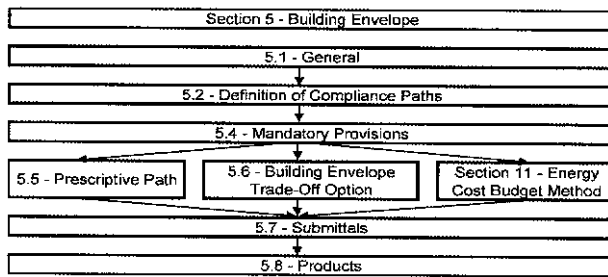


5. BUILDING ENVELOPE



5.1 General

5.1.1 Scope. Section 5 specifies requirements for the *building envelope*.

5.1.2 Space-Conditioning Categories

5.1.2.1 Separate *exterior building envelope* requirements are specified for each of three categories of conditioned space: (a) *nonresidential conditioned space*, (b) *residential conditioned space*, and (c) *semiheated space*.

5.1.2.2 *Spaces* shall be assumed to be *conditioned spaces* and shall comply with the requirements for *conditioned space* at the time of construction, regardless of whether mechanical or electrical equipment is included in the building permit application or installed at that time.

5.1.2.3 In climate zones 3 through 8, a space may be designated as either *semiheated* or *unconditioned* only if approved by the *building official*.

5.1.3 Envelope Alterations. *Alterations* to the *building envelope* shall comply with the requirements of Section 5 for insulation, air leakage, and *fenestration* applicable to those specific portions of the building that are being altered.

Exceptions: The following *alterations* need not comply with these requirements, provided such *alterations* will not increase the energy usage of the building:

- installation of storm windows over existing glazing
- replacement of glazing in existing sash and frame provided the *U-factor* and *SHGC* will be equal to or lower than before the glass replacement
- alterations* to roof/ceiling, wall, or floor cavities, which are insulated to full depth with insulation having a minimum nominal value of R-3.0/in.
- alterations* to walls and floors, where the existing structure is without framing cavities and no new framing cavities are created
- replacement of a roof membrane where either the roof sheathing or roof insulation is not exposed or, if there is existing roof insulation, below the roof deck
- replacement of existing doors that separate conditioned space from the exterior shall not require the installation of a vestibule or revolving door, provided, however, that an existing vestibule that sepa-

rates a conditioned space from the exterior shall not be removed

- replacement of existing fenestration, provided, however, that the area of the replacement fenestration does not exceed 25% of the total fenestration area of an *existing building* and that the *U-factor* and *SHGC* will be equal to or lower than before the fenestration replacement

5.1.4 Climate. Determine the climate zone for the location. For US locations, follow the procedure in Section 5.1.4.1. For international locations, follow the procedure in Section 5.1.4.2.

5.1.4.1 United States Locations. Use Figure B-1 or Table B-1 in Appendix B to determine the required climate zone.

Exception: If there are recorded historical climatic data available for a construction site, they may be used to determine compliance if approved by the *building official*.

5.1.4.2 International Locations. For locations in Canada that are listed in Table B-2 in Appendix B, use this table to determine the required climate zone number and, when a climate zone letter is also required, use Table B-4 and the Major Climate Type Definitions in Appendix B to determine the letter (A, B, or C). For locations in other international countries that are listed in Table B-3, use this table to determine the required climate zone number and, when a climate zone letter is also required, use Table B-4 and the Major Climate Type Definitions in Appendix B to determine the letter (A, B, or C). For all international locations that are not listed either in Table B-2 or B-3, use Table B-4 and the Major Climate Type Definitions in Appendix B to determine both the climate zone letter and number.

5.2 Compliance Paths

5.2.1 Compliance. For the appropriate climate, *space-conditioning category*, and *class of construction*, the *building envelope* shall comply with Section 5.1, General; Section 5.4, Mandatory Provisions; Section 5.7, Submittals; and Section 5.8, Product Information and Installation Requirements; and either

- 5.5, Prescriptive Building Envelope Option, provided that
 - the *vertical fenestration area* does not exceed 40% of the *gross wall area* for each *space-conditioning category* and
 - the *skylight fenestration area* does not exceed 5% of the *gross roof area* for each *space-conditioning category*; or
- 5.6, Building Envelope Trade-Off Option.

5.2.2 Projects using the Energy Cost Budget Method (Section 11 of this standard) must comply with Section 5.4, the mandatory provisions of this section, as a portion of that compliance path.

5.3 Simplified Building (Not Used)

5.4 Mandatory Provisions

5.4.1 Insulation. Where insulation is required in Section 5.5 or 5.6, it shall comply with the requirements found in Sections 5.8.1.1 through 5.8.1.9.

5.4.2 Fenestration and Doors. Procedures for determining *fenestration* and door performance are described in Section 5.8.2. Product samples used for determining *fenestration* performance shall be production line units or representative of units purchased by the consumer or contractor.

5.4.3 Air Leakage

5.4.3.1 Building Envelope Sealing. The following areas of the *building envelope* shall be sealed, caulked, gasketed, or weather-stripped to minimize air leakage:

- a. joints around *fenestration* and *door* frames
- b. junctions between *walls* and foundations, between *walls* at building corners, between *walls* and structural *floors* or *roofs*, and between *walls* and *roof* or *wall* panels
- c. openings at penetrations of utility services through *roofs*, *walls*, and *floors*
- d. site-built *fenestration* and *doors*
- e. building assemblies used as ducts or plenums
- f. joints, seams, and penetrations of vapor retarders
- g. all other openings in the *building envelope*

5.4.3.2 Fenestration and Doors. Air leakage for *fenestration* and *doors* shall be determined in accordance with NFRC 400. Air leakage shall be determined by a laboratory accredited by a nationally recognized accreditation organization, such as the National Fenestration Rating Council, and shall be *labeled* and certified by the *manufacturer*. Air leakage shall not exceed 1.0 cfm/ft² for glazed swinging entrance doors and for revolving doors and 0.4 cfm/ft² for all other products.

Exceptions:

- a. Field-fabricated fenestration and doors.
- b. For garage *doors*, air leakage determined by test at standard test conditions in accordance with ANSI/DASMA 105 shall be an acceptable alternate for compliance with air leakage requirements.

5.4.3.3 Loading Dock Weatherseals. In climate zones 4 through 8, cargo *doors* and loading dock *doors* shall be equipped with weatherseals to restrict *infiltration* when vehicles are parked in the doorway.

5.4.3.4 Vestibules. Building entrances that separate *conditioned space* from the exterior shall be protected with an enclosed vestibule, with all *doors* opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior *doors* to open at the same time. Interior and exterior *doors* shall have a minimum distance between them of not less than 7 ft when in the closed position. The exterior envelope of conditioned vestibules shall comply with the requirements for a conditioned space. The

interior and exterior envelope of unconditioned vestibules shall comply with the requirements for a semiheated space.

