance, three options have been provided for measurement: (1) ASTM C1549 with air mass 1.5 global vertical (AM1.5GV) output (labeled "1.590" for air mass 1.5, 90 degree tilt in an upgrade to the Devices and Services Solar Spectrum Reflectometer v6, available from its manufacturer); (2) ASTM E903, using the AM1.5GV solar spectral irradiance to weight near normal-hemispherical solar spectral reflectance; or (3) the "G197GT90" output of the Surface Optics 410-Solar-i Hemispherical Reflectometer, operated following Appendix 9 of the CRRC-1 Program Manual (https://coolroofs.org/documents/CRRC-1_Program_Manual.pdf). All three options are based on the global solar spectral irradiance for a 90 degree sun-facing tilted surface specified in ASTM G197.*
c. *For emittance, ASTM C1371 is the simplest and least expensive measurement method but other options have been provided.*
d. *Initial reflectance is specified because there isn't a fully developed measurement technique for measuring aged wall reflectance. Preliminary testing shows that walls become much less dirty than roofs because they are vertical surfaces.*
e. *We have removed planted material as a shading option, as plants are not considered durable or guaranteed to last the life of the building.*
f. *This proposal removes "reflectance" as a defined term within the standard. The ESC agreed that the current definition is inaccurate and that there is no question about what the term reflectance means. In an effort to simplify the standard, it was decided to remove the definition rather than amend it.*

There is no increase in stringency as part of this proposal, and therefore cost-effectiveness need not be shown.

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 s to Standard 90.1-2019

Modify Section 3.2 as shown (I-P and SI units).

3.2 Definitions

[. . .]

north-oriented: facing within ~~45~~67.5 degrees of true north in the northern hemisphere; ~~(however,~~ facing within 67.5 degrees of true south in the southern hemisphere.~~)~~

south-oriented: facing within 45 degrees of true south in the northern hemisphere; facing within 45 degrees of true north in the southern hemisphere.

east-oriented: facing within 45 degrees of true east to the south and within less than 22.5 degrees of true east to the north in the northern hemisphere; facing within 45 degrees of true east to the north and within less than 22.5 degrees of true east to the south in the southern hemisphere.

west-oriented: facing within 45 degrees of true west to the south and within less than 22.5 degrees of true west to the north in the northern hemisphere; facing within 45 degrees of true west to the north and within less than 22.5 degrees of true west to the south in the southern hemisphere.

~~***reflectance:*** the ratio of the light reflected by a surface to the light incident upon it.~~

[. . .]

Modify Section 5.5.3.1.1 as shown (I-P and SI units).

5.5.3.1.1 Roof Solar Reflectance and Thermal Emittance. *Roofs* in Climate Zones 0 through 3 shall have one of the following:

a. A minimum three-year-aged solar ~~*reflectance*~~reflectance of 0.55 and a minimum three-year-aged thermal *emittance* of 0.75 when tested in accordance with CRRC S100.
b. A minimum 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·°F (12 W/m^2·K), based on three-year-aged solar ~~*reflectance*~~reflectance and three-year-aged thermal *emittance* tested in accordance with CRRC S100.
c. Increased *roof* insulation levels found in Table 5.5.3.1.1.

The values for three-year-aged solar ~~*reflectance*~~reflectance and three-year-aged thermal *emittance* shall be determined by a laboratory accredited by a nationally recognized accreditation organization and shall be *labeled* and certified by the *manufacturer*.

[. . .]

Modify Section 5.53.2 as shown (I-P and SI units).

5.5.3.2 Above-Grade Wall Insulation. All *above-grade* walls shall comply with the insulation values specified in Tables 5.5-0 through 5.5-8.

Exception to 5.5.3.2: Alternatively, for *mass walls* [. . .]

5.5.3.2.1 Walls That Are Both above and below Grade. When a *wall* consists of both *above-grade* and *below-grade* portions [. . .]

5.5.3.2.2 Wall Solar Reflectance and Thermal Emittance. ~~In addition, f~~For Climate Zone 0, *above-grade east-oriented*, *south-oriented*, and *west-oriented walls* ~~*above-grade walls*~~ shall comply with ~~one of the following~~ subparagraph (a) or (b):

a. ~~For east and west *walls*, a~~A minimum of 75% of the *opaque wall* area shall have a minimum ~~SRI of 29~~ area-weighted initial solar reflectance of 0.30 when tested in accordance with ASTM C1549 with AM1.5GV output, or ASTM E903 with the AM1.5GV output, or determined in accordance with *generally accepted engineering standards*, and a minimum *emittance* or emissivity of 0.75 when tested in accordance with ASTM C835, C1371, E408, or determined in accordance with *generally accepted engineering standards.* For the portion of the *opaque wall* that is glass spandrel area, a minimum solar ~~*reflectance*~~ reflectance of 0.29 determined in accordance with NFRC 300 or ISO 9050 shall be permitted. ~~Each *wall* is allowed to be considered separately.~~ Area-weighting is permitted only between the *south-*, *east-*, and *west-oriented walls* and only between *walls* of the same *space conditioning category*.
b. b.~~ For east and west *walls*, a~~A minimum of 30% of the *above-grade wall* area shall be shaded through the use of ~~shade providing plants,~~ manmade structures, *existing buildings*, hillsides, permanent *building* projections, *on-site renewable energy systems*, or a combination of these. Shade coverage shall be calculated by projecting the shading surface downward on the *wall* at an angle of 45 degrees.~~ at 10 a.m. for the east-oriented *walls* and 3 p.m. for the west-oriented *walls* on the summer solstice.~~

~~The *building* is allowed to be rotated up to 45 degrees to the nearest cardinal *orientation* for purposes of calculations and showing compliance.~~

Exception to 5.5.3.2.2: *Exterior walls* of *semiheated spaces*.

