

COP	coefficient of performance	rpm	revolutions per minute
CTI	Cooling Technology Institute	SC	shading coefficient
DDC	direct digital control	SEER	seasonal energy efficiency ratio
DOE	U.S. Department of Energy	SHGC	solar heat gain coefficient
Ec	combustion efficiency	SL	standby loss
EER	energy efficiency ratio	SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
EF	energy factor	T_{db}	dry-bulb temperature
ENVSTD	Envelope System Performance Compliance Program	T_{wb}	wet-bulb temperature
Et	thermal efficiency	UL	Underwriters Laboratories Inc.
F	Fahrenheit	VAV	variable-air-volume
ft	foot	VLT	visible light transmittance
h	hour	W	watt
HC	heat capacity	W/ft ²	watts per square foot
HDD	heating degree-day	Wh	watt-hour
HDD65	heating degree-days base 65°F		
h·ft ² ·°F/Btu	hour per square foot per degree Fahrenheit per British thermal unit		
HID	high-intensity discharge		
hp	horsepower		
HSPF	heating seasonal performance factor		
HVAC	heating, ventilating, and air conditioning		
IESNA	Illuminating Engineering Society of North America		
in.	inch		
I-P	inch-pound		
IPLV	integrated part-load value		
K	kelvin		
kVA	kilovolt-ampere		
kW	kilowatt		
kWh	kilowatt-hour		
lb	pound		
lin	linear		
lin ft	linear foot		
LPD	lighting power density		
MICA	Midwest Insulation Contractors Association		
NAECA	U.S. National Appliance Energy Conservation Act of 1987		
NFPA	National Fire Protection Association		
NFRC	National Fenestration Rating Council		
NPLV	nonstandard part-load value		
PF	projection factor		
PTAC	packaged terminal air conditioner		
PTHP	packaged terminal heat pump		
R	R-value (thermal resistance)		
R_c	thermal resistance of a material or construction from surface to surface		
R_u	total thermal resistance of a material or construction including air film resistances		

4. ADMINISTRATION AND ENFORCEMENT

4.1 General

4.1.1 Scope

4.1.1.1 New Buildings. New buildings shall comply with the standard as described in Section 4.2.

4.1.1.2 Additions to Existing Buildings. An extension or increase in the floor area or height of a building outside of the *existing building* envelope shall be considered *additions to existing buildings* and shall comply with the standard as described in Section 4.2.

4.1.1.3 Alterations of Existing Buildings. *Alterations of existing buildings* shall comply with the standard as described in Section 4.2.

4.1.1.4 Replacement of Portions of Existing Buildings. Portions of a building envelope, heating, ventilating, air-conditioning, service water heating, power, lighting, and other systems and equipment that are being replaced shall be considered as alterations of existing buildings and shall comply with the standard as described in Section 4.2.

4.1.1.5 Changes in Space Conditioning. Whenever *unconditioned* or *semiheated* spaces in a building are converted to *conditioned spaces*, such *conditioned spaces* shall be brought into compliance with all the applicable requirements of this standard that would apply to the building envelope, heating, ventilating, air-conditioning, service water heating, power, lighting, and other systems and equipment of the space as if the building were new.

4.1.2 Administrative Requirements. Administrative requirements relating to permit requirements, enforcement by the *authority having jurisdiction*, locally adopted energy standards, interpretations, claims of exemption, and rights of appeal are specified by the *authority having jurisdiction*.

4.1.3 Alternative Materials, Methods of Construction, or Design. The provisions of this standard are not intended to prevent the use of any material, method of construction, design, equipment, or building system not specifically prescribed herein.

4.1.4 Validity. If any term, part, provision, section, paragraph, subdivision, table, chart, or referenced standard of this standard shall be held unconstitutional, invalid, or ineffective, in whole or in part, such determination shall not be deemed to invalidate any remaining term, part, provision, section, paragraph, subdivision, table, chart, or referenced standard of this standard.

4.1.5 Other Laws. The provisions of this standard shall not be deemed to nullify any provisions of local, state, or federal law. Where there is a conflict between a requirement of this standard and such other law affecting construction of the building, precedence shall be determined by the *authority having jurisdiction*.

4.1.6 Referenced Standards. The standards referenced in this standard and listed in Section 12 shall be considered part of the requirements of this standard to the prescribed extent of such reference. Where differences occur between the provision of this standard and referenced standards, the provisions of this standard shall apply. Informative references are cited to acknowledge sources and are not part of this standard. They are identified in Informative Appendix E.

4.1.7 Normative Appendices. The normative appendices to this standard are considered to be integral parts of the mandatory requirements of this standard, which, for reasons of convenience, are placed apart from all other normative elements.

4.1.8 Informative Appendices. The informative appendices to this standard and informative notes located within this standard contain additional information and are not mandatory or part of this standard.

4.2 Compliance

4.2.1 Compliance Paths

4.2.1.1 New Buildings. New Buildings shall comply with either the provisions of Sections 5, 6, 7, 8, 9, and 10 or Section 11.