Exceptions:

- a. *Building entrances* with revolving *doors*.
- b. *Doors* not intended to be used as a *building entrance*.
- c. *Doors* opening directly from a *dwelling unit*.
- d. *Building entrances* in buildings located in climate zone 1 or 2.
- e. *Building entrances* in buildings located in climate zone 3 or 4 that are less than four stories above grade and less than 10,000 ft² in area.
- f. *Building entrances* in buildings located in climate zone 5, 6, 7, or 8 that are less than 1000 ft² in area.
- g. *Doors* that open directly from a *space* that is less than 3000 ft² in area and is separate from the *building entrance*.

5.5 Prescriptive Building Envelope Option

5.5.1 For a *conditioned space*, the *exterior building envelope* shall comply with either the “nonresidential” or “residential” requirements in Tables 5.5-1 through 5.5-8 for the appropriate climate.

5.5.2 If a building contains any *semiheated space* or *unconditioned space*, then the *semi-exterior building envelope* shall comply with the requirements for *semiheated space* in Tables 5.5-1 through 5.5-8 for the appropriate climate. (See Figure 5.5.)

5.5.3 Opaque Areas. For all opaque surfaces except doors, compliance shall be demonstrated by one of the following two methods:

1. Minimum *rated R-values of insulation* for the thermal resistance of the added insulation in framing cavities and *continuous insulation* only. Specifications listed in Normative Appendix A for each *class of construction* shall be used to determine compliance.
2. Maximum *U-factor*, *C-factor*, or *F-factor* for the entire assembly. The values for typical construction assemblies listed in Normative Appendix A shall be used to determine compliance.

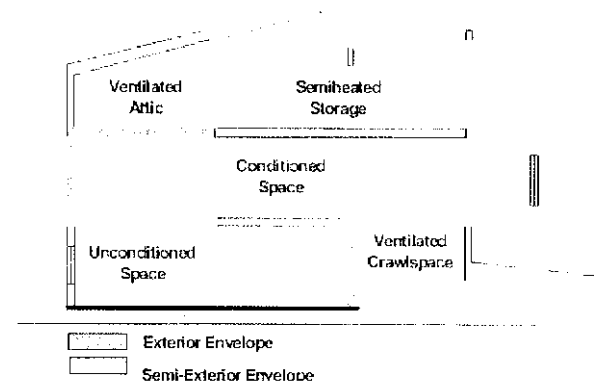


Figure 5.5 Exterior and semi-exterior building envelope.

TABLE 5.5-1 Building Envelope Requirements for Climate Zone 1 (A, B)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
<i>Roofs</i>						
Insulation Entirely above Deck	U-0.063	R-15.0 c.i.	U-0.048	R-20.0 c.i.	U-0.218	R-3.8 ci
Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	U-1.280	NR
Attic and Other	U-0.034	R-30.0	U-0.027	R-38.0	U-0.081	R-13.0
<i>Walls, Above-Grade</i>						
Mass	U-0.580	NR	U-0.151 ^a	R-5.7 c.i. ^a	U-0.580	NR
Metal Building	U-0.113	R-13.0	U-0.113	R-13.0	U-1.180	NR
Steel-Framed	U-0.124	R-13.0	U-0.124	R-13.0	U-0.352	NR
Wood-Framed and Other	U-0.089	R-13.0	U-0.089	R-13.0	U-0.292	NR
<i>Walls, Below-Grade</i>						
Below-Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
<i>Floors</i>						
Mass	U-0.322	NR	U-0.322	NR	U-0.322	NR
Steel-Joist	U-0.350	NR	U-0.350	NR	U-0.350	NR
Wood-Framed and Other	U-0.282	NR	U-0.282	NR	U-0.282	NR
<i>Slab-On-Grade Floors</i>						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.
<i>Opaque Doors</i>						
Swinging	U-0.700		U-0.700		U-0.700	
Nonswinging	U-1.450		U-1.450		U-1.450	
Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC
<i>Vertical Glazing, 0%–40% of Wall</i>						
Nonmetal framing (all) ^b	U-1.20		U-1.20		U-1.20	
Metal framing (curtainwall/storefront) ^c	U-1.20	SHGC-0.25 all	U-1.20	SHGC-0.25 all	U-1.20	SHGC-NR all
Metal framing (entrance door) ^c	U-1.20		U-1.20		U-1.20	
Metal framing (all other) ^c	U-1.20		U-1.20		U-1.20	
<i>Skylight with Curb, Glass, % of Roof</i>						
0%–2.0%	U _{all} -1.98	SHGC _{all} -0.36	U _{all} 1.98	SHGC _{all} -0.19	U _{all} -1.98	SHGC _{all} -NR
2.1%–5.0%	U _{all} 1.98	SHGC _{all} -0.19	U _{all} -1.98	SHGC _{all} -0.16	U _{all} -1.98	SHGC _{all} -NR
<i>Skylight with Curb, Plastic, % of Roof</i>						
0%–2.0%	U _{all} -1.90	SHGC _{all} -0.34	U _{all} -1.90	SHGC _{all} -0.27	U _{all} -1.90	SHGC _{all} -NR
2.1%–5.0%	U _{all} -1.90	SHGC _{all} -0.27	U _{all} -1.90	SHGC _{all} -0.27	U _{all} -1.90	SHGC _{all} -NR
<i>Skylight without Curb, All, % of Roof</i>						
0%–2.0%	U _{all} -1.36	SHGC _{all} -0.36	U _{all} -1.36	SHGC _{all} -0.19	U _{all} -1.36	SHGC _{all} -NR
2.1%–5.0%	U _{all} -1.36	SHGC _{all} 0.19	U _{all} -1.36	SHGC _{all} -0.19	U _{all} -1.36	SHGC _{all} -NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.

^aException to Section A3.1.3.1 applies.

^bNonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.