[. . .]

Modify Section 5.5.4.5 as shown (I-P and SI units).

5.5.4.5 Fenestration Orientation

[. . .]

where

A_w = west-oriented *vertical fenestration area* ~~(oriented within 45 degrees of true west to the south and within 22.5 degrees of true west to the north in the northern hemisphere; oriented within 45 degrees of true west to the north and within 22.5 degrees of true west to the south in the southern hemisphere)~~

A_e = east-oriented *vertical fenestration area* ~~(oriented within 45 degrees of true east to the south and within 22.5 degrees of true east to the north in the northern hemisphere; oriented within 45 degrees of true east to the north and within 22.5 degrees of true east to the south in the southern hemisphere)~~

[. . .]

Modify Table 11.5.1 as shown (I-P and SI units).

Table 11.5.1 Modeling Requirements for Calculating *Design Energy Cost* and *Energy Cost Budget*

Proposed 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 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. 1. Any *building 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 a *building envelope* assembly must be added to the area of the adjacent assembly of that same type. 2. Exterior surfaces whose azimuth *orientation* and tilt differ by less than 45 degrees and are otherwise the same shall be described as either a single surface or by using multipliers. 3. The exterior *roof* surface shall be modeled using the aged solar ~~*reflectance*~~reflectance and thermal *emittance* determined in accordance with Section 5.5.3.1.1(a). Where aged test data are unavailable, the *roof* surface shall be modeled with a solar ~~*reflectance*~~reflectance of 0.30 and a thermal *emittance* of 0.90. The *above-grade wall* surfaces of *buildings* shall be modeled with an initial solar reflectance and thermal *emittance* determined in accordance with the test methods identified in Section 5.5.3.2.2(a). Where initial test data are unavailable, the *above-grade wall* surfaces shall be modeled with a solar reflectance of 0.25 and a thermal *emittance* of 0.90. 4. 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 design*, except as follows: a. *Opaque* assemblies, such as *roof*, *floors*, *doors*, and *walls*, shall be modeled as having the same *heat capacity* as the *proposed 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. The exterior *roof* surfaces shall be modeled with a solar ~~*reflectance*~~reflectance and thermal *emittance* as required in Section 5.5.3.1.1(a). All other *roofs*, including *roofs* exempted from the requirements in Section 5.5.3.1.1, shall be modeled the same as the *proposed design*. The *above-grade wall* surfaces of *buildings* shall be modeled with a solar reflectance and thermal *emittance* as required in Section 5.5.3.2.2 and 5.5.3.2.2(a). All other *above-grade walls*, including those exempt from the requirements in Section 5.5.3.2.2, shall be modeled the same as the *proposed design*. c. No shading projections are to be modeled; *fenestration* shall be assumed to be flush with the *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. If the *vertical fenestration area* facing west or east of the *proposed design* exceeds the area limit set in Section 5.5.4.5 then the *energy cost budget* shall be generated by simulating the *budget building design* with its actual *orientation* and again after rotating the entire *budget building design* 90, 180, and 270 degrees and then averaging the results. *Fenestration U-factor* shall be equal to the criteria from Tables 5.5-0 through 5.5-8 for the appropriate climate, and the *SHGC* shall be equal to the criteria from Tables 5.5-0 through 5.5-8 for the appropriate climate. For portions of those tables where there are no *SHGC* requirements, the *SHGC* shall be equal to that determined in accordance with Section C3.6(c). The *VT* shall be equal to that determined in accordance with Section C3.6(c). The *fenestration* model for *building envelope alterations* shall reflect the limitations on area, *U-factor*, and *SHGC* as described in Section 5.1.3. [. . .]

Modify Section 12 as shown (I-P and SI units).

12. NORMATIVE REFERENCES

Reference	Title
ASTM International **100 Barr Harbor Dr., West Conshohocken, PA 19428-2959**	
[. . .]	
ASTM C1363-11	Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus
ASTM C1371-15	Standard Test Method for Determination of Emittance of Materials Near Room Temperature using Portable Emissometers.
ASTM C1549-16	Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
ASTM E408-13	Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques
[. . .]	

Modify Appendix C as shown (I-P and SI units).

C1.2.1 For Roofs. The *class of construction*, *opaque* area, *U-factor*, *HC*, and insulation position shall be specified. Where three-year-aged test data for the solar ~~*reflectance*~~reflectance and three-year-aged thermal *emittance* of the exterior *roof* surface are available, the three-year-aged solar ~~*reflectance*~~reflectance and three-year-aged thermal *emittance* shall be specified.

