

**4101:8-11-01 Energy efficiency.**

*[Comment: When a reference is made within this rule to a federal statutory provision, an industry consensus standard, or any other technical publication, the specific date and title of the publication as well as the name and address of the promulgating agency are listed in rule 4101:8-44-01 of the Administrative Code. The application of the referenced standards shall be limited and as prescribed in section 102.5 of rule 4101:8-1-01 of the Administrative Code.]*

**SECTION 1101**  
**GENERAL**

**1101.1 Scope and intent.** This chapter regulates the energy efficiency for the design and construction of buildings regulated by this code. *This chapter shall regulate the design and construction of buildings for the effective use and conservation of energy over the useful life of each building. This chapter is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This chapter is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.*

**1101.2 Compliance.** *Sections 1101.1 through 1101.12 shall apply to all compliance paths.*

**1101.2.1. Compliance paths.** *Compliance shall be demonstrated by meeting the requirements of one of the following options:*

- 1. Sections 1101.14 through 1104 of this chapter, or*
- 2. Section 1105 (the Simulated Performance approach) and the provisions of Sections 1101.14 through 1104 indicated as “Mandatory,” or*
- 3. Section 1106 (the Energy Rating Index (ERI) approach) and the provisions of Sections 1101.14 through 1104 indicated as “Mandatory,” and Section 1103.5.3, or*
- 4. Section 1112 (“The Ohio Home Builder’s Association (OHBA) Alternative Energy Code Option”), or*
- 5. The “International Energy Conservation Code.”*

**1101.3 Compliance materials.** The building official shall be permitted to approve specific computer software, worksheets, compliance manuals and other similar materials that meet the intent of this chapter.

**1101.4 Above code programs.** *Deleted.*

**1101.5 Information on construction documents.** *Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted*

to be submitted when approved by the building official. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include the following as applicable:

1. Insulation materials and their R-values.
2. Fenestration U-factors and solar heat gain coefficients (SHGC).
3. Area-weighted U-factor and solar heat gain coefficient (SHGC) calculations.
4. Mechanical system design criteria.
5. Mechanical and service water heating systems and equipment types, sizes and efficiencies.
6. Equipment and system controls.
7. Duct sealing, duct and pipe insulation and location.
8. Air sealing details.

**1101.5.1 Building thermal envelope depiction.** The building thermal envelope shall be represented on the construction documents.

**1101.6 Defined terms.** The following terms are defined in Chapter 2:

**ABOVE-GRADE WALL.**

**ACCESSIBLE.**

**ADDITION.**

**AIR BARRIER.**

**ALTERATION.**

**AUTOMATIC.**

**BASEMENT WALL.**

**BUILDING.**

**BUILDING SITE.**

**BUILDING THERMAL ENVELOPE.**

**CIRCULATING HOT WATER SYSTEM.**

**CLIMATE ZONE.**

**CONDITIONED FLOOR AREA.**

**CONDITIONED SPACE.**

**CONTINUOUS AIR BARRIER.**

**CONTINUOUS INSULATION (ci).**

**CRAWL SPACE WALL.**

**CURTAIN WALL.**

**DEMAND RECIRCULATION WATER SYSTEM.**

**DUCT.**

**DUCT SYSTEM.**

**DWELLING UNIT.**

**ENERGY ANALYSIS.**

**ENERGY COST.**

**ENERGY SIMULATION TOOL.**

**ERI REFERENCE DESIGN.**

**EXTERIOR WALL.**

**FENESTRATION.**

***Site-built fenestration product.***

**Skylights.**

**Vertical fenestration.**

**HEATED SLAB.**

**HIGH-EFFICACY LAMPS.**

**HISTORIC BUILDING.**

**INFILTRATION.**

**INSULATED SIDING.**

**INSULATING SHEATHING.**

**LABELED.**

**LISTED.**

**LOW-VOLTAGE LIGHTING.**

**MANUAL.**

**OPAQUE DOOR.**

**PROPOSED DESIGN.**

**RATED DESIGN.**

**READILY ACCESSIBLE.**

**REPAIR.**

**REROOFING.**

**RESIDENTIAL BUILDING.**

**ROOF ASSEMBLY.**

**ROOF RECOVER.**

**ROOF REPAIR.**

**ROOF REPLACEMENT.**

**R-VALUE (THERMAL RESISTANCE).**

**SERVICE WATER HEATING.**

**SOLAR HEAT GAIN COEFFICIENT (SHGC).**

**STANDARD REFERENCE DESIGN.**

**SUNROOM.**

**THERMAL ISOLATION.**

**THERMOSTAT.**

**U-FACTOR (THERMAL TRANSMITTANCE).**

**VENTILATION.**

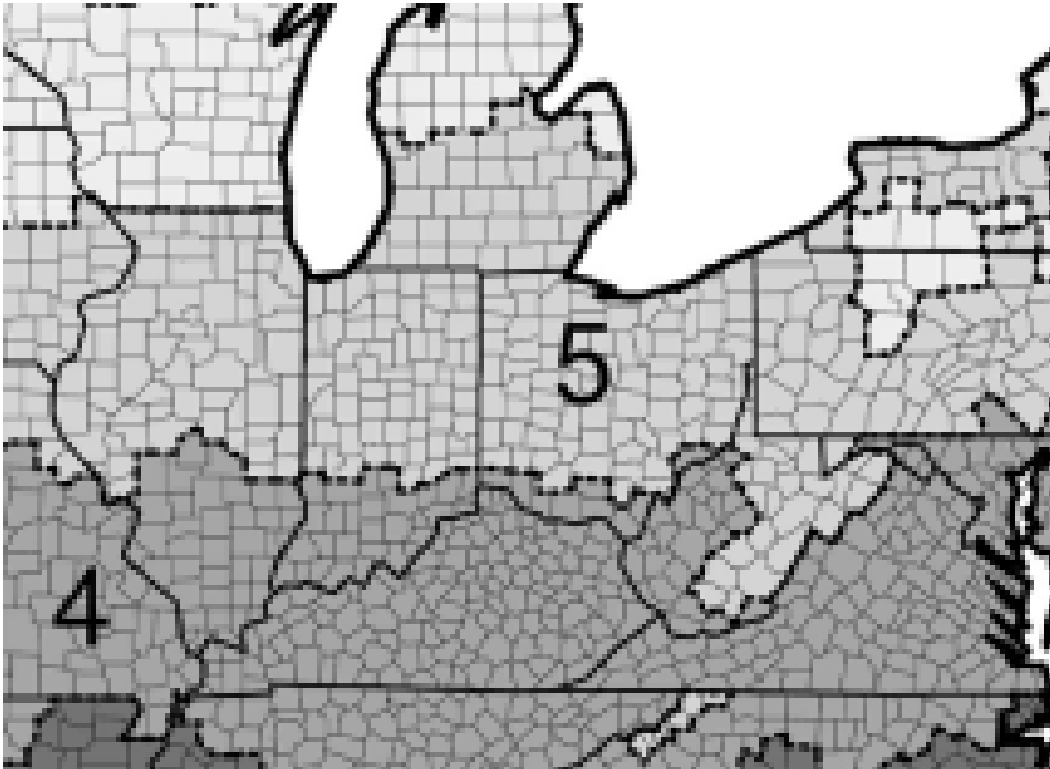
**VENTILATION AIR.**

**VISIBLE TRANSMITTANCE [VT].**

**WHOLE HOUSE MECHANICAL VENTILATION SYSTEM.**

**ZONE.**

**1101.7 Climate zones.** Climate zones from Figure 1101.7 or Table 1101.7 shall be used for determining the applicable requirements in Sections 1101 through 1111.



**FIGURE 1101.7**  
**CLIMATE ZONES**

**TABLE 1101.7**  
**CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID**  
**DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

<b><u>OHIO</u></b>		
<u>4A Adams</u>	<u>4A Hamilton</u>	<u>5A Noble</u>
<u>5A Allen</u>	<u>5A Hancock</u>	<u>5A Ottawa</u>
<u>5A Ashland</u>	<u>5A Hardin</u>	<u>5A Paulding</u>
<u>5A Ashtabula</u>	<u>5A Harrison</u>	<u>5A Perry</u>
<u>5A Athens</u>	<u>5A Henry</u>	<u>5A Pickaway</u>
<u>5A Auglaize</u>	<u>5A Highland</u>	<u>4A Pike</u>
<u>5A Belmont</u>	<u>5A Hocking</u>	<u>5A Portage</u>
<u>4A Brown</u>	<u>5A Holmes</u>	<u>5A Preble</u>
<u>5A Butler</u>	<u>5A Huron</u>	<u>5A Putnam</u>
<u>5A Carroll</u>	<u>5A Jackson</u>	<u>5A Richland</u>
<u>5A Champaign</u>	<u>5A Jefferson</u>	<u>5A Ross</u>
<u>5A Clark</u>	<u>5A Knox</u>	<u>5A Sandusky</u>
<u>4A Clermont</u>	<u>5A Lake</u>	<u>4A Scioto</u>
<u>5A Clinton</u>	<u>4A Lawrence</u>	<u>5A Seneca</u>

<u>5A Columbiana</u>	<u>5A Licking</u>	<u>5A Shelby</u>
<u>5A Coshocton</u>	<u>5A Logan</u>	<u>5A Stark</u>
<u>5A Crawford</u>	<u>5A Lorain</u>	<u>5A Summit</u>
<u>5A Cuyahoga</u>	<u>5A Lucas</u>	<u>5A Trumbull</u>
<u>5A Darke</u>	<u>5A Madison</u>	<u>5A Tuscarawas</u>
<u>5A Defiance</u>	<u>5A Mahoning</u>	<u>5A Union</u>
<u>5A Delaware</u>	<u>5A Marion</u>	<u>5A Van Wert</u>
<u>5A Erie</u>	<u>5A Medina</u>	<u>5A Vinton</u>
<u>5A Fairfield</u>	<u>5A Meigs</u>	<u>5A Warren</u>
<u>5A Fayette</u>	<u>5A Mercer</u>	<u>4A Washington</u>
<u>5A Franklin</u>	<u>5A Miami</u>	<u>5A Wayne</u>
<u>5A Fulton</u>	<u>5A Monroe</u>	<u>5A Williams</u>
<u>4A Gallia</u>	<u>5A Montgomery</u>	<u>5A Wood</u>
<u>5A Geauga</u>	<u>5A Morgan</u>	<u>5A Wyandot</u>
<u>5A Greene</u>	<u>5A Morrow</u>	
<u>5A Guernsey</u>	<u>5A Muskingum</u>	

Key: A – Moist.