^cMetal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

TABLE 5.5-2 Building Envelope Requirements for Climate Zone 2 (A, B)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
<i>Roofs</i>						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.218	R-3.8 c.i.
Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	U-0.167	R-6.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.081	R-13.0
<i>Walls, Above-Grade</i>						
Mass	U-0.151 ^a	R-5.7 c.i. ^a	U-0.123	R-7.6 c.i.	U-0.580	NR
Metal Building	U-0.113	R-13.0	U-0.113	R-13.0	U-0.184	R-6.0
Steel-Framed	U-0.124	R-13.0	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.089	R-13.0	U-0.089	R-13.0	U-0.089	R-13.0
<i>Walls, Below-Grade</i>						
Below-Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
<i>Floors</i>						
Mass	U-0.107	R-6.3 c.i.	U-0.087	R-8.3 c.i.	U-0.322	NR
Steel-Joist	U-0.052	R-19.0	U-0.052	R-19.0	U-0.069	R-13.0
Wood-Framed and Other	U-0.051	R-19.0	U-0.033	R-30.0	U-0.066	R-13.0
<i>Slab-On-Grade Floors</i>						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.
<i>Opaque Doors</i>						
Swinging	U-0.700		U-0.700		U-0.700	
Nonswinging	U-1.450		U-0.500		U-1.450	
Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC
<i>Vertical Glazing, 0%–40% of Wall</i>						
Nonmetal framing (all) ^b	U-0.75		U-0.75		U-1.20	
Metal framing (curtainwall/storefront) ^c	U-0.70	SHGC-0.25 all	U-0.70	SHGC-0.25 all	U-1.20	SHGC-NR all
Metal framing (entrance door) ^c	U-1.10		U-1.10		U-1.20	
Metal framing (all other) ^c	U-0.75		U-0.75		U-1.20	
<i>Skylight with Curb, Glass, % of Roof</i>						
0%–2.0%	U _{all} 1.98	SHGC _{all} -0.36	U _{all} 1.98	SHGC _{all} -0.19	U _{all} 1.98	SHGC _{all} -NR
2.1%–5.0%	U _{all} 1.98	SHGC _{all} -0.19	U _{all} 1.98	SHGC _{all} -0.19	U _{all} 1.98	SHGC _{all} -NR
<i>Skylight with Curb, Plastic, % of Roof</i>						
0%–2.0%	U _{all} 1.90	SHGC _{all} -0.39	U _{all} 1.90	SHGC _{all} -0.27	U _{all} 1.90	SHGC _{all} -NR
2.1%–5.0%	U _{all} 1.90	SHGC _{all} -0.34	U _{all} 1.90	SHGC _{all} -0.27	U _{all} 1.90	SHGC _{all} -NR
<i>Skylight without Curb, All, % of Roof</i>						
0%–2.0%	U _{all} 1.36	SHGC _{all} -0.36	U _{all} 1.36	SHGC _{all} -0.19	U _{all} 1.36	SHGC _{all} -NR
2.1%–5.0%	U _{all} 1.36	SHGC _{all} -0.19	U _{all} 1.36	SHGC _{all} -0.19	U _{all} 1.36	SHGC _{all} -NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.

^aException to Section A3.1.3.1 applies.

^bNonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.

^cMetal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

TABLE 5.5-3 Building Envelope Requirements for Climate Zone 3 (A, B, C)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
<i>Roofs</i>						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.173	R-5.0 c.i.
Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	U-0.097	R-10.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.053	R-19.0
<i>Walls, Above-Grade</i>						
Mass	U-0.123	R-7.6 c.i.	U-0.104	R-9.5 c.i.	U-0.580	NR
Metal Building	U-0.113	R-13.0	U-0.113	R-13.0	U-0.184	R-6.0
Steel-Framed	U-0.084	R-13.0 + R-3.8 c.i.	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.089	R-13.0	U-0.089	R-13.0	U-0.089	R-13.0
<i>Walls, Below-Grade</i>						
Below-Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
<i>Floors</i>						
Mass	U-0.107	R-6.3 c.i.	U-0.087	R-8.3 c.i.	U-0.322	NR
Steel-Joist	U-0.052	R-19.0	U-0.052	R-19.0	U-0.069	R-13.0
Wood-Framed and Other	U-0.051	R-19.0	U-0.033	R-30.0	U-0.066	R-13.0
<i>Slab-On-Grade Floors</i>						
Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
Heated	F-0.900	R-10 for 24 in.	F-0.900	R-10 for 24 in.	F-1.020	R-7.5 for 12 in.
<i>Opaque Doors</i>						
Swinging	U-0.700		U-0.700		U-0.700	
Nonswinging	U-1.450		U-0.500		U-1.450	
Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC
<i>Vertical Glazing, 0%–40% of Wall</i>						
Nonmetal framing (all) ^b	U-0.65		U-0.65		U-1.20	
Metal framing (curtainwall/storefront) ^c	U-0.60	SHGC-0.25 all	U-0.60	SHGC-0.25 all	U-1.20	SHGC-NR all
Metal framing (entrance door) ^c	U-0.90		U-0.90		U-1.20	
Metal framing (all other) ^c	U-0.65		U-0.65		U-1.20	
<i>Skylight with Curb, Glass, % of Roof</i>						
0%–2.0%	U _{all} -1.17	SHGC _{all} -0.39	U _{all} -1.17	SHGC _{all} -0.36	U _{all} -1.98	SHGC _{all} -NR
2.1%–5.0%	U _{all} -1.17	SHGC _{all} -0.19	U _{all} -1.17	SHGC _{all} -0.19	U _{all} -1.98	SHGC _{all} -NR
<i>Skylight with Curb, Plastic, % of Roof</i>						
0%–2.0%	U _{all} -1.30	SHGC _{all} -0.65	U _{all} -1.30	SHGC _{all} -0.27	U _{all} -1.90	SHGC _{all} -NR
2.1%–5.0%	U _{all} -1.30	SHGC _{all} -0.34	U _{all} -1.30	SHGC _{all} -0.27	U _{all} -1.90	SHGC _{all} -NR
<i>Skylight without Curb, All, % of Roof</i>						
0%–2.0%	U _{all} -0.69	SHGC _{all} -0.39	U _{all} -0.69	SHGC _{all} -0.36	U _{all} -1.36	SHGC _{all} -NR
2.1%–5.0%	U _{all} -0.69	SHGC _{all} -0.19	U _{all} -0.69	SHGC _{all} -0.19	U _{all} -1.36	SHGC _{all} -NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.

^bNonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.