[. . .]

C3.5.5 Building Envelope. The *building envelope* shall reflect the information specified in Section C1.

Exception to C3.5.5: Where three-year-aged test data for the solar ~~*reflectance*~~reflectance and three-year-aged thermal *emittance* of the exterior *roof* surface are unavailable, the exterior *roof* surface shall be modeled with a solar ~~*reflectance*~~reflectance of 0.30 and a thermal *emittance* of 0.90.

C3.5.5.1 Shading. Manually operated interior shades shall be modeled on all *vertical fenestration*. Shades shall be modeled to be in the lowered position when either the transmitted luminance is greater than 200 cd/ft^2 (2000 cd/m^2) or the direct solar transmitted *energy* exceeds 30 Btu/h·ft^2 (95 W/m^2) and then remain lowered for rest of the day. Shades shall be modeled with visible light transmittance of 0.10, visible light ~~*reflectance*~~reflectance of 0.40, solar transmittance of 0.21, and solar ~~*reflectance*~~reflectance of 0.23. Permanent shading devices such as fins and overhangs shall be modeled.

[. . .]

C3.6 Calculation of Base Envelope Performance Factor

a. [. . .]

b. The exterior *roof* surfaces shall be modeled with a solar ~~*reflectance*~~reflectance and thermal *emittance* as required in Section 5.5.3.1.1(a). All other *roofs*, including *roofs* exempted from the requirements in Section 5.5.3.1.1, shall be modeled the same as in the *proposed design*. The *above-grade wall* surfaces of *buildings* shall be modeled with a solar reflectance and thermal *emittance* as required in Section 5.5.3.2.2 and Section 5.5.3.2.2(a). All other *above-grade walls*, including those exempt from the requirements in Section 5.5.3.2.2, shall be modeled the same as the *proposed design*.

[. . .]

Modify Table G3.1 as shown (I-P and SI units).

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

No.	Proposed Building Performance	Baseline Building Performance
5.	***Building Envelope***	
a.	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: 1. 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: a. Separate model of each of these assemblies within the *energy* simulation model. b. 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 *building 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 a *building envelope* assembly shall be added to the area of an assembly of that same type with the same *orientation* and thermal properties. 2. 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. 3. The exterior *roof* surface shall be modeled using the aged solar *reflectance* and thermal *emittance* determined in accordance with Section 5.5.3.1.1(a). Where aged test data are unavailable, the *roof* surface may be modeled with a ~~*reflectance*~~reflectance of 0.30 and a thermal *emittance* of 0.90. 4. *Manual fenestration* shading devices, such as blinds or shades, shall be modeled or not modeled the same as in the *baseline building design*. *Automatically* controlled *fenestration* shades or blinds shall be modeled. Permanent shading devices, such as fins, overhangs, and light shelves shall be modeled. 5. *Automatically* controlled *dynamic glazing* may be modeled. Manually controlled *dynamic glazing* shall use the average of the minimum and maximum *SHGC* and *VT*. 6. The *above-grade wall* surface shall be modeled using the initial solar reflectance and thermal *emittance* determined in accordance with the test methods identified in Section 5.5.3.2.2(a). Where initial test data are unavailable, the *wall* surface may be modeled with a solar reflectance of 0.25 and a thermal *emittance* of 0.90. [. . .]	Equivalent dimensions shall be assumed for each *building envelope* component type as in the *proposed design*; i.e., the total gross area of *walls* shall be the same in the *proposed design* and *baseline building design*. 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 design* and *baseline building design*. 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. **Exceptions:** 1. If it can be demonstrated to the satisfaction of the *rating authority* that the *building orientation* is dictated by site considerations. 2. *Buildings* where the *vertical fenestration area* on each *orientation* varies by less than 5%. b. ***Opaque* Assemblies.** *Opaque* assemblies used for new *buildings*, *existing buildings*, or additions shall conform with assemblies detailed in Normative Appendix A and shall match the appropriate assembly maximum *U-factors* in Tables G3.4-1 through G3.4-8: • Roofs—Insulation entirely above deck (A2.2). • *Above-grade walls—Steel-framed* (A3.3). • *Below-grade walls*—Concrete block (A4). • *Floors—Steel-joist* (A5.3). • *Slab-on-grade floors* shall match the *F-factor* for unheated slabs from the same tables (A6). [. . .] f. **Roof Solar ~~*Reflectance*~~Reflectance and Thermal Emittance.** The exterior *roof* surfaces shall be modeled using a solar ~~*reflectance*~~reflectance of 0.30 and a thermal *emittance* of 0.90. [. . .] i. **Wall Solar Reflectance and Thermal Emittance.** *Above-grade wall* surfaces shall be modeled with a solar reflectance of 0.25 and a thermal *emittance* of 0.90.

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted Standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the Standards and Guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive Technical Committee structure, continue to generate up-to-date Standards and Guidelines where appropriate and adopt, recommend, and promote those new and revised Standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date Standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating Standards and Guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

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