**1101.7.1 Warm humid counties.** *Deleted.*

**1101.7.2 International climate zones.** *Deleted.*

**TABLE 1101.7.2(1)**  
**INTERNATIONAL CLIMATE ZONE DEFINITIONS**

*Deleted.*

**TABLE 1101.7.2(2)**  
**INTERNATIONAL CLIMATE ZONE DEFINITIONS**

*Deleted.*

**1101.8 Tropical climate zone.** *Deleted.*

**1101.9 Interior design conditions.** The interior design temperatures used for heating and cooling load calculations shall be a maximum of 72°F (22°C) for heating and minimum of 75°F (24°C) for cooling.

**1101.10 Identification.** Materials, systems and equipment shall be identified in a manner that will allow a determination of compliance with the applicable provisions of this code.

**1101.10.1 Building thermal envelope insulation.** An R-value identification mark shall be applied by the manufacturer to each piece of building thermal envelope insulation that is 12 inches (305 mm) or greater in width. Alternatively, the insulation installers shall provide a certification that indicates the type, manufacturer and R-value of insulation installed in each element of

the building thermal envelope. For blown-in or sprayed fiberglass and cellulose insulation, the initial installed thickness, settled thickness, settled R-value, installed density, coverage area and number of bags installed shall be indicated on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered and the R-value of the installed thickness shall be indicated on the certification. For insulated siding, the R-value shall be on a label on the product's package and shall be indicated on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

**Exception:** For roof insulation installed above the deck, the R-value shall be labeled as required by the material standards specified in Table 906.2.

**1101.10.1.1 Blown-in or sprayed roof and ceiling insulation.** The thickness of blown-in or sprayed fiberglass and cellulose roof and ceiling insulation shall be written in inches (mm) on markers that are installed at not less than one for every 300 square feet (28 m<sup>2</sup>) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers not less than 1 inch (25 mm) in height. Each marker shall face the attic access opening. The thickness and installed R-value of sprayed polyurethane foam insulation shall be indicated on the certification provided by the insulation installer.

**1101.10.2 Insulation mark installation.** Insulating materials shall be installed such that the manufacturer's R-value mark is readily observable at inspection.

**1101.10.3 Fenestration product rating.** U-factors of fenestration products such as windows, doors and skylights shall be determined in accordance with NFRC 100.

**Exception:** Where required, garage door U-factors shall be determined in accordance with either NFRC 100 or ANSI/DASMA 105.

U-factors shall be determined by an accredited, independent laboratory, and labeled and certified by the manufacturer.

Products lacking such a labeled U-factor shall be assigned a default U-factor from Table 1101.10.3(1) or 1101.10.3(2). The solar heat gain coefficient (SHGC) and visible transmittance (VT) of glazed fenestration products such as windows, glazed doors and skylights shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled SHGC or VT shall be assigned a default SHGC or VT from Table 1101.10.3(3).

**TABLE 1101.10.3(1)**

**DEFAULT GLAZED WINDOW,  
GLASS DOOR AND SKYLIGHT U-FACTORS**

<u>FRAME TYPE</u>	<u>WINDOW AND GLASS DOOR</u>		<u>SKYLIGHT</u>	
	<u>Single pane</u>	<u>Double pane</u>	<u>Single</u>	<u>Double</u>
<u>Metal</u>	<u>1.20</u>	<u>0.80</u>	<u>2.00</u>	<u>1.30</u>
<u>Metal with Thermal Break</u>	<u>1.10</u>	<u>0.65</u>	<u>1.90</u>	<u>1.10</u>
<u>Nonmetal or Metal Clad</u>	<u>0.95</u>	<u>0.55</u>	<u>1.75</u>	<u>1.05</u>
<u>Glazed Block</u>	<u>0.60</u>			

**TABLE 1101.10.3(2)  
DEFAULT OPAQUE DOOR U-FACTORS**

<u>DOOR TYPE</u>	<u>OPAQUE U-FACTOR</u>
<u>Uninsulated Metal</u>	<u>1.20</u>
<u>Insulated Metal</u>	<u>0.60</u>
<u>Wood</u>	<u>0.50</u>
<u>Insulated, nonmetal edge, not exceeding 45% glazing, any glazing double pane</u>	<u>0.35</u>

**TABLE 1101.10.3(3)  
DEFAULT GLAZED FENESTRATION SHGC AND VT**

	<u>SINGLE GLAZED</u>		<u>DOUBLE GLAZED</u>		<u>GLAZED BLOCK</u>
	<u>Clear</u>	<u>Tinted</u>	<u>Clear</u>	<u>Tinted</u>	
<u>SHGC</u>	<u>0.8</u>	<u>0.7</u>	<u>0.7</u>	<u>0.6</u>	<u>0.6</u>
<u>VT</u>	<u>0.6</u>	<u>0.3</u>	<u>0.6</u>	<u>0.3</u>	<u>0.6</u>

**1101.10.4 Insulation product rating.** The thermal resistance, R-value, of insulation shall be determined in accordance with Part 460 of US-FTC CFR Title 16 in units of  $h \cdot ft^2 \cdot ^\circ F/Btu$  at a mean temperature of 75°F (24°C).

**1101.10.4.1 Insulated siding.** The thermal resistance, R-value, of insulated siding shall be determined in accordance with ASTM C1363. Installation for testing shall be in accordance with the manufacturer's instructions.

**1101.11 Installation.** Materials, systems and equipment shall be installed in accordance with the manufacturer's instructions and this code.

**1101.11.1 Protection of exposed foundation insulation.** Insulation applied to the exterior of basement walls, crawl space walls and the perimeter of slab-on-grade floors shall have a rigid, opaque and weather-resistant protective covering to prevent the degradation of the insulation's thermal performance. The protective covering shall cover the exposed exterior insulation and extend not less than 6 inches (153 mm) below grade.

**1101.12 Maintenance information.** Maintenance instructions shall be furnished for equipment and systems that require preventive maintenance. Required regular maintenance actions shall be clearly stated and incorporated on a readily accessible label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.

**1101.13 Compliance.** *Deleted. See Section 1101.2.*

**1101.13.1 Tropical zone.** *Deleted.*

**1101.14 Certificate (Mandatory).** A permanent certificate shall be completed by the owner or the owner's representative and posted on a wall in the space where the furnace is located, a utility room or an approved location inside the building. Where located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. The certificate shall indicate the predominant R-values of insulation installed in or on ceilings, roofs, walls, foundation components such as slabs, basement walls, crawl space walls and floors, and ducts outside conditioned spaces; U-factors of fenestration and the solar heat gain coefficient (SHGC) of fenestration, and the results from any required duct system and building envelope air leakage testing performed on the building. Where there is more than one value for each component, the certificate shall indicate the value covering the largest area. The certificate shall indicate the types and efficiencies of heating, cooling and service water heating equipment. Where a gas-fired unvented room heater, electric furnace, or baseboard electric heater is installed in the residence, the certificate shall indicate "gas-fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate. An efficiency shall not be indicated for gas-fired unvented room heaters, electric furnaces and electric baseboard heaters.

## **SECTION 1102** **BUILDING THERMAL ENVELOPE**

**1102.1 General (Prescriptive).** The building thermal envelope shall comply with the requirements of Sections 1102.1.1 through 1102.1.5.

**Exceptions:**

1. The following low-energy buildings, or portions thereof, separated from the remainder of the building by building thermal envelope assemblies complying with this section shall be exempt from the building thermal envelope provisions of Section 1102.
  - 1.1. Those with a peak design rate of energy usage less than 3.4 Btu/h • ft<sup>2</sup> (10.7 W/m<sup>2</sup>) or 1.0 watt/ft<sup>2</sup> of floor area for space-conditioning purposes.
  - 1.2. Those that do not contain conditioned space.



2. Log homes designed in accordance with ICC 400.
3. Existing buildings comply with Section 1107.

**1102.1.1 Vapor retarder.** Wall assemblies in the building thermal envelope shall comply with the vapor retarder requirements of Section 702.7.

**1102.1.2 Insulation and fenestration criteria.** The building thermal envelope shall meet the requirements of Table 1102.1.2 based on the climate zone specified in Section 1101.7.

**TABLE 1102.1.2**  
**INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT<sup>a</sup>**

<u>CLIMATE ZONE</u>	<u>FENESTRATION U-FACTOR<sup>b</sup></u>	<u>SKYLIGHT<sup>b</sup> U-FACTOR</u>	<u>GLAZED FENESTRATION SHGC<sup>b, c</sup></u>	<u>CEILING R-VALUE</u>	<u>WOOD FRAME WALL R-VALUE</u>	<u>MASS WALL R-VALUE<sup>i</sup></u>	<u>FLOOR R-VALUE</u>	<u>BASEMENT<sup>c</sup> WALL R-VALUE</u>	<u>SLAB<sup>d</sup> R-VALUE &amp; DEPTH</u>	<u>CRAWL SPACE<sup>e</sup> WALL R-VALUE</u>
4 except Marine	0.32	0.55	0.40	49	20 or 13 + 5 <sup>h</sup>	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.30	0.55	NR	49	20 or 13 + 5 <sup>h</sup>	13/17	30 <sup>e</sup>	10/13	10, 2 ft	10/13

For SI: 1 foot = 304.8 mm.

NR = Not Required.

- a. R-values are minimums. U-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed R-value of the insulation shall be not less than the R-value specified in the table.
- b. The fenestration U-factor column excludes skylights. The SHGC column applies to all glazed fenestration.  
**Exception: Deleted.**
- c. "10/13" means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation on the interior of the basement wall.
- d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation R-value for slabs, as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.
- e. There are no SHGC requirements in the Marine Zone.
- f. Basement wall insulation shall not be required in warm-humid locations as defined by Figure 1101.10 and Table 1101.10.
- g. Alternatively, insulation sufficient to fill the framing cavity providing not less than an R-value of R-19.
- h. The first value is cavity insulation, the second value is continuous insulation. Therefore, as an example, "13+5" means R-13 cavity insulation plus R-5 continuous insulation.
- i. Mass walls shall be in accordance with Section 1102.2.5. The second R-value applies where more than half of the insulation is on the interior of the mass wall.

**1102.1.3 R-value computation.** Insulation material used in layers, such as framing cavity insulation or continuous insulation, shall be summed to compute the corresponding component R-value. The manufacturer's settled R-value shall be used for blown-in insulation. Computed R-values shall not include an R-value for other building materials or air films. Where insulated siding is used for the purpose of complying with the continuous insulation requirements of Table 1102.1.2, the manufacturer's labeled R-value for insulated siding shall be reduced by R-0.6.