^cMetal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

TABLE 5.5-4 Building Envelope Requirements for Climate Zone 4 (A, B, C)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
<i>Roofs</i>						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.173	R-5.0 c.i.
Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	U-0.097	R-10.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.053	R-19.0
<i>Walls, Above-Grade</i>						
Mass	U-0.104	R-9.5 c.i.	U-0.090	R-11.4 c.i.	U-0.580	NR
Metal Building	U-0.113	R-13.0	U-0.113	R-13.0	U-0.134	R-10.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.089	R-13.0	U-0.064	R-13.0 + R-3.8 c.i.	U-0.089	R-13.0
<i>Walls, Below-Grade</i>						
Below-Grade Wall	C-1.140	NR	C-0.119	R-7.5 c.i.	C-1.140	NR
<i>Floors</i>						
Mass	U-0.087	R-8.3 c.i.	U-0.074	R-10.4 c.i.	U-0.137	R-4.2 c.i.
Steel-Joist	U-0.038	R-30.0	U-0.038	R-30.0	U-0.069	R-13.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.066	R-13.0
<i>Slab-On-Grade Floors</i>						
Unheated	F-0.730	NR	F-0.540	R-10 for 24 in.	F-0.730	NR
Heated	F-0.860	R-15 for 24 in.	F-0.860	R-15 for 24 in.	F-1.020	R-7.5 for 12 in.
<i>Opaque Doors</i>						
Swinging	U-0.700		U-0.700		U-0.700	
Nonswinging	U-1.500		U-0.500		U-1.450	
Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC
<i>Vertical Glazing, 0%–40% of Wall</i>						
Nonmetal framing (all) ^b	U-0.40		U-0.40		U-1.20	
Metal framing (curtainwall/storefront) ^c	U-0.50	SHGC-0.40 all	U-0.50	SHGC-0.40 all	U-1.20	SHGC-NR all
Metal framing (entrance door) ^c	U-0.85		U-0.85		U-1.20	
Metal framing (all other) ^c	U-0.55		U-0.55		U-1.20	
<i>Skylight with Curb, Glass, % of Roof</i>						
0%–2.0%	U _{all} -1.17	SHGC _{all} -0.49	U _{all} -0.98	SHGC _{all} -0.36	U _{all} -1.98	SHGC _{all} -NR
2.1%–5.0%	U _{all} -1.17	SHGC _{all} -0.39	U _{all} -0.98	SHGC _{all} -0.19	U _{all} -1.98	SHGC _{all} -NR
<i>Skylight with Curb, Plastic, % of Roof</i>						
0%–2.0%	U _{all} -1.30	SHGC _{all} -0.65	U _{all} -1.30	SHGC _{all} -0.62	U _{all} -1.90	SHGC _{all} -NR
2.1%–5.0%	U _{all} -1.30	SHGC _{all} -0.34	U _{all} -1.30	SHGC _{all} -0.27	U _{all} -1.90	SHGC _{all} -NR
<i>Skylight without Curb, All, % of Roof</i>						
0%–2.0%	U _{all} -0.69	SHGC _{all} -0.49	U _{all} -0.58	SHGC _{all} -0.36	U _{all} -1.36	SHGC _{all} -NR
2.1%–5.0%	U _{all} -0.69	SHGC _{all} -0.39	U _{all} -0.58	SHGC _{all} -0.19	U _{all} -1.36	SHGC _{all} -NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.

^bNonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.

^cMetal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

TABLE 5.5-5 Building Envelope Requirements for Climate Zone 5 (A, B, C)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
<i>Roofs</i>						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.119	R-7.6 c.i.
Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	U-0.097	R-10.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.053	R-19.0
<i>Walls, Above-Grade</i>						
Mass	U-0.090	R-11.4 c.i.	U-0.080	R-13.3 c.i.	U-0.151 ^a	R-5.7 c.i. ^a
Metal Building	U-0.113	R-13.0	U-0.057	R-13.0 + R-13.0	U-0.123	R-11.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.064	R-13.0 + R-3.8 c.i.	U-0.051	R-13.0 + R-7.5 c.i.	U-0.089	R-13.0
<i>Walls, Below-Grade</i>						
Below-Grade Wall	C-0.119	R-7.5 c.i.	C-0.119	R-7.5 c.i.	C-1.140	NR
<i>Floors</i>						
Mass	U-0.074	R-10.4 c.i.	U-0.064	R-12.5 c.i.	U-0.137	R-4.2 c.i.
Steel-Joist	U-0.038	R-30.0	U-0.038	R-30.0	U-0.052	R-19.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.051	R-19.0
<i>Slab-On-Grade Floors</i>						
Unheated	F-0.730	NR	F-0.540	R-10 for 24 in.	F-0.730	NR
Heated	F-0.860	R-15 for 24 in.	F-0.860	R-15 for 24 in.	F-1.020	R-7.5 for 12 in.
<i>Opaque Doors</i>						
Swinging	U-0.700		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	
Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC
<i>Vertical Glazing, % of Wall</i>						
Nonmetal framing (all) ^b	U-0.35		U-0.35		U-1.20	
Metal framing (curtainwall/storefront) ^c	U-0.45	SHGC-0.40 all	U-0.45	SHGC-0.40 all	U-1.20	SHGC-NR all
Metal framing (entrance door) ^c	U-0.80		U-0.80		U-1.20	
Metal framing (all other) ^c	U-0.55		U-0.55		U-1.20	
<i>Skylight with Curb, Glass, % of Roof</i>						
0%–2.0%	U _{all} -1.17	SHGC _{all} -0.49	U _{all} -1.17	SHGC _{all} -0.49	U _{all} -1.98	SHGC _{all} -NR
2.1%–5.0%	U _{all} -1.17	SHGC _{all} -0.39	U _{all} -1.17	SHGC _{all} -0.39	U _{all} -1.98	SHGC _{all} -NR
<i>Skylight with Curb, Plastic, % of Roof</i>						
0%–2.0%	U _{all} -1.10	SHGC _{all} -0.77	U _{all} -1.10	SHGC _{all} -0.77	U _{all} -1.90	SHGC _{all} -NR
2.1%–5.0%	U _{all} -1.10	SHGC _{all} -0.62	U _{all} -1.10	SHGC _{all} -0.62	U _{all} -1.90	SHGC _{all} -NR
<i>Skylight without Curb, All, % of Roof</i>						
0%–2.0%	U _{all} -0.69	SHGC _{all} -0.49	U _{all} -0.69	SHGC _{all} -0.49	U _{all} -1.36	SHGC _{all} -NR
2.1%–5.0%	U _{all} -0.69	SHGC _{all} -0.39	U _{all} -0.69	SHGC _{all} -0.39	U _{all} -1.36	SHGC _{all} -NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.

^aException to Section A3.1.3.1 applies.

^bNonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.