4.2.1.2 Additions to Existing Buildings. *Additions to existing buildings* shall comply with either the provisions of Sections 5, 6, 7, 8, 9, and 10 or Section 11.

Exceptions: When an addition to an *existing building* cannot comply by itself, trade-offs will be allowed by modification to one or more of the existing components of the *existing building*. Modeling of the modified components of the *existing building* and addition shall employ the procedures of Section 11; the addition shall not increase the energy consumption of the *existing building* plus the addition beyond the energy that would be consumed by the *existing building* plus the addition if the addition alone did comply.

4.2.1.3 Alterations of Existing Buildings. *Alterations of existing buildings* shall comply with the provisions of Sections 5, 6, 7, 8, 9, and 10, provided, however, that nothing in this standard shall require compliance with any provision of this standard if such compliance will result in the increase of energy consumption of the building.

Exceptions:

- a. A building that has been specifically designated as historically significant by the *adopting authority* or is listed in The National Register of Historic Places or has been determined to be eligible for listing by the US Secretary of the Interior need not comply with these requirements.
- b. Where one or more components of an *existing building* or portions thereof are being replaced, the annual energy consumption of the comprehensive design shall not be greater than the annual energy consumption of a substantially identical design, using the same energy types, in which the applicable requirements of Sections 5, 6, 7, 8, 9, and 10, as provided in Section 4.2.1.3, and such compliance is verified by a *design professional*, by the use of any calculation methods acceptable to the *authority having jurisdiction*.

4.2.2 Compliance Documentation

4.2.2.1 Construction Details. Compliance documents shall show all the pertinent data and features of the building, equipment, and systems in sufficient detail to permit a determination of compliance by the *building official* and to indicate compliance with the requirements of this standard.

4.2.2.2 Supplemental Information. Supplemental information necessary to verify compliance with this standard, such as calculations, worksheets, compliance forms, vendor literature, or other data, shall be made available when required by the *building official*.

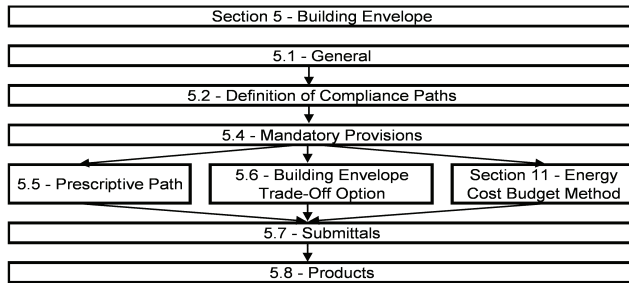
4.2.2.3 Manuals. Operating and maintenance information shall be provided to the building owner. This information shall include, but not be limited to, the information specified in Sections 6.7.2.2 and 8.7.2.

4.2.3 Labeling of Material and Equipment. Materials and equipment shall be labeled in a manner that will allow for a determination of their compliance with the applicable provisions of this standard.

4.2.4 Inspections. All building construction, *additions*, or *alterations* subject to the provisions of this standard shall be subject to inspection by the *building official*, and all such work shall remain accessible and exposed for inspection purposes until approved in accordance with the procedures specified by the *building official*. Items for inspection include at least the following:

- a. wall insulation after the insulation and vapor retarder are in place but before concealment
- b. roof/ceiling insulation after roof/insulation is in place but before concealment
- c. slab/foundation wall after slab/foundation insulation is in place but before concealment
- d. fenestration after all glazing materials are in place
- e. mechanical systems and equipment and insulation after installation but before concealment
- f. electrical equipment and systems after installation but before concealment

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:

- joints around *fenestration* and *door* frames
- 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
- openings at penetrations of utility services through *roofs*, *walls*, and *floors*
- site-built *fenestration* and *doors*
- building assemblies used as ducts or plenums
- joints, seams, and penetrations of vapor retarders
- 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:

- Field-fabricated fenestration and doors.
- 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:

- Building entrances* with revolving *doors*.
- Doors* not intended to be used as a *building entrance*.
- Doors* opening directly from a *dwelling unit*.
- Building entrances* in buildings located in climate zone 1 or 2.
- 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.
- Building entrances* in buildings located in climate zone 5, 6, 7, or 8 that are less than 1000 ft² in area.
- 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:

- 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.
- 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.

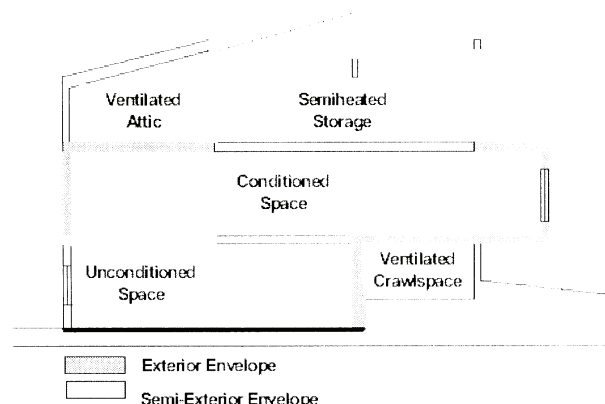


Figure 5.5 Exterior and semi-exterior building envelope.