**1102.1.4 U-factor alternative.** An assembly with a U-factor equal to or less than that specified in Table 1102.1.4 shall be permitted as an alternative to the R-value in Table 1102.1.2.

**TABLE 1102.1.4  
EQUIVALENT U-FACTORS<sup>a</sup>**

<u>CLIMATE ZONE</u>	<u>FENESTRATION U-FACTOR</u>	<u>SKYLIGHT U-FACTOR</u>	<u>CEILING U-FACTOR</u>	<u>FRAME WALL U-FACTOR</u>	<u>MASS WALL U-FACTOR<sup>b</sup></u>	<u>FLOOR U-FACTOR</u>	<u>BASEMENT WALL U-FACTOR</u>	<u>CRAWL SPACE WALL U-FACTOR</u>
<u>4 except Marine</u>	<u>0.32</u>	<u>0.55</u>	<u>0.026</u>	<u>0.060</u>	<u>0.098</u>	<u>0.047</u>	<u>0.059</u>	<u>0.065</u>
<u>5 and Marine 4</u>	<u>0.30</u>	<u>0.55</u>	<u>0.026</u>	<u>0.060</u>	<u>0.082</u>	<u>0.033</u>	<u>0.059</u>	<u>0.065</u>

- Nonfenestration U-factors shall be obtained from measurement, calculation or an approved source.
- Mass walls shall be in accordance with Section 1102.2.5. Where more than half the insulation is on the interior, the mass wall U-factors shall not exceed 0.087 in Climate Zone 4, and 0.065 in Climate Zone 5.
- In warm-humid locations as defined by Figure 1101.7 and Table 1101.7, the basement wall U-factor shall not exceed 0.360.

**1102.1.5 Total UA alternative.** Where the total building thermal envelope UA, the sum of U-factor times assembly area, is less than or equal to the Total UA resulting from multiplying the U-factors in Table 1102.1.4 by the same assembly area as in the proposed building, the building shall be considered to be in compliance with Table 1102.1.2. The UA calculation shall be performed using a method consistent with the ASHRAE Handbook of Fundamentals and shall include the thermal bridging effects of framing materials. In addition to UA compliance, SHGC requirements shall be met.

**1102.2 Specific insulation requirements (Prescriptive).** In addition to the requirements of Section 1102.1, insulation shall meet the specific requirements of Sections 1102.2.1 through 1102.2.13.

**1102.2.1 Ceilings with attic spaces.** Where Section 1102.1.2 requires R-38 insulation in the ceiling, installing R-30 insulation over 100 percent of the ceiling area requiring insulation shall satisfy the requirement for R-38 insulation wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Where Section 1102.1.2 requires R-49 insulation in the ceiling, installing R-38 insulation over 100 percent of the ceiling area requiring insulation shall satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the U-factor alternative approach in Section 1102.1.4 and the Total UA alternative in Section 1102.1.5.

**1102.2.2 Ceilings without attic spaces.** Where Section 1102.1.2 requires insulation R-values greater than R-30 in the ceiling and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation R-value for such roof/ceiling assemblies shall be R-30. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed. This reduction of insulation from the requirements of Section 1102.1.2 shall be limited to 500 square feet (46 m<sup>2</sup>) or 20 percent of the total insulated ceiling area, whichever is less. This reduction shall not apply to the U-factor alternative approach in Section 1102.1.4 and the Total UA alternative in Section 1102.1.5.

**1102.2.3 Eave baffle.** For air-permeable insulations in vented attics, a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain an opening equal or greater than the size of the vent. The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material.

**1102.2.4 Access hatches and doors.** Access doors from conditioned spaces to unconditioned spaces such as attics and crawl spaces shall be weatherstripped and insulated to a level equivalent to the insulation on the surrounding surfaces. Access that prevents damaging or compressing the insulation shall be provided to all equipment. Where loose-fill insulation is installed, a wood-framed or equivalent baffle or retainer shall be installed to prevent the loose-fill insulation from spilling into the living space when the attic access is opened. The baffle or retainer shall provide a permanent means of maintaining the installed R-value of the loose-fill insulation.

**Exception:** Vertical doors providing access from conditioned spaces to unconditioned spaces that comply with the fenestration requirements of Table 1102.1.2 based on the applicable climate zone specified in Section 1101.7.

**1102.2.5 Mass walls.** Mass walls where used as a component of the building thermal envelope shall be one of the following:

1. Above-ground walls of concrete block, concrete, insulated concrete form, masonry cavity, brick but not brick veneer, adobe, compressed earth block, rammed earth, solid timber or solid logs.
2. Any wall having a heat capacity greater than or equal to 6 Btu/ft<sup>2</sup> • °F (123 kJ/m<sup>2</sup> • K).

**1102.2.6 Steel-frame ceilings, walls, and floors.** Steel-frame ceilings, walls, and floors shall comply with the insulation requirements of Table 1102.2.6 or the U-factor requirements of Table 1102.1.4. The calculation of the U-factor

for a steel-frame envelope assembly shall use a series-parallel path calculation method.

**TABLE 1102.2.6**  
**STEEL-FRAME CEILING, WALL AND FLOOR INSULATION**  
**R-VALUES**

<u>WOOD FRAME R-VALUE REQUIREMENT</u>	<u>COLD-FORMED STEEL-FRAME EQUIVALENT R-VALUE<sup>a</sup></u>
<b>Steel Truss Ceilings<sup>b</sup></b>	
<u>R-30</u>	<u>R-38 or R-30 + 3 or R-26 + 5</u>
<u>R-38</u>	<u>R-49 or R-38 + 3</u>
<u>R-49</u>	<u>R-38 + 5</u>
<b>Steel Joist Ceilings<sup>b</sup></b>	
<u>R-30</u>	<u>R-38 in 2 x 4 or 2 x 6 or 2 x 8 R-49 in any framing</u>
<u>R-38</u>	<u>R-49 in 2 x 4 or 2 x 6 or 2 x 8 or 2 x 10</u>
<b>Steel-Framed Wall, 16 inches on center</b>	
<u>R-13</u>	<u>R-13 + 4.2 or R-21 + 2.8 or R-0 + 9.3 or R-15 + 3.8 or R-21 + 3.1</u>
<u>R-13 + 3</u>	<u>R-0 + 11.2 or R-13 + 6.1 or R-15 + 5.7 or R-19 + 5.0 or R-21 + 4.7</u>
<u>R-20</u>	<u>R-0 + 14.0 or R-13 + 8.9 or R-15 + 8.5 or R-19 + 7.8 or R-19 + 6.2 or R-21 + 7.5</u>
<u>R-20 + 5</u>	<u>R-13 + 12.7 or R-15 + 12.3 or R-19 + 11.6 or R-21 + 11.3 or R-25 + 10.9</u>
<u>R-21</u>	<u>R-0 + 14.6 or R-13 + 9.5 or R-15 + 9.1 or R-19 + 8.4 or R-21 + 8.1 or R-25 + 7.7</u>
<b>Steel-Framed Wall, 24 inches on center</b>	
<u>R-13</u>	<u>R-0 + 9.3 or R-13 + 3.0 or R-15 + 2.4</u>
<u>R-13 + 3</u>	<u>R-0 + 11.2 or R-13 + 4.9 or R-15 + 4.3 or R-19 + 3.5 or R-21 + 3.1</u>
<u>R-20</u>	<u>R-0 + 14.0 or R-13 + 7.7 or R-15 + 7.1 or R-19 + 6.3 or R-21 + 5.9</u>
<u>R-20 + 5</u>	<u>R-13 + 11.5 or R-15 + 10.9 or R-19 + 10.1 or R-21 + 9.7 or R-25 + 9.1</u>
<u>R-21</u>	<u>R-0 + 14.6 or R-13 + 8.3 or R-15 + 7.7 or R-19 + 6.9 or R-21 + 6.5 or R-25 + 5.9</u>
<b>Steel Joist Floor</b>	
<u>R-13</u>	<u>R-19 in 2 x 6, or R-19 + 6 in 2 x 8 or 2 x 10</u>
<u>R-19</u>	<u>R-19 + 6 in 2 x 6, or R-19 + 12 in 2 x 8 or 2 x 10</u>

- a. The first value is cavity insulation R-value, the second value is continuous insulation R-value. Therefore, for example, "R-30+3" means R-30 cavity insulation plus R-3 continuous insulation.
- b. Insulation exceeding the height of the framing shall cover the framing.

**1102.2.7 Walls with partial structural sheathing.** Where Section 1102.1.2 requires continuous insulation on exterior walls and structural sheathing covers 40 percent or less of the gross area of all exterior walls, the required continuous insulation R-value shall be permitted to be reduced by an amount necessary, but not more than R-3, to result in a consistent total sheathing thickness on areas of the walls covered by structural sheathing. This reduction shall not apply to the

U-factor alternative in Section 1102.1.4 and the Total UA alternative in Section 1102.1.5.

**1102.2.8 Floors.** Floor framing-cavity insulation shall be installed to maintain permanent contact with the underside of the subfloor decking.

**Exception:** As an alternative, the floor framing-cavity insulation shall be in contact with the topside of sheathing or continuous insulation installed on the bottom side of floor framing where combined with insulation that meets or exceeds the minimum wood frame wall R-value in Table 1102.1.2 and that extends from the bottom to the top of all perimeter floor framing members.

**1102.2.9 Basement walls.** Walls associated with conditioned basements shall be insulated from the top of the basement wall down to 10 feet (3048 mm) below grade or to the basement floor, whichever is less. Walls associated with unconditioned basements shall comply with this requirement except where the floor overhead is insulated in accordance with Sections 1102.1.2 and 1102.2.8.

**1102.2.10 Slab-on-grade floors.** Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table 1102.1.2. The insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall. Insulation located below grade shall be extended the distance provided in Table 1102.1.2 by any combination of vertical insulation, insulation extending under the slab or insulation extending out from the building. Insulation extending away from the building shall be protected by pavement or by not less than 10 inches (254 mm) of soil. The top edge of the insulation installed between the exterior wall and the edge of the interior slab shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the exterior wall. Slab-edge insulation is not required in jurisdictions designated by the building official as having a very heavy termite infestation.

**1102.2.11 Crawl space walls.** As an alternative to insulating floors over crawl spaces, crawl space walls shall be insulated provided that the crawl space is not vented to the outdoors. Crawl space wall insulation shall be permanently fastened to the wall and shall extend downward from the floor to the finished grade elevation and then vertically or horizontally for not less than an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with this code. Joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (153 mm) up the stem walls and shall be attached to the stem walls.

**1102.2.12 Masonry veneer.** Insulation shall not be required on the horizontal portion of a foundation that supports a masonry veneer.