^cMetal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

TABLE 5.5-6 Building Envelope Requirements for Climate Zone 6 (A, B)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
<i>Roofs</i>						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.093	R-10.0 c.i.
Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	U-0.097	R-10.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.034	R-30.0
<i>Walls, Above-Grade</i>						
Mass	U-0.080	R-13.3 c.i.	U-0.071	R-15.2 c.i.	U-0.151 ^a	R-5.7 c.i. ^a
Metal Building	U-0.113	R-13.0	U-0.057	R-13.0 + R-13.0	U-0.113	R-13.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.051	R-13.0 + R-7.5 c.i.	U-0.051	R-13.0 + R-7.5 c.i.	U-0.089	R-13.0
<i>Walls, Below-Grade</i>						
Below-Grade Wall	C-0.119	R-7.5 c.i.	C-0.119	R-7.5 c.i.	C-1.140	NR
<i>Floors</i>						
Mass	U-0.064	R-12.5 c.i.	U-0.057	R-14.6 c.i.	U-0.137	R-4.2 c.i.
Steel-Joist	U-0.038	R-30.0	U-0.032	R-38.0	U-0.052	R-19.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.051	R-19.0
<i>Slab-On-Grade Floors</i>						
Unheated	F-0.540	R-10 for 24 in.	F-0.520	R-15 for 24 in.	F-0.730	NR
Heated	F-0.860	R-15 for 24 in.	F-0.688	R-20 for 48 in.	F-1.020	R-7.5 for 12 in.
<i>Opaque Doors</i>						
Swinging	U-0.700		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	
Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC
<i>Vertical Glazing, 0%–40% of Wall</i>						
Nonmetal framing (all) ^b	U-0.35		U-0.35		U-0.65	
Metal framing (curtainwall/storefront) ^c	U-0.45	SHGC-0.40 all	U-0.45	SHGC-0.40 all	U-0.60	SHGC-NR all
Metal framing (entrance door) ^c	U-0.80		U-0.80		U-0.90	
Metal framing (all other) ^c	U-0.55		U-0.55		U-0.65	
<i>Skylight with Curb, Glass, % of Roof</i>						
0%–2.0%	U _{all} -1.17	SHGC _{all} -0.49	U _{all} -0.98	SHGC _{all} -0.46	U _{all} -1.98	SHGC _{all} -NR
2.1%–5.0%	U _{all} -1.17	SHGC _{all} -0.49	U _{all} -0.98	SHGC _{all} -0.36	U _{all} -1.98	SHGC _{all} -NR
<i>Skylight with Curb, Plastic, % of Roof</i>						
0%–2.0%	U _{all} -0.87	SHGC _{all} 0.71	U _{all} -0.74	SHGC _{all} -0.65	U _{all} -1.90	SHGC _{all} -NR
2.1%–5.0%	U _{all} -0.87	SHGC _{all} -0.58	U _{all} -0.74	SHGC _{all} -0.55	U _{all} -1.90	SHGC _{all} -NR
<i>Skylight without Curb, All, % of Roof</i>						
0%–2.0%	U _{all} -0.69	SHGC _{all} -0.49	U _{all} -0.58	SHGC _{all} -0.49	U _{all} -1.36	SHGC _{all} -NR
2.1%–5.0%	U _{all} -0.69	SHGC _{all} 0.49	U _{all} -0.58	SHGC _{all} -0.39	U _{all} -1.36	SHGC _{all} -NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.

^aException to Section A3.1.3.1 applies.

^bNonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.

^cMetal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

TABLE 5.5-7 Building Envelope Requirements for Climate Zone 7*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
<i>Roofs</i>						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.093	R-10.0 c.i.
Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	U-0.097	R-10.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.034	R-30.0
<i>Walls, Above-Grade</i>						
Mass	U-0.071	R-15.2 c.i.	U-0.071	R-15.2 c.i.	U-0.123	R-7.6 c.i.
Metal Building	U-0.057	R-13.0 + R-13.0	U-0.057	R-13.0 + R-13.0	U-0.113	R-13.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.042	R-13.0 + R-15.6 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.051	R-13.0 + R-7.5 c.i.	U-0.051	R-13.0 + R-7.5 c.i.	U-0.089	R-13.0
<i>Walls, Below-Grade</i>						
Below-Grade Wall	C-0.119	R-7.5 c.i.	C-0.092	R-10.0 c.i.	C-1.140	NR
<i>Floors</i>						
Mass	U-0.064	R-12.5 c.i.	U-0.051	R-16.7 c.i.	U-0.107	R-6.3 c.i.
Steel-Joist	U-0.038	R-30.0	U-0.032	R-38.0	U-0.052	R-19.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.051	R-19.0
<i>Slab-On-Grade Floors</i>						
Unheated	F-0.520	R-15 for 24 in.	F-0.520	R-15 for 24 in.	F-0.730	NR
Heated	F-0.843	R-20 for 24in.	F-0.688	R-20 for 48 in.	F-0.900	R-10 for 24 in.
<i>Opaque Doors</i>						
Swinging	U-0.500		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-1.450	
Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC
<i>Vertical Glazing, 0%–40% of Wall</i>						
Nonmetal framing (all) ^b	U-0.35		U-0.35		U-0.65	
Metal framing (curtainwall/storefront) ^c	U-0.40	SHGC-0.45 all	U-0.40	SHGC-NR all	U-0.60	SHGC-NR all
Metal framing (entrance door) ^c	U-0.80		U-0.80		U-0.90	
Metal framing (all other) ^c	U-0.45		U-0.45		U-0.65	
<i>Skylight with Curb, Glass, % of Roof</i>						
0%–2.0%	U _{all} -1.17	SHGC _{all} -0.68	U _{all} -1.17	SHGC _{all} 0.64	U _{all} -1.98	SHGC _{all} -NR
2.1%–5.0%	U _{all} 1.17	SHGC _{all} -0.64	U _{all} 1.17	SHGC _{all} -0.64	U _{all} -1.98	SHGC _{all} -NR
<i>Skylight with Curb, Plastic, % of Roof</i>						
0%–2.0%	U _{all} -0.87	SHGC _{all} -0.77	U _{all} -0.61	SHGC _{all} -0.77	U _{all} -1.90	SHGC _{all} -NR
2.1%–5.0%	U _{all} -0.87	SHGC _{all} -0.71	U _{all} -0.61	SHGC _{all} -0.77	U _{all} -1.90	SHGC _{all} -NR
<i>Skylight without Curb, All, % of Roof</i>						
0%–2.0%	U _{all} -0.69	SHGC _{all} -0.68	U _{all} -0.69	SHGC _{all} -0.64	U _{all} -1.36	SHGC _{all} NR
2.1%–5.0%	U _{all} -0.69	SHGC _{all} -0.64	U _{all} -0.69	SHGC _{all} -0.64	U _{all} -1.36	SHGC _{all} -NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.

^bNonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.