**1102.2.13 Sunroom insulation.** Sunrooms enclosing conditioned space shall meet the insulation requirements of this code.

**Exception:** For sunrooms with thermal isolation, and enclosing conditioned space, the following exceptions to the insulation requirements of this code shall apply:

- 1.** The minimum ceiling insulation R-values shall be R-19 in Climate Zones 1 through 4 and R-24 in Climate Zones 5 through 8.
- 2.** The minimum wall insulation R-value shall be R-13 in all climate zones. Walls separating a sunroom with a thermal isolation from conditioned space shall comply with the building thermal envelope requirements of this code.

**1102.3 Fenestration (Prescriptive).** In addition to the requirements of Section 1102, fenestration shall comply with Sections 1102.3.1 through 1102.3.5.

**1102.3.1 U-factor.** An area-weighted average of fenestration products shall be permitted to satisfy the U-factor requirements.

**1102.3.2 Glazed fenestration SHGC.** An area-weighted average of fenestration products more than 50-percent glazed shall be permitted to satisfy the SHGC requirements.

Dynamic glazing shall be permitted to satisfy the SHGC requirements of Table 1102.1.2 provided that the ratio of the higher to lower labeled SHGC is greater than or equal to 2.4, and the dynamic glazing is automatically controlled to modulate the amount of solar gain into the space in multiple steps. Dynamic glazing shall be considered separately from other fenestration, and area-weighted averaging with other fenestration that is not dynamic glazing shall be prohibited.

**Exception:** Dynamic glazing shall not be required to comply with this section where both the lower and higher labeled SHGC comply with the requirements of Table 1102.1.2.

**1102.3.3 Glazed fenestration exemption.** Not greater than 15 square feet (1.4 m<sup>2</sup>) of glazed fenestration per dwelling unit shall be exempt from the U-factor and SHGC requirements in Section 1102.1.2. This exemption shall not apply to the U-factor alternative in Section 1102.1.4 and the Total UA alternative in Section 1102.1.5.

**1102.3.4 Opaque door exemption.** One side-hinged opaque door assembly not greater than 24 square feet (2.22 m<sup>2</sup>) in area shall be exempt from the U-

factor requirement in Section 1102.1.2. This exemption shall not apply to the U-factor alternative in Section 1102.1.4 and the Total UA alternative in Section 1102.1.5.

**1102.3.5 Sunroom fenestration.** Sunrooms enclosing conditioned space shall comply with the fenestration requirements of this code.

New fenestration separating the sunroom with thermal isolation from conditioned space shall comply with the building thermal envelope requirements of this code.

**Exception:** In Climate Zones 2 through 8, for sunrooms with thermal isolation and enclosing conditioned space, the fenestration U-factor shall not exceed 0.45 and the skylight U-factor shall not exceed 0.70.

**1102.4 Air leakage (Mandatory).** The building thermal envelope shall be constructed to limit air leakage in accordance with the requirements of Sections 1102.4.1 through 1102.4.5.

**1102.4.1 Building thermal envelope.** The building thermal envelope shall comply with Sections 1102.4.1.1 and 1102.4.1.2. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.

**1102.4.1.1 Installation.** The components of the building thermal envelope as indicated in Table 1102.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria indicated in Table 1102.4.1.1, as applicable to the method of construction.

**1102.4.1.2 Testing.** The building or dwelling unit shall be tested and verified as having an air leakage rate of not *more than five* air changes per hour. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). A written report of the results of the test shall be signed by the party conducting the test and provided to the building official. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.

4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

**Exception:** *Existing buildings complying with Section 1107.*

**1102.4.2 Fireplaces.** New wood-burning fireplaces shall have tight-fitting flue dampers or doors, and outdoor combustion air. Where using tight-fitting doors on factory-built fireplaces listed and labeled in accordance with UL 127, the doors shall be tested and listed for the fireplace.

**1102.4.3 Fenestration air leakage.** Windows, skylights and sliding glass doors shall have an air infiltration rate of not greater than 0.3 cfm per square foot (1.5 L/s/m<sup>2</sup>), and for swinging doors not greater than 0.5 cfm per square foot (2.6 L/s/m<sup>2</sup>), when tested in accordance with NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 by an *approved agency* and listed and labeled by the manufacturer.

**Exception:** *Site-built fenestration products.*

**TABLE 1102.4.1.1**  
**AIR BARRIER AND INSULATION INSTALLATION<sup>a</sup>**

<b>COMPONENT</b>	<b>AIR BARRIER CRITERIA</b>	<b>INSULATION INSTALLATION CRITERIA</b>
<u>General requirements</u>	<u>A continuous air barrier shall be installed in the building envelope.</u> <u>The exterior thermal envelope contains a continuous air barrier.</u> <u>Breaks or joints in the air barrier shall be sealed.</u>	<u>Air-permeable insulation shall not be used as a sealing material.</u>
<u>Ceiling/attic</u>	<u>The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier sealed.</u> <u>Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.</u>	<u>The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.</u>
<u>Walls</u>	<u>The junction of the foundation and sill plate shall be sealed.</u> <u>The junction of the top plate and the top of exterior walls shall be sealed.</u> <u>Knee walls shall be sealed.</u>	<u>Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of not less than R-3 per inch.</u> <u>Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and in continuous alignment with the air barrier.</u>
<u>Windows, skylights and doors</u>	<u>The space between framing and skylights, and the jambs of windows and doors, shall be sealed.</u>	=
<u>Rim joists</u>	<u>Rim joists shall include the air barrier.</u>	<u>Rim joists shall be insulated.</u>



<u>COMPONENT</u>	<u>AIR BARRIER CRITERIA</u>	<u>INSULATION INSTALLATION CRITERIA</u>
<u>Floors including cantilevered floors and floors above garages.</u>	<u>The air barrier shall be installed at any exposed edge of insulation.</u>	<u>Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing or continuous insulation installed on the underside of floor framing; and extending from the bottom to the top of all perimeter floor framing members.</u>
<u>Crawl space walls</u>	<u>Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.</u>	<u>Crawl space insulation, where provided instead of floor insulation, shall be permanently attached to the walls.</u>
<u>Shafts, penetrations</u>	<u>Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.</u>	=
<u>Narrow cavities</u>	=	<u>Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space</u> <u>Narrow cavities less than 1/2" may be left void.</u>
<u>Garage separation</u>	<u>Air sealing shall be provided between the garage and conditioned spaces.</u>	=
<u>Recessed lighting</u>	<u>Recessed light fixtures installed in the building thermal envelope shall be sealed to the finished surface.</u>	<u>Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.</u>
<u>Plumbing and wiring</u>	=	<u>In exterior walls, batt insulation shall be cut neatly to fit around wiring and plumbing or insulation that on installation, readily conforms to available space, shall extend behind piping and wiring.</u>
<u>Shower/tub on exterior wall</u>	<u>The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.</u>	<u>Exterior walls adjacent to showers and tubs shall be insulated.</u>
<u>Electrical/phone box on exterior walls</u>	<u>The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.</u>	=
<u>HVAC register boots</u>	<u>HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.</u>	=
<u>Concealed sprinklers</u>	<u>Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.</u>	=

- a. Inspection of log walls shall be in accordance with the provisions of ICC 400.

**1102.4.4 Rooms containing fuel-burning appliances.** In Climate Zones 3 through 8, where open combustion air ducts provide combustion air to open combustion fuel-burning appliances, the appliances and combustion air opening shall be located outside the building thermal envelope or enclosed in a room

that is isolated from inside the thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table 1102.1.2, where the walls, floors and ceilings shall meet a minimum of the basement wall R-value requirement. The door into the room shall be fully gasketed and any water lines and ducts in the room insulated in accordance with Section 1103. The combustion air duct shall be insulated where it passes through conditioned space to an R-value of not less than R-8.

**Exceptions:**

1. Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.
2. Fireplaces and stoves complying with Sections 1102.4.2 and 1006.

**1102.4.5 Recessed lighting.** Recessed luminaires installed in the building thermal envelope shall be sealed to limit air leakage between conditioned and unconditioned spaces. Recessed luminaires shall be IC-rated and labeled as having an air leakage rate of not greater than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E283 at a pressure differential of 1.57 psf (75 Pa). Recessed luminaires shall be sealed with a gasket or caulked between the housing and the interior wall or ceiling covering.

**1102.5 Maximum fenestration U-factor and SHGC (Mandatory).** The area-weighted average maximum fenestration U-factor permitted using tradeoffs from Section 1102.1.5 or 1105 shall be 0.48 in Climate Zones 4 and 5 for vertical fenestration, and 0.75 in Climate Zones 4 through 8 for skylights.

## **SECTION 1103** **SYSTEMS**

**1103.1 Controls (Mandatory).** Not less than one thermostat shall be provided for each separate heating and cooling system.

**1103.1.1 Programmable thermostat.** The thermostat controlling the primary heating or cooling system of the dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures of not less than 55°F (13°C) to not greater than 85°F (29°C). The thermostat shall be programmed initially by the manufacturer with a heating temperature setpoint of not greater than 70°F (21°C) and a cooling temperature setpoint of not less than 78°F (26°C).

**1103.1.2 Heat pump supplementary heat (Mandatory).** Heat pumps having supplementary electric-resistance heat shall have controls that, except during

defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

**1103.2 Hot water boiler outdoor temperature setback.** Hot water boilers that supply heat to the building through one- or two-pipe heating systems shall have an outdoor setback control that decreases the boiler water temperature based on the outdoor temperature.

**1103.3 Ducts.** Ducts and air handlers shall be installed in accordance with Sections 1103.3.1 through 1103.3.8.

**1103.3.1 Insulation (Prescriptive).** Supply and return ducts in attics shall be insulated to an R-value of not less than R-8 for ducts 3 inches (76 mm) in diameter and larger and not less than R-6 for ducts smaller than 3 inches (76 mm) in diameter. Supply and return ducts in other portions of the building shall be insulated to not less than R-6 for ducts 3 inches (76 mm) in diameter and to not less than R-4.2 for ducts smaller than 3 inches (76.2 mm) in diameter.

**Exception:** Ducts located completely inside *conditioned space*.

**1103.3.2 Sealing (Mandatory).** Ducts, air handlers and filter boxes shall be sealed. Joints and seams shall comply with Section 1601.4.1.

**1103.3.2.1 Sealed air handler.** Air handlers shall have a manufacturer's designation for an air leakage of not greater than 2 percent of the design airflow rate when tested in accordance with ASHRAE 193.

**1103.3.3 Duct testing (Mandatory).** Ducts shall be pressure tested to determine air leakage by one of the following methods:

1. Rough-in test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure if installed at the time of the test. Registers shall be taped or otherwise sealed during the test.
2. Postconstruction test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. Registers shall be taped or otherwise sealed during the test.

**Exceptions:**

1. A duct air-leakage test shall not be required where the ducts and air handlers are located entirely *inside conditioned space*.
2. A duct air-leakage test shall not be required for ducts serving heat or energy recovery ventilators that are not integrated with ducts serving heating or cooling systems.

A written report of the results of the test shall be signed by the party conducting the test and provided to the building official.

**1103.3.4 Duct leakage (Prescriptive).** The total leakage of the ducts, where measured in accordance with Section 1103.3.3, shall be as follows:

1. Rough-in test: The total leakage shall be less than or equal to 4 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m<sup>2</sup>) of conditioned floor area where the air handler is installed at the time of the test. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to 3 cubic feet per minute (85 L/min) per 100 square feet (9.29 m<sup>2</sup>) of conditioned floor area.
2. Postconstruction test: Total leakage shall be less than or equal to 4 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m<sup>2</sup>) of conditioned floor area.

**1103.3.5 Building cavities (Mandatory).** Building framing cavities shall not be used as *supply* ducts.

**1103.3.6 Ducts buried within ceiling insulation.** Where supply and return air ducts are partially or completely buried in ceiling insulation, such ducts shall comply with all of the following:

1. The supply and return duct shall have an insulation R-value not less than R-8.
2. At all points along each duct, the sum of the ceiling insulation R-values against and above the top of the duct, and against and below the bottom of the duct shall be not less than R-19, excluding the R-value of the duct insulation.
3. Deleted.

**1103.3.6.1 Effective R-value of deeply buried ducts.** Where using a simulated energy performance analysis, sections of ducts that are installed in accordance with Section 1103.3.6, located directly on, or within 5.5 inches (140 mm) of the ceiling, surrounded with blown-in attic insulation having an R-value of R-30 or greater and located such that the top of the duct is not less than 3.5 inches (89 mm) below the top of the insulation, shall be considered as having an effective duct insulation R-value of R-25.

**1103.3.7 Ducts located in conditioned space.** For ducts to be considered as inside a conditioned space, such ducts shall comply with either of the following:

1. The duct system is located completely within the continuous air barrier and inside conditioned space.
2. The ducts are buried within ceiling insulation in accordance with Section 1103.3.6 and all of the following conditions exist:

- 2.1. The air handler is located completely within the continuous air barrier and *inside conditioned space*.
- 2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the building thermal envelope in accordance with Section 1103.3.4, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m<sup>2</sup>) of conditioned floor area served by the duct system.
- 2.3. The ceiling insulation R-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation R-value, less the R-value of the insulation on the duct.

**1103.4 Mechanical system piping insulation (Mandatory).** Mechanical system piping capable of carrying fluids greater than 105°F (41°C) or less than 55°F (13°C) shall be insulated to an R-value of not less than R-3.

**1103.4.1 Protection of piping insulation.** Piping insulation exposed to weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance and wind. The protection shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall be prohibited.

**1103.5 Service hot water systems.** Energy conservation measures for service hot water systems shall be in accordance with Sections 1103.5.1 through 1103.5.4.

**1103.5.1 Heated water circulation and temperature maintenance systems (Mandatory).** Heated water circulation systems shall be in accordance with Section 1103.5.1.1. Heat trace temperature maintenance systems shall be in accordance with Section 1103.5.1.2. Automatic controls, temperature sensors and pumps shall be accessible. Manual controls shall be readily accessible.

**1103.5.1.1 Circulation systems.** Heated water circulation systems shall be provided with a circulation pump. The system return pipe shall be a dedicated return pipe or a cold water supply pipe. Gravity and thermosyphon circulation systems shall be prohibited. Controls for circulating hot water system pumps shall start the pump based on the identification of a demand for hot water within the occupancy. The controls shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is no demand for hot water.

**1103.5.1.2 Heat trace systems.** Electric heat trace systems shall comply with IEEE 515.1 or UL 515. Controls for such systems shall automatically adjust the energy input to the heat tracing to maintain the desired water

temperature in the piping in accordance with the times when heated water is used in the occupancy.

**1103.5.2 Demand recirculation water systems.** Demand recirculation water systems shall have controls that comply with both of the following:

1. The controls shall start the pump upon receiving a signal from the action of a user of a fixture or appliance, sensing the presence of a user of a fixture or sensing the flow of hot or tempered water to a fixture fitting or appliance.
2. The controls shall limit the temperature of the water entering the cold water piping to not greater than 104°F (40°C).

**1103.5.3 Hot water pipe insulation (Prescriptive).** Insulation for hot water piping with a thermal resistance, R-value, of not less than R-3 shall be applied to the following:

1. Piping  $\frac{3}{4}$ -inch (19 mm) and larger in nominal diameter.
2. Piping serving more than one dwelling unit.
3. Piping located outside the conditioned space.
4. Piping from the water heater to a distribution manifold.
5. Piping located under a floor slab.
6. Buried piping.
7. Supply and return piping in recirculation systems other than demand recirculation systems.

**1103.5.4 Drain water heat recovery units.** Drain water heat recovery units shall comply with CSA B55.2. Drain water heat recovery units shall be tested in accordance with CSA B55.1. Potable water-side pressure loss of drain water heat recovery units shall be less than 3 psi (20.7 kPa) for individual units connected to one or two showers. Potable water-side pressure loss of drain water heat recovery units shall be less than 2 psi (13.8 kPa) for individual units connected to three or more showers.

**1103.6 Mechanical ventilation (Mandatory).** The building shall be provided with ventilation that complies with the requirements of Section 1505 or with other approved means of ventilation. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

**1103.6.1 Whole-house mechanical ventilation system fan efficacy.** Fans used to provide whole-house mechanical ventilation shall meet the efficacy requirements of Table 1103.6.1.

**Exception:** Where an air handler that is integral to tested and listed HVAC equipment is used to provide whole-house mechanical ventilation, the air handler shall be powered by an electronically commutated motor.

**TABLE 1103.6.1**  
**WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM FAN**  
**EFFICACY<sup>a</sup>**

<u>FAN LOCATION</u>	<u>AIR FLOW RATE MINIMUM (CFM)</u>	<u>MINIMUM EFFICACY (CFM/WATT)</u>	<u>AIR FLOW RATE MAXIMUM (CFM)</u>
<u>HRV or ERV</u>	<u>Any</u>	<u>1.2 cfm/watt</u>	<u>Any</u>
<u>Range hoods</u>	<u>Any</u>	<u>2.8 cfm/watt</u>	<u>Any</u>
<u>In-line fan</u>	<u>Any</u>	<u>2.8 cfm/watt</u>	<u>Any</u>
<u>Bathroom, utility room</u>	<u>10</u>	<u>1.4 cfm/watt</u>	<u>&lt; 90</u>
<u>Bathroom, utility room</u>	<u>90</u>	<u>2.8 cfm/watt</u>	<u>Any</u>

For SI: 1 cubic foot per minute = 28.3 L/min.

a. When tested in accordance with HVI Standard 916.

**1103.7 Equipment sizing and efficiency rating (Mandatory).** Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies. New or replacement heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the equipment is installed.

**1103.8 Systems serving multiple dwelling units (Mandatory).** Systems serving multiple dwelling units shall comply with Sections 403 and 404 of the International Energy Conservation Code—Commercial Provisions instead of Section 1103.

**1103.9 Snow melt system controls (Mandatory).** Snow- and ice-melting systems, supplied through energy service to the building, shall include automatic controls capable of shutting off the system when the pavement temperature is greater than 50°F (10°C) and precipitation is not falling, and an automatic or manual control that will allow shutoff when the outdoor temperature is greater than 40°F (4.8°C).

**1103.10 Pools and permanent spa energy consumption (Mandatory).** *Deleted.*

## **SECTION 1104**

### **ELECTRICAL POWER AND LIGHTING SYSTEMS**

#### **(MANDATORY)**

**1104.1 Lighting equipment (Mandatory).** Not less than 90 percent of the permanently installed lighting fixtures shall contain only high-efficacy lamps.

**1104.1.1 Lighting equipment (Mandatory).** Fuel gas lighting systems shall not have continuously burning pilot lights.

**SECTION 1105**  
**SIMULATED PERFORMANCE ALTERNATIVE**  
**(PERFORMANCE)**

**1105.1 Scope.** This section establishes criteria for compliance using simulated energy performance analysis. Such analysis shall include heating, cooling, mechanical ventilation and service water heating energy only.

**1105.2 Mandatory requirements.** Compliance with this section requires that the mandatory provisions identified in Section *1101.14-1104* be met. Supply and return ducts not completely inside the building thermal envelope shall be insulated to an R-value of not less than R-6.

**1105.3 Performance-based compliance.** Compliance based on simulated energy performance requires that a proposed residence (proposed design) be shown to have an annual energy cost that is less than or equal to the annual energy cost of the standard reference design. Energy prices shall be taken from a source approved by the building official, such as the Department of Energy, Energy Information Administration's State Energy Data System Prices and Expenditures reports. Building officials shall be permitted to require time-of-use pricing in energy cost calculations.

**Exception:** The energy use based on source energy expressed in Btu (J) or Btu per square foot ( $J/m^2$ ) of conditioned floor area shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be 3.16. The source energy multiplier for fuels other than electricity shall be 1.1.

**1105.4 Documentation.** Documentation of the software used for the performance design and the parameters for the building shall be in accordance with Sections 1105.4.1 through 1105.4.3.

**1105.4.1 Compliance software tools.** Documentation verifying that the methods and accuracy of the compliance software tools conform to the provisions of this section shall be provided to the building official.

**1105.4.2 Compliance report.** Compliance software tools shall generate a report that documents that the proposed design complies with Section 1105.3. A compliance report on the proposed design shall be submitted with the application for the building permit. Upon completion of the building, a compliance report based on the as-built condition of the building shall be



submitted to the building official before a certificate of occupancy is issued. Batch sampling of buildings to determine energy code compliance shall only be allowed for stacked multiple-family units.

Compliance reports shall include information in accordance with Sections 1105.4.2.1 and 1105.4.2.2. Where the proposed design of a building could be built on different sites where the cardinal orientation of the building on each site is different, compliance of the proposed design for the purposes of the application for the building permit shall be based on the worst-case orientation, worst-case configuration, worst-case building air leakage and worst-case duct leakage. Such worst-case parameters shall be used as inputs to the compliance software for energy analysis.