^cMetal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

TABLE 5.5-8 Building Envelope Requirements for Climate Zone 8*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
<i>Roofs</i>						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.063	R-15.0 c.i.
Metal Building	U-0.049	R-13.0 + R-19.0	U-0.049	R-13.0 + R-19.0	U-0.072	R-16.0
Attic and Other	U-0.021	R-49.0	U-0.021	R-49.0	U-0.034	R-30.0
<i>Walls, Above-Grade</i>						
Mass	U-0.071	R-15.2 c.i.	U-0.052	R-25.0 c.i.	U-0.104	R-9.5 c.i.
Metal Building	U-0.057	R-13.0 + R-13.0	U-0.057	R-13.0 + R-13.0	U-0.113	R-13.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.037	R-13.0 + R-18.8 c.i.	U-0.084	R-13.0 + R-3.8 c.i.
Wood-Framed and Other	U-0.036	R-13.0 + R-15.6 c.i.	U-0.036	R-13.0 + R-15.6 c.i.	U-0.089	R-13.0
<i>Walls, Below-Grade</i>						
Below-Grade Wall	C-0.119	R-7.5 c.i.	C-0.075	R-12.5 c.i.	C-1.140	NR
<i>Floors</i>						
Mass	U-0.057	R-14.6 c.i.	U-0.051	R-16.7 c.i.	U-0.087	R-8.3 c.i.
Steel-Joist	U-0.032	R-38.0	U-0.032	R-38.0	U-0.052	R-19.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.033	R-30.0
<i>Slab-On-Grade Floors</i>						
Unheated	F-0.520	R-15 for 24 in.	F-0.510	R-20 for 24 in.	F-0.730	NR
Heated	F-0.688	R-20 for 48 in.	F-0.688	R-20 for 48 in.	F-0.900	R-10.0 for 24 in.
<i>Opaque Doors</i>						
Swinging	U-0.500		U-0.500		U-0.700	
Nonswinging	U-0.500		U-0.500		U-0.500	
Fenestration	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC	Assembly Max. U	Assembly Max. SHGC
<i>Vertical Glazing, 0%–40% of Wall</i>						
Nonmetal framing (all) ^b	U-0.35		U-0.35		U-0.65	
Metal framing (curtainwall/storefront) ^c	U-0.40	SHGC-0.45 all	U-0.40	SHGC-NR all	U-0.60	SHGC-NR all
Metal framing (entrance door) ^c	U-0.80		U-0.80		U-0.90	
Metal framing (all other) ^c	U-0.45		U-0.45		U-0.65	
<i>Skylight with Curb, Glass, % of Roof</i>						
0%–2.0%	U _{all} -0.98	SHGC _{all} -NR	U _{all} -0.98	SHGC _{all} -NR	U _{all} -1.30	SHGC _{all} -NR
2.1%–5.0%	U _{all} -0.98	SHGC _{all} -NR	U _{all} -0.98	SHGC _{all} -NR	U _{all} -1.30	SHGC _{all} -NR
<i>Skylight with Curb, Plastic, % of Roof</i>						
0%–2.0%	U _{all} -0.61	SHGC _{all} -NR	U _{all} -0.61	SHGC _{all} -NR	U _{all} -1.10	SHGC _{all} -NR
2.1%–5.0%	U _{all} -0.61	SHGC _{all} -NR	U _{all} -0.61	SHGC _{all} -NR	U _{all} -1.10	SHGC _{all} -NR
<i>Skylight without Curb, All, % of Roof</i>						
0%–2.0%	U _{all} -0.58	SHGC _{all} -NR	U _{all} -0.58	SHGC _{all} -NR	U _{all} -0.81	SHGC _{all} -NR
2.1%–5.0%	U _{all} -0.58	SHGC _{all} -NR	U _{all} -0.58	SHGC _{all} -NR	U _{all} -0.81	SHGC _{all} -NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.

^bNonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.

^cMetal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

Exceptions to Section 5.5.3:

- a. For assemblies significantly different from those in Appendix A, calculations shall be performed in accordance with the procedures required in Appendix A.
- b. For multiple assemblies within a single class of construction for a single space-conditioning category, compliance shall be shown for either (1) the most restrictive requirement or (2) an area-weighted average *U-factor*, *C-factor*, or *F-factor*.

5.5.3.1 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, whichever is less.

5.5.3.1.1 High Albedo Roofs. For roofs, 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 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
- b. a minimum Solar Reflective Index of 82 when determined in accordance with the Solar Reflectance Index method in ASTM E1980,

the insulation value for the roof shall comply with the values in Table 5.5.3.1. The values for solar reflectance and 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.

5.5.3.2 Above-Grade Wall Insulation. All above-grade walls shall comply with the insulation values specified in Tables 5.5-1 through 5.5-8. When a wall consists of both above-grade and below-grade portions, the entire wall for that story shall be insulated on either the exterior or the interior or be integral.

- a. If insulated on the interior, the wall shall be insulated to the above-grade wall requirements.
- b. If insulated on the exterior or integral, the below-grade wall portion shall be insulated to the below-grade wall requirements, and the above-grade wall portion shall be insulated to the above-grade wall requirements.

5.5.3.3 Below-Grade Wall Insulation. Below-grade walls shall have a rated *R-value of insulation* not less than the insulation values specified in Tables 5.5-1 through 5.5-8.

Exception: Where framing, including metal and wood studs, is used, compliance shall be based on the maximum assembly *C-factor*.

5.5.3.4 Floor Insulation. All floors shall comply with the insulation values specified in Tables 5.5-1 through 5.5-8.

5.5.3.5 Slab-on-Grade Floor Insulation. All slab-on-grade floors, including heated slab-on-grade floors and unheated slab-on-grade floors, shall comply with the insulation values specified in Tables 5.5-1 through 5.5-8.

5.5.3.6 Opaque Doors. All opaque doors shall have a *U-factor* not greater than that specified in Tables 5.5-1 through 5.5-8.

TABLE 5.5.3.1 High Albedo Roof Insulation

Climate Zone	Opaque Elements (Roofs)	Nonresidential		Residential	
		Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
1	Insulation entirely above deck	U-0.082	R-12.0 c.i.	U-0.081	R-12.0 c.i.
	Metal building	U-0.084	R-13	U-0.084	R-13.0
	Attic and other ^a	U-0.044	R-24.0	U-0.035	R-30.0
2	Insulation entirely above deck	U-0.076	R-13.0 c.i.	U-0.076	R-13.0 c.i.
	Metal building	U-0.078	R-13.0	U-0.078	R-13.0
	Attic and other ^a	U-0.041	R-25.0	U-0.032	R-30.0
3	Insulation entirely above deck	U-0.074	R-13.0 c.i.	U-0.074	R-13.0 c.i.
	Metal building	U-0.076	R-16	U-0.076	R-16.0
	Attic and other ^a	U-0.040	R-25.0	U-0.032	R-30.0
4, 5, 6, 7, 8	All roof opaque elements	NP	NP	NP	NP

NP = Not permitted.

^aExcludes roofs over ventilated attics, or roofs over semiheated spaces, or roofs over conditioned spaces that are not cooled spaces.

5.5.4 Fenestration

5.5.4.1 General. Compliance with *U*-factors and *SHGC* shall be demonstrated for the overall fenestration product. Gross wall areas and gross roof areas shall be calculated separately for each *space-conditioning category* for the purposes of determining compliance.