**1105.4.2.1 Compliance report for permit application.** A compliance report submitted with the application for building permit shall include the following:

1. Building street address, or other building site identification.
2. A statement indicating that the proposed design complies with Section 1105.3.
3. An inspection checklist documenting the building component characteristics of the proposed design as indicated in Table 1105.5.2(1). The inspection checklist shall show results for both the standard reference design and the proposed design with user inputs to the compliance software to generate the results.
4. A site-specific energy analysis report that is in compliance with Section 1105.3.
5. The name of the individual performing the analysis and generating the report.
6. The name and version of the compliance software tool.

**1105.4.2.2 Compliance report for certificate of occupancy.** A compliance report submitted for obtaining the certificate of occupancy shall include the following:

1. Building street address, or other building site identification.
2. A statement indicating that the as-built building complies with Section 1105.3.
3. A certificate indicating that the building passes the performance matrix for code compliance and indicating the energy saving features of the buildings.
4. A site-specific energy analysis report that is in compliance with Section 1105.3.
5. The name of the individual performing the analysis and generating the report.
6. The name and version of the compliance software tool.

**1105.4.3 Additional documentation.** The building official shall be permitted to require the following documents:

1. Documentation of the building component characteristics of the standard reference design.
2. A certification signed by the *owner or the owner's representative* providing the building component characteristics of the proposed design as given in Table 1105.5.2(1).
3. Documentation of the actual values used in the software calculations for the proposed design.

**1105.5 Calculation procedure.** Calculations of the performance design shall be in accordance with Sections 1105.5.1 and 1105.5.2.

**1105.5.1 General.** Except as specified by this section, the standard reference design and proposed design shall be configured and analyzed using identical methods and techniques.

**1105.5.2 Residence specifications.** The standard reference design and proposed design shall be configured and analyzed as specified by Table 1105.5.2(1). Table 1105.5.2(1) shall include, by reference, all notes contained in Table 1102.1.2.

**TABLE 1105.5.2(1)**  
**SPECIFICATIONS FOR THE STANDARD REFERENCE AND**  
**PROPOSED DESIGNS**

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Above-grade walls	Type: mass where the proposed wall is a mass wall; otherwise wood frame.	As proposed
	Gross area: same as proposed.	As proposed
	<i>U</i> -factor: as specified in Table 1102.1.4.	As proposed
	Solar absorptance = 0.75.	As proposed
	Emittance = 0.90.	As proposed
Basement and crawl space walls	Type: same as proposed.	As proposed
	Gross area: same as proposed.	As proposed
	<i>U</i> -factor: as specified in Table 1102.1.4, with the insulation layer on the interior side of the walls.	As proposed
Above-grade floors	Type: wood frame.	As proposed
	Gross area: same as proposed.	As proposed
	<i>U</i> -factor: as specified in Table 1102.1.4.	As proposed
Ceilings	Type: wood frame.	As proposed
	Gross area: same as proposed.	As proposed
	<i>U</i> -factor: as specified in Table 1102.1.4.	As proposed
Roofs	Type: composition shingle on wood sheathing.	As proposed
	Gross area: same as proposed.	As proposed
	Solar absorptance = 0.75.	As proposed
	Emittance = 0.90.	As proposed
Attics	Type: vented with an aperture of 1 ft <sup>2</sup> per 300 ft <sup>2</sup> of ceiling area.	As proposed
Foundations	Type: same as proposed.	As proposed
	Foundation wall area above and below grade and soil characteristics: same as proposed.	As proposed
Opaque doors	Area: 40 ft <sup>2</sup> .	As proposed
	Orientation: North.	As proposed
	<i>U</i> -factor: same as fenestration as specified in Table 1102.1.4.	As proposed
Vertical fenestration other than opaque doors	Total area <sup>a</sup> = (a) The proposed glazing area, where the proposed glazing area is less than 15 percent of the conditioned floor area. (b) 15 percent of the conditioned floor area, where the proposed glazing area is 15 percent or more of the conditioned floor area.	As proposed
	Orientation: equally distributed to four cardinal compass orientations (N, E, S & W).	As proposed
	<i>U</i> -factor: as specified in Table 1102.1.4.	As proposed
	SHGC: as specified in Table 1102.1.2 except for <i>climate zones</i> ; without an SHGC requirement, the SHGC shall be equal to 0.40.	As proposed
	Interior shade fraction: 0.92-(0.21 × SHGC for the standard reference design).	Interior shade fraction: 0.92-(0.21 × SHGC as proposed)
	External shading: none	As proposed
Skylights	None	As proposed
Thermally isolated sunrooms	None	As proposed

(continued)

**TABLE 1105.5.2(1)—continued**  
**SPECIFICATIONS FOR THE STANDARD REFERENCE AND**  
**PROPOSED DESIGNS**

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Air exchange rate	The air leakage rate at a pressure of 0.2 inch w.g. (50 Pa) shall be  <i>Climate Zones 1 and 2:</i> 5 air changes per hour. <i>Climate Zones 3 through 8:</i> 3 air changes per hour.  The mechanical ventilation rate shall be in addition to the air leakage rate and shall be the same as in the proposed design, but not greater than $0.01 \times CFA + 7.5 \times (N_{br} + 1)$ where: $CFA$ = conditioned floor area, ft <sup>2</sup> . $N_{br}$ = number of bedrooms. Energy recovery shall not be assumed for mechanical ventilation.	The measured air exchange rate <sup>a</sup> .  The mechanical ventilation rate <sup>b</sup> shall be in addition to the air leakage rate and shall be as proposed.
Mechanical ventilation	Where mechanical ventilation is not specified in the proposed design: None Where mechanical ventilation is specified in the proposed design, the annual vent fan energy use, in units of kWh/yr, shall equal $(1/e_f) \times [0.0876 \times CFA + 65.7 \times (N_{br} + 1)]$ where: $e_f$ = the minimum exhaust fan efficacy, as specified in Table 403.6.1, corresponding to a flow rate of $0.01 \times CFA + 7.5 \times (N_{br} + 1)$ $CFA$ = conditioned floor area, ft <sup>2</sup> . $N_{br}$ = number of bedrooms.	As proposed
Internal gains	IGain, in units of Btu/day per dwelling unit, shall equal $17,900 + 23.8 \times CFA + 4,104 \times N_{br}$ where: $CFA$ = conditioned floor area, ft <sup>2</sup> . $N_{br}$ = number of bedrooms.	Same as standard reference design.
Internal mass	Internal mass for furniture and contents: 8 pounds per square foot of floor area.	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element <sup>c</sup> but not integral to the building envelope or structure.
Structural mass	For masonry floor slabs: 80 percent of floor area covered by R-2 carpet and pad, and 20 percent of floor directly exposed to room air.	As proposed
	For masonry basement walls, as proposed, but with insulation as specified in Table 1102.1.4, located on the interior side of the walls.	As proposed
	For other walls, ceilings, floors, and interior walls: wood frame construction.	As proposed
Heating systems <sup>d,e</sup>	For other than electric heating without a heat pump: as proposed. Where the proposed design utilizes electric heating without a heat pump, the standard reference design shall be an air source heat pump meeting the requirements of Section 403 of the IECC—Commercial Provisions.  Capacity: sized in accordance with Section 1103.7.	As proposed
Cooling systems <sup>d,f</sup>	As proposed. Capacity: sized in accordance with Section 1103.7.	As proposed
Service water heating <sup>d,g,h</sup>	As proposed. Use: same as proposed design.	As proposed Use, in units of gal/day = $30 + (10 \times N_{br})$ where: $N_{br}$ = number of bedrooms.

(continued)

**TABLE 1105.5.2(1)—continued**  
**SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED**  
**DESIGNS**

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Thermal distribution systems	<p>Duct insulation: in accordance with Section 1103.3.1.</p> <p>A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems.</p> <p><b>Exception:</b> For nonducted heating and cooling systems that do not have a fan, the standard reference design thermal distribution system efficiency (DSE) shall be 1.</p> <p>For tested duct systems, the leakage rate shall be 4 cfm (113.3 L/min) per 100 ft<sup>2</sup> (9.29 m<sup>2</sup>) of <i>conditioned floor area</i> at a pressure of differential of 0.1 inch w.g. (25 Pa).</p>	<p>Duct insulation: as proposed.</p> <p>As tested or, where not tested, as specified in Table 1105.5.2(2).</p>
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F.	Same as standard reference design.

For SI: 1 square foot = 0.93 m<sup>2</sup>, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m<sup>2</sup>, 1 gallon (US) = 3.785 L, °C = (°F-32)/1.8, 1 degree = 0.79 rad.

- a. The measured air exchange rate shall be determined by testing conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827. Hourly calculations as specified in the ASHRAE Handbook of Fundamentals, or the equivalent, shall be used to determine the energy loads resulting from infiltration.
- b. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE Handbook of Fundamentals, page 26.24 and the "Whole-house Ventilation" provisions of 2001 ASHRAE Handbook of Fundamentals, page 26.19 for intermittent mechanical ventilation.
- c. Thermal storage element shall mean a component that is not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element shall be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or shall be connected to such a room with pipes or ducts that allow the element to be actively charged.
- d. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.
- e. For a proposed design without a proposed heating system, a heating system having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.
- f. For a proposed design home without a proposed cooling system, an electric air conditioner having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.
- g. For a proposed design with a nonstorage-type water heater, a 40-gallon storage-type water heater having the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For a proposed design without a proposed water heater, a 40-gallon storage-type water heater with the prevailing federal minimum efficiency for the same fuel as the predominant heating fuel type shall be assumed for both the proposed design and standard reference design.
- h. For residences with conditioned basements, R-2 and R-4 residences, and for townhouses, the following formula shall be used to determine glazing area:

$$AF = A_s \times FA \times F$$

where:

AF = Total glazing area.

As = Standard reference design total glazing area.

$FA = \frac{\text{Above-grade thermal boundary gross wall area}}{\text{(above-grade boundary wall area} + 0.5 \times \text{below-grade boundary wall area)}}$

$F = \frac{\text{(above-grade thermal boundary wall area)}}{\text{(above-grade thermal boundary wall area} + \text{common wall area)}} \text{ or } 0.56, \text{ whichever is greater.}$

and where:

Thermal boundary wall is any wall that separates conditioned space from unconditioned space or ambient conditions.

Above-grade thermal boundary wall is any thermal boundary wall component not in contact with soil.

Below-grade boundary wall is any thermal boundary wall in soil contact.

Common wall area is the area of walls shared with an adjoining dwelling unit. L and CFA are in the same units.

**TABLE 1105.5.2(2)**  
**DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED**  
**DESIGNS<sup>a</sup>**

<b><u>DISTRIBUTION SYSTEM CONFIGURATION AND CONDITION</u></b>	<b><u>FORCED AIR SYSTEMS</u></b>	<b><u>HYDRONIC SYSTEMS<sup>b</sup></u></b>
<u>Distribution system components located in unconditioned space</u>	=	0.95
<u>Untested distribution systems entirely located in conditioned space<sup>c</sup></u>	0.88	1
<u>“Ductless” systems<sup>d</sup></u>	1	=

For SI: 1 cubic foot per minute = 0.47 L/s, 1 square foot = 0.093m<sup>2</sup>, 1 pound per square inch = 6895 Pa, 1 inch water gauge = 1250 Pa.

- a. Default values this table are for untested distribution systems, which must still meet minimum requirements for duct system insulation.
- b. Hydronic systems shall mean those systems that distribute heating and cooling energy directly to individual spaces using liquids pumped through closed-loop piping and that do not depend on ducted, forced airflow to maintain space temperatures.
- c. Entire system in conditioned space shall mean that no component of the distribution system, including the air handler unit, is located outside of the conditioned space.
- d. Ductless systems shall be allowed to have forced airflow across a coil but shall not have any ducted airflow external to the manufacturer’s air handler enclosure.

**1105.6 Calculation software tools.** Calculation software, where used, shall be in accordance with Sections 1105.6.1 through 1105.6.3.

**1105.6.1 Minimum capabilities.** Calculation procedures used to comply with this section shall be software tools capable of calculating the annual energy consumption of all building elements that differ between the standard reference design and the proposed design and shall include the following capabilities:

1. Computer generation of the standard reference design using only the input for the proposed design. The calculation procedure shall not allow the user to directly modify the building component characteristics of the standard reference design.
2. Calculation of whole-building (as a single zone) sizing for the heating and cooling equipment in the standard reference design residence in accordance with Section 1103.6.

3. Calculations that account for the effects of indoor and outdoor temperatures and part-load ratios on the performance of heating, ventilating and air-conditioning equipment based on climate and equipment sizing.
4. Printed building official inspection checklist listing each of the proposed design component characteristics from Table 1105.5.2(1) determined by the analysis to provide compliance, along with their respective performance ratings such as R-value, U-factor, SHGC, HSPF, AFUE, SEER and EF.

**1105.6.2 Specific approval.** Performance analysis tools meeting the applicable provisions of Section 1105 shall be permitted to be approved. Tools are permitted to be approved based on meeting a specified threshold for a jurisdiction. The building official shall be permitted to approve such tools for a specified application or limited scope.

**1105.6.3 Input values.** When calculations require input values not specified by Sections 1102, 1103, 1104 and 1105, those input values shall be taken from an approved source.

## **SECTION 1106** **ENERGY RATING INDEX** **COMPLIANCE ALTERNATIVE**

**1106.1 Scope.** This section establishes criteria for compliance using an Energy Rating Index (ERI) analysis.

**1106.2 Mandatory requirements.** Compliance with this section requires that the provisions identified in Sections 1101.14 through 1104 indicated as “mandatory” and in Section 1103.5.3 be met. The building thermal envelope shall be greater than or equal to levels of efficiency and Solar Heat Gain Coefficients in Table 402.1.1 or 402.1.3 of the 2009 International Energy Conservation Code.

**Exception:** Supply and return ducts not completely inside the building thermal envelope shall be insulated to an R-value of not less than R-6.

**1106.3 Energy rating index.** The Energy Rating Index (ERI) shall be determined in accordance with RESNET/ICC 301 except that the ERI reference design ventilation rate shall be in accordance with Equation 11-1 and the ERI rated design ventilation rate shall comply with the mechanical ventilation requirements of the RCO Section 1505.

Ventilation rate, CFM = (0.01 × total square foot area of house) + [7.5 × (number of bedrooms + 1)]

**(Equation 11-1)**

Energy used to recharge or refuel a vehicle used for transportation on roads that are not on the building site shall not be included in the ERI reference design or the rated design.

**1106.4 ERI-based compliance.** Compliance based on an ERI analysis requires that the rated design be shown to have an ERI less than or equal to the appropriate value indicated in Table 1106.4 when compared to the ERI reference design.

**TABLE 1106.4**  
**MAXIMUM ENERGY RATING INDEX**

<u>CLIMATE ZONE</u>	<u>ENERGY RATING INDEX<sup>a</sup></u>
<u>4</u>	<u>62</u>
<u>5</u>	<u>61</u>

- a. Where on-site renewable energy is included for compliance using the ERI analysis of Section 1106.4, the building shall meet the mandatory requirements of Section 1106.2, and the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table 1102.1.2 or Table 1102.1.4.

**1106.5 Verification.** Verification of compliance with Section 1106 shall be *submitted to the residential building official.*

**1106.6 Documentation.** Documentation of the software used to determine the ERI and the parameters for the residential building shall be in accordance with Sections 1106.6.1 through 1106.6.3.

**1106.6.1 Compliance software tools.** Software tools used for determining ERI shall be Approved Software Rating Tools in accordance with RESNET/ICC 301.

**1106.6.2 Compliance report.** Compliance software tools shall generate a report that documents that the ERI of the rated design complies with Sections 1106.3 and 1106.4. The compliance documentation shall include the following information:

1. Address or other identification of the residential building.
2. An inspection checklist documenting the building component characteristics of the rated design. The inspection checklist shall show results for both the ERI reference design and the rated design, and shall document all inputs entered by the user necessary to reproduce the results.
3. Name of individual completing the compliance report.
4. Name and version of the compliance software tool.

**Exception:** Where an otherwise identical building model is offered in multiple orientations, compliance for any orientation shall be permitted by



documenting that the building meets the performance requirements in each of the four (north, east, south and west) cardinal orientations.

**1106.6.3 Additional documentation.** The code official shall be permitted to require the following documents:

1. Documentation of the building component characteristics of the ERI reference design.
2. A certification signed by the owner or the owner's representative providing the building component characteristics of the rated design.
3. Documentation of the actual values used in the software calculations for the rated design.

**1106.6.4 Specific approval.** Performance analysis tools meeting the applicable sections of Section 1106 shall be approved. Documentation demonstrating the approval of performance analysis tools in accordance with Section 1106.6.1 shall be provided.

**1106.6.5 Input values.** Where calculations require input values not specified by Sections 1102, 1103, 1104 and 1105, those input values shall be taken from RESNET/ICC 301.

## **SECTION 1107** **EXISTING BUILDINGS—GENERAL**

**1107.1 Scope.** The provisions of Sections 1107 through 1111 shall control the alteration, repair, addition and change of occupancy of existing buildings and structures. *Where provisions of Sections 1107 through 1111 conflict with Section 113, the provisions of Section 113 shall take precedence.*

**1107.1.1 Additions, alterations, or repairs: General.** Additions, alterations, or repairs to an existing building, building system or portion thereof shall comply with Section 1108, 1109 or 1110. Unaltered portions of the existing building or building supply system shall not be required to comply with this chapter.

**1107.2 Existing buildings.** Except as specified in this chapter, this code shall not be used to require the removal, alteration or abandonment of, nor prevent the continued use and maintenance of, an existing building or building system lawfully in existence at the time of adoption of this code.

**1107.3 Maintenance.** Buildings and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices and systems that are required by this code shall be maintained in compliance with the code edition under which

installed. The owner or the owner's authorized agent shall be responsible for the maintenance of buildings and structures. The requirements of this chapter shall not provide the basis for removal or abrogation of energy conservation, fire protection and safety systems and devices in existing structures.

**1107.4 Compliance.** Alterations, repairs, additions and changes of occupancy to, or relocation of, existing buildings and structures shall comply with the provisions for alterations, repairs, additions and changes of occupancy or relocation, respectively, in this code.

**1107.4.1 Compliance alternative for existing buildings.** Table 1107.4.1 may be used for existing buildings in lieu of Table 1102.1.2.

**TABLE 1107.4.1**  
**INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT<sup>a</sup>**

<u>CLIMATE ZONE</u>	<u>FENESTRATION U-FACTOR<sup>b</sup></u>	<u>SKYLIGHT<sup>b</sup> U-FACTOR</u>	<u>GLAZED FENESTRATION SHGC<sup>b</sup></u>	<u>CEILING R-VALUE</u>	<u>WOOD FRAME WALL R-VALUE</u>	<u>MASS WALL R-VALUE<sup>i</sup></u>	<u>FLOOR R-VALUE</u>	<u>BASEMENT<sup>c</sup> WALL R-VALUE</u>	<u>SLAB<sup>d</sup> R-VALUE AND DEPTH</u>	<u>CRAWL SPACE<sup>e</sup> WALL R-VALUE</u>
<u>4</u>	<u>0.35</u>	<u>0.60</u>	<u>NR</u>	<u>38</u>	<u>13</u>	<u>5/10</u>	<u>19</u>	<u>10/13</u>	<u>10, 2 ft</u>	<u>10/13</u>
<u>5</u>	<u>0.35</u>	<u>0.60</u>	<u>NR</u>	<u>38</u>	<u>20 or 13 + 5<sup>h</sup></u>	<u>13/17</u>	<u>30<sup>e</sup></u>	<u>10/13</u>	<u>10, 2 ft</u>	<u>10/13</u>

- a. R-values are minimums. U-factors and solar heat gain coefficient (SHGC) are maximums. R-19 batts compressed in to nominal 2 x 6 framing cavity such that the R-value is reduced by R-1 or more shall be marked with the compressed batt R-value in addition to the full thickness R-value.
- b. The fenestration U-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
- c. "10/13" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.
- d. R-5 shall be added to the required slab edge R-values for heated slabs.
- e. Deleted.
- f. Deleted.
- g. Or insulation sufficient to fill the framing cavity, R-19 minimum.
- h. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25% or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25% of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.
- i. The second R-value applies when more than half the insulation is on the interior of the mass wall.
- j. Deleted.

**1107.5 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs, provided that hazards to life, health or property are not created. Hazardous materials shall not be used where the code for new construction would not allow their use in buildings of similar occupancy, purpose and location.

**1107.6 Historic buildings.** Provisions of this chapter relating to the construction, repair, alteration, restoration and movement of structures, and change of occupancy shall not be mandatory for historic buildings provided that a report has been submitted to the building official and signed by the owner, a registered design

professional, or a representative of the State Preservation Office at the Ohio History Connection or the historic preservation authority having jurisdiction, demonstrating that compliance with that provision would threaten, degrade or destroy the historic form, fabric or function of the building.