Exception: If there are multiple assemblies within a single *class of construction* for a single *space-conditioning category*, compliance shall be based on an area-weighted average *U*-factor or *SHGC*. It is not acceptable to do an area-weighted average across multiple *classes of construction* or multiple *space-conditioning categories*.

5.5.4.2 Fenestration Area

5.5.4.2.1 Vertical Fenestration Area. The total *vertical fenestration area* shall be less than 40% of the *gross wall area*.

Exception: *Vertical fenestration* complying with Exception (b) to Section 5.5.4.4.1.

5.5.4.2.2 Skylight Fenestration Area. The total *skylight area* shall be less than 5% of the *gross roof area*.

5.5.4.3 Fenestration U-Factor. *Fenestration* shall have a *U*-factor not greater than that specified in Tables 5.5-1 through 5.5-8 for the appropriate *fenestration area*.

5.5.4.4 Fenestration Solar Heat aGain Coefficient (SHGC)

5.5.4.4.1 SHGC of Vertical Fenestration. *Vertical fenestration* shall have an *SHGC* not greater than that specified for “all” orientations in Tables 5.5-1 through 5.5-8 for the appropriate total *vertical fenestration area*.

Exceptions:

- a. For demonstrating compliance for *vertical fenestration* shaded by opaque permanent projections that will last as long as the building itself, the *SHGC* in the proposed building shall be reduced by using the multipliers in Table 5.5.4.4.1. Permanent projections

TABLE 5.5.4.4.1 SHGC Multipliers for Permanent Projections

Projection Factor	SHGC Multiplier (All Other Orientations)	SHGC Multiplier (North-Oriented)
0–0.10	1.00	1.00
>0.10–0.20	0.91	0.95
>0.20–0.30	0.82	0.91
>0.30–0.40	0.74	0.87
>0.40–0.50	0.67	0.84
>0.50–0.60	0.61	0.81
>0.60–0.70	0.56	0.78
>0.70–0.80	0.51	0.76
>0.80–0.90	0.47	0.75
>0.90–1.00	0.44	0.73

consisting of open louvers shall be considered to provide shading, provided that no sun penetrates the louvers during the peak sun angle on June 21.

- b. For demonstrating compliance for *vertical fenestration* shaded by partially opaque permanent projections (e.g., framing with glass or perforated metal) that will last as long as the building itself, the *PF* shall be reduced by multiplying it by a factor of O_s , which is derived as follows:

$$O_s = (A_i \cdot O_i) + (A_f \cdot O_f)$$

where

O_s = percent opacity of the shading device

A_i = percent of the area of the shading device that is a partially opaque infill

O_i = percent opacity of the infill—for glass $O_i = (100\% - T_s)$, where T_s is the solar transmittance as determined in accordance with NFRC 300; for perforated or decorative metal panels O_i = percentage of solid material

A_f = percent of the area of the shading device that represents the framing members

O_f = percent opacity of the framing members; if solid, then 100%

And then the *SHGC* in the proposed building shall be reduced by using the multipliers in Table 5.5.4.4.1 for each *fenestration product*.

- c. *Vertical fenestration* that is located on the street side of the street-level story only, provided that
 1. the street side of the street-level story does not exceed 20 ft in height,
 2. the *fenestration* has a continuous overhang with a weighted average *PF* greater than 0.5, and
 3. the *fenestration area* for the street side of the street-level story is less than 75% of the *gross wall area* for the street side of the street-level story.

When this exception is utilized, separate calculations shall be performed for these sections of the *building envelope*, and these values shall not be averaged with any others for compliance purposes. No credit shall be given here or elsewhere in the building for not fully utilizing the *fenestration area* allowed.

5.5.4.4.2 SHGC of Skylights. *Skylights* shall have an *SHGC* not greater than that specified for “all” orientations in Tables 5.5-1 through 5.5-8 for the appropriate total *skylight area*.

5.6 Building Envelope Trade-Off Option

5.6.1 The *building envelope* complies with the standard if

- a. the proposed building satisfies the provisions of Sections 5.1, 5.4, 5.7, and 5.8, and
- b. the *envelope performance factor* of the proposed building is less than or equal to the *envelope performance factor* of the budget building.

5.6.1.1 The *envelope performance factor* considers only the *building envelope* components.

5.6.1.2 Schedules of operation, lighting power, equipment power, occupant density, and mechanical systems shall be the same for both the proposed building and the budget building.

5.6.1.3 *Envelope performance factor* shall be calculated using the procedures of Normative Appendix C.

5.7 Submittals

5.7.1 General. The *authority having jurisdiction* may require submittal of compliance documentation and supplemental information, in accordance with Section 4.2.2 of this standard.

5.7.2 Submittal Document Labeling of Space Conditioning Categories. For buildings that contain spaces that will be only semiheated or unconditioned, and compliance is sought using the “semiheated” envelope criteria, such spaces shall be clearly indicated on the floor plans that are submitted for review.

5.8 Product Information and Installation Requirements

5.8.1 Insulation

5.8.1.1 Labeling of Building Envelope Insulation. The *rated R-value* shall be clearly identified by an identification mark applied by the *manufacturer* to each piece of *building envelope* insulation.

Exception: When insulation does not have such an identification mark, the installer of such insulation shall provide a signed and dated certification for the installed insulation listing the type of insulation, the *manufacturer*, the *rated R-value*, and, where appropriate, the initial installed thickness, the settled thickness, and the coverage area.

5.8.1.2 Compliance with Manufacturers’ Requirements. Insulation materials shall be installed in accordance with *manufacturers’* recommendations and in such a manner as to achieve *rated R-value of insulation*.

Exception: Where *metal building roof* and *metal building wall* insulation is compressed between the *roof* or *wall* skin and the structure.

5.8.1.3 Loose-Fill Insulation Limitation. Open-blown or poured loose-fill insulation shall not be used in *attic roof* spaces when the slope of the ceiling is more than three in twelve.

5.8.1.4 Baffles. When eave vents are installed, baffling of the vent openings shall be provided to deflect the incoming air above the surface of the insulation.

5.8.1.5 Substantial Contact. Insulation shall be installed in a permanent manner in *substantial contact* with the inside surface in accordance with *manufacturers’* recommendations for the framing system used. Flexible batt insulation installed in floor cavities shall be supported in a permanent manner by supports no greater than 24 in. on center.

Exception: Insulation materials that rely on air spaces adjacent to reflective surfaces for their rated performance.

5.8.1.6 Recessed Equipment. Lighting fixtures; heating, ventilating, and air-conditioning equipment, including wall heaters, ducts, and plenums; and other equipment shall

not be recessed in such a manner as to affect the insulation thickness unless

- a. the total combined area affected (including necessary clearances) is less than 1% of the opaque area of the assembly,
- b. the entire *roof*, *wall*, or *floor* is covered with insulation to the full depth required, or
- c. the effects of reduced insulation are included in calculations using an area-weighted average method and compressed insulation values obtained from Table A9.4.C.

In all cases, air leakage through or around the recessed equipment to the *conditioned space* shall be limited in accordance with Section 5.4.3.

5.8.1.7 Insulation Protection. Exterior insulation shall be covered with a protective material to prevent damage from sunlight, moisture, landscaping operations, equipment maintenance, and wind.

5.8.1.7.1 In *attics* and mechanical rooms, a way to access equipment that prevents damaging or compressing the insulation shall be provided.

5.8.1.7.2 Foundation vents shall not interfere with the insulation.

5.8.1.7.3 Insulation materials in ground contact shall have a water absorption rate no greater than 0.3% when tested in accordance with ASTM C272.

5.8.1.8 Location of Roof Insulation. The *roof* insulation shall not be installed on a suspended ceiling with removable ceiling panels.

5.8.1.9 Extent of Insulation. Insulation shall extend over the full component area to the required rated R-value of insulation, U-factor, C-factor, or F-factor, unless otherwise allowed in Section 5.8.1.

5.8.2 Fenestration and Doors

5.8.2.1 Rating of Fenestration Products. The U-factor, SHGC, and air leakage rate for all manufactured *fenestration* products shall be determined by a laboratory accredited by a nationally recognized accreditation organization, such as the National Fenestration Rating Council.

5.8.2.2 Labeling of Fenestration Products. All manufactured *fenestration* products shall have a permanent nameplate, installed by the *manufacturer*, listing the U-factor, SHGC, and air leakage rate.

Exception: When the *fenestration* product does not have such nameplate, the installer or supplier of such *fenestration* shall provide a signed and dated certification for the installed fenestration listing the U-factor, SHGC, and the air leakage rate.

5.8.2.3 Labeling of Doors. The *U-factor* and the air leakage rate for all manufactured *doors* installed between *conditioned space*, *semi-heated space*, *unconditioned space*, and exterior *space* shall be identified on a permanent nameplate installed on the product by the *manufacturer*.

Exception: When doors do not have such a nameplate, the installer or supplier of any such doors shall provide a signed and dated certification for the installed doors listing the *U-factor* and the air leakage rate.

5.8.2.4 U-factor. U-factors shall be determined in accordance with NFRC 100. U-factors for skylights shall be determined for a slope of 20 degrees above the horizontal.

Exceptions:

- a. U-factors from Section A8.1 shall be an acceptable alternative for determining compliance with the U-factor criteria for *skylights*. Where credit is being taken for a low-emissivity coating, the emissivity of the coating shall be determined in accordance with NFRC 300. Emissivity shall be verified and certified by the *manufacturer*.
- b. U-factors from Section A8.2 shall be an acceptable alternative for determining compliance with the U-factor criteria for *vertical fenestration*.
- c. U-factors from Section A7 shall be an acceptable alternative for determining compliance with the U-factor criteria for *opaque doors*.
- d. For garage doors, ANSI/DASMA105 shall be an acceptable alternative for determining *U-factors*.

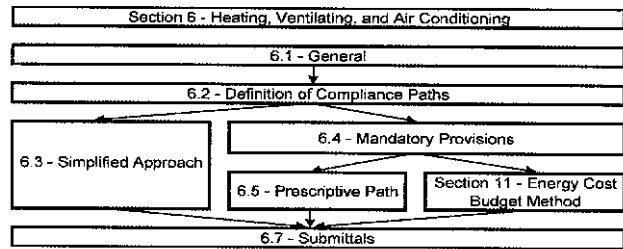
5.8.2.5 Solar Heat Gain Coefficient. *SHGC* for the overall *fenestration area* shall be determined in accordance with NFRC 200.

Exceptions:

- a. *SC* of the center-of-glass multiplied by 0.86 shall be an acceptable alternative for determining compliance with the *SHGC* requirements for the overall *fenestration area*. *SC* shall be determined using a spectral data file determined in accordance with NFRC 300. *SC* shall be verified and certified by the *manufacturer*.
- b. *SHGC* of the center-of-glass shall be an acceptable alternative for determining compliance with the *SHGC* requirements for the overall *fenestration area*. *SHGC* shall be determined using a spectral data file determined in accordance with NFRC 300. *SHGC* shall be verified and certified by the *manufacturer*.
- c. *SHGC* from Section A8.1 shall be an acceptable alternative for determining compliance with the *SHGC* criteria for *skylights*. Where credit is being taken for a low-emissivity coating, the emissivity of the coating shall be determined in accordance with NFRC 300. Emissivity shall be verified and certified by the *manufacturer*.
- d. *SHGC* from Section A8.2 shall be an acceptable alternative for determining compliance with the *SHGC* criteria for *vertical fenestration*.

5.8.2.6 Visible Light Transmittance. *VLT* shall be determined in accordance with NFRC 200. *VLT* shall be verified and certified by the *manufacturer*.

6. HEATING, VENTILATING, AND AIR CONDITIONING



6.1 General

6.1.1 Scope

6.1.1.1 New Buildings. Mechanical equipment and systems serving the heating, cooling, or ventilating needs of new buildings shall comply with the requirements of this section as described in Section 6.2.

6.1.1.2 Additions to Existing Buildings. Mechanical equipment and systems serving the heating, cooling, or ventilating needs of *additions to existing buildings* shall comply with the requirements of this section as described in Section 6.2.

Exception: When HVAC to an *addition* is provided by existing *HVAC systems* and equipment, such existing *systems* and *equipment* shall not be required to comply with this standard. However, any new *systems* or *equipment* installed must comply with specific requirements applicable to those *systems* and *equipment*.

6.1.1.3 Alterations to Heating, Ventilating, and Air Conditioning in Existing Buildings

6.1.1.3.1 New HVAC equipment as a direct replacement of existing HVAC equipment shall comply with the specific minimum *efficiency* requirements applicable to that equipment.

6.1.1.3.2 New cooling systems installed to serve previously uncooled spaces shall comply with this section as described in Section 6.2.

6.1.1.3.3 *Alterations* to existing cooling systems shall not decrease economizer capability unless the system complies with Section 6.5.1.

6.1.1.3.4 New and replacement ductwork shall comply with Sections 6.4.4.1 and 6.4.4.2.

6.1.1.3.5 New and replacement piping shall comply with Section 6.4.4.1.

Exceptions: Compliance shall not be required

- a. for *equipment* that is being modified or repaired but not replaced, provided that such modifications and/or repairs will not result in an increase in the annual energy consumption of the equipment using the same energy type;
- b. where a replacement or *alteration of equipment* requires extensive revisions to other *systems, equip-*