## **SECTION 1108** **ADDITIONS**

**1108.1 General.** Additions to an existing building, building system or portion thereof shall conform to the provisions of this chapter as they relate to new construction without requiring the unaltered portion of the existing building or building system to comply with this chapter. Additions shall not create an unsafe or hazardous condition or overload existing building systems. An addition shall be deemed to comply with this chapter where the addition alone complies, where the existing building and addition comply with this chapter as a single building, or where the building with the addition does not use more energy than the existing building. Additions shall be in accordance with Section 1108.1.1 or 1108.1.2.

**1108.1.1 Prescriptive compliance.** Additions shall comply with Sections 1108.1.1.1 through 1108.1.1.4.

**1108.1.1.1 Building envelope.** New building envelope assemblies that are part of the addition shall comply with Sections 1102.1, 1102.2, 1102.3.1 through 1102.3.5, and 1102.4.

**Exceptions:**

1. Where unconditioned space is changed to conditioned space, the building envelope of the addition shall comply where the Total UA, as determined in Section 1102.1.5, of the existing building and the addition, and any alterations that are part of the project, is less than or equal to the Total UA generated for the existing building.
2. Building thermal envelope testing is not required.

**1108.1.1.2 Heating and cooling systems.** New heating, cooling and duct systems that are part of the addition shall comply with Section 1103.

**Exception:** Where ducts from an existing heating and cooling system are extended to an addition, duct systems with less than 40 linear feet (12.19 m) in unconditioned spaces shall not be required to be tested in accordance with Section 1103.3.3

**1108.1.1.3 Service hot water systems.** New service hot water systems that are part of the addition shall comply with Section 1103.4.

**1108.1.1.4 Lighting.** New lighting systems that are part of the addition shall comply with Section 1104.1.

**1108.1.2 Existing plus addition compliance (Simulated Performance Alternative).** Where unconditioned space is changed to conditioned space, the addition shall comply where the annual energy cost or energy use of the addition and the existing building, and any alterations that are part of the project, is less than or equal to the annual energy cost of the existing building when modeled in accordance with Section 1105. The addition and any alterations that are part of the project shall comply with Section 1105 in its entirety.

## **SECTION 1109** **ALTERATIONS**

**1109.1 General.** Alterations to any building or structure shall comply with the requirements of the code for new construction. Alterations shall be such that the existing building or structure is not less conforming with the provisions of this chapter than the existing building or structure was prior to the alteration.

Alterations to an existing building, building system or portion thereof shall conform to the provisions of this chapter as they relate to new construction without requiring the unaltered portions of the existing building or building system to comply with this chapter. Alterations shall not create an unsafe or hazardous condition or overload existing building systems. Alterations shall be such that the existing building or structure does not use more energy than the existing building or structure prior to the alteration. Alterations to existing buildings shall comply with Sections 1109.1.1 through 1109.2.

**1109.1.1 Building envelope.** Building envelope assemblies that are part of the alteration shall comply with Section 1102.1.2 or 1102.1.4, Sections 1102.2.1 through 1102.2.13, 1102.3.1, 1102.3.2, 1102.4.3 and 1102.4.5.

**Exception:** The following alterations shall not be required to comply with the requirements for new construction provided that the energy use of the building is not increased:

1. Storm windows installed over existing fenestration.
2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation.
3. Construction where the existing roof, wall or floor cavity is not exposed.
4. Roof recover.
5. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.

6. Surface-applied window film installed on existing single-pane fenestration assemblies to reduce solar heat gain provided that the code does not require the glazing or fenestration assembly to be replaced.

**1109.1.1.1 Replacement fenestration.** Where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for U-factor and SHGC as specified in Table 1102.1.2. Where more than one replacement fenestration unit is to be installed, an area-weighted average of the U-factor, SHGC or both of all replacement fenestration units shall be an alternative that can be used to show compliance.

**1109.1.2 Heating and cooling systems.** New heating, cooling and duct systems that are part of the alteration shall comply with Section 1103.

**Exception:** Where ducts from an existing heating and cooling system are extended, duct systems with less than 40 linear feet (12.19 m) in unconditioned spaces shall not be required to be tested in accordance with Section 1103.3.3.

**1109.1.3 Service hot water systems.** New service hot water systems that are part of the alteration shall comply with Section 1103.5.

**1109.1.4 Lighting.** New lighting systems that are part of the alteration shall comply with Section 1104.1.

**Exception:** Alterations that replace less than 50 percent of the luminaires in a space, provided that such alterations do not increase the installed interior lighting power.

**1109.2 Change in space conditioning.** Any nonconditioned or low energy space that is altered to become conditioned space shall be required to be brought into full compliance with this chapter.

**Exception:** Where the simulated performance option in Section 1105 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110 percent of the annual energy cost otherwise allowed by Section 1105.3.

## **SECTION 1110** **REPAIRS**

**1110.1 General.** Buildings, structures and parts thereof shall be repaired in compliance with Section 1107.3 and this section. Work on nondamaged

components necessary for the required repair of damaged components shall be considered to be part of the repair and shall not be subject to the requirements for alterations in this chapter. Routine maintenance required by Section 1107.3, ordinary repairs exempt from permit, and abatement of wear due to normal service conditions shall not be subject to the requirements for repairs in this section.

**1110.2 Application.** For the purposes of this code, the following shall be considered to be repairs:

1. Glass-only replacements in an existing sash and frame.
2. Roof repairs.
3. Repairs where only the bulb, ballast or both within the existing luminaires in a space are replaced provided that the replacement does not increase the installed interior lighting power.

## **SECTION 1111** **CHANGE OF OCCUPANCY OR USE**

**1111.1 General.** Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this chapter.

**1111.2 General.** Any space that is converted to a dwelling unit or portion thereof from another use or occupancy shall comply with this chapter.

**Exception:** Where the simulated performance option in Section 1105 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110 percent of the annual energy cost allowed by Section 1105.3.

## **SECTION 1112** **OHIO HOME BUILDERS ASSOCIATION (OHBA) ALTERNATIVE** **ENERGY CODE OPTION**

**1112.1 General.**

**1112.1.1 Scope.** *This section provides an alternative set of requirements for regulating the energy efficiency for the design and construction of new buildings regulated by this code.*

**Exception:** *Portions of the building envelope that do not enclose conditioned space are exempt from thermal envelope provisions of this section.*

**1112.1.2 Compliance.** *Compliance shall be demonstrated by meeting the requirements of this section, known as the OHBA Alternative Code. The*

applicant shall choose to comply with either Compliance Path #1 or Compliance Path #2 and shall demonstrate compliance with all applicable requirements of that one chosen path. The chosen path shall be identified on the construction documents. The requirements in this section are in lieu of the requirements found in Sections 1101.14 through 1106.

**1112.1.3 Identification.** Materials, systems and equipment shall be identified in a manner that will allow a determination of compliance with the applicable provisions of this section.

**1112.1.4 Building thermal envelope insulation.** An R-value identification mark shall be applied by the manufacturer to each piece of building thermal envelope insulation 12 inches (305 mm) or more wide. Alternately, the insulation installers shall provide a certification listing the type, manufacturer and R-value of insulation installed in each element of the building thermal envelope. For blown or sprayed insulation (fiberglass and cellulose), the initial installed thickness, settled thickness, settled R-value, installed density, coverage area and number of bags installed shall be listed on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the area covered and R-value of installed thickness shall be listed on the certificate. The insulation installer shall sign, date and post the certificate in a conspicuous location on the job site.

**1112.1.4.1 Blown or sprayed roof/ceiling insulation.** The thickness of blown in or sprayed roof/ceiling insulation (fiberglass or cellulose) shall be written in inches (mm) on markers that are installed at least one for every 300 ft<sup>2</sup> (28 m<sup>2</sup>) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers a minimum of 1 inch (25 mm) high. Each marker shall face the attic access opening. Spray polyurethane foam thickness and installed R-value shall be listed on the certificate provided by the insulation installer.

**1112.1.4.2 Insulation mark installation.** Insulating materials shall be installed such that the manufacturer's R-value mark is readily observable upon inspection.

**1112.1.5 Fenestration product rating.** U-factors of fenestration products (windows, doors and skylights) shall be determined in accordance with NFRC 100 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled U-factor shall be assigned a default U-factor from Tables 1112.1.5(1) and 1112.1.5(2). The solar heat gain coefficient (SHGC) of glazed fenestration products (windows, glazed doors and skylights) shall be determined in accordance with NFRC 200 by an accredited,

independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled SHGC shall be assigned a default SHGC from Table 1112.1.5(3).

**1112.1.6 Insulation product rating.** The thermal resistance (R-value) of insulation shall be determined in accordance with the CFR Title 16, Part 460, in units of  $h \cdot ft^2 \cdot ^\circ F/Btu$  at a mean temperature of 75°F (24°C).

**1112.1.7 Installation.** All materials, systems and equipment shall be installed in accordance with the manufacturer's installation instructions and the provisions of this code.

**1112.1.7.1 Protection of exposed foundation insulation.** Insulation applied to the exterior of basement walls, crawl space walls, and the perimeter of slab-on-grade floors shall have a rigid, opaque and weather-resistant protective covering to prevent the degradation of the insulation's thermal performance. The protective covering shall cover the exposed exterior insulation and extend a minimum of 6 inches (152 mm) below grade.

**1112.1.8 Certificate.** A permanent certificate shall be posted on or in the electrical distribution panel. The certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. The certificate shall be completed by the builder or registered design professional. The certificate shall list the predominant R-values of insulation installed in or on ceiling/roof, walls, foundation (slab, basement wall, crawlspace wall and/or floor) and ducts outside conditioned spaces; U-factors for fenestration; and the solar heat gain coefficient (SHGC) of fenestration. Where there is more than one value for each component, the certificate shall list the value covering the largest area. The certificate shall list the types and efficiencies of heating, cooling and service water heating equipment. Where a gas-fired unvented room heater, electric furnace and/or baseboard electric heater is installed in the residence, the certificate shall list "gas-fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate. An efficiency shall not be listed for gas-fired unvented room heaters, electric furnaces or electric base board heaters.

**TABLE 1112.1.5(1)**  
**DEFAULT GLAZED FENESTRATION U-FACTORS**

<b><u>FRAME TYPE</u></b>	<b><u>SINGLE PANE</u></b>	<b><u>DOUBLE PANE</u></b>	<b><u>SKYLIGHT</u></b>	
			<b><u>Single</u></b>	<b><u>Double</u></b>
<i>Metal</i>	<i>1.2</i>	<i>0.8</i>	<i>2</i>	<i>1.3</i>
<i>Metal with thermal break</i>	<i>1.1</i>	<i>0.65</i>	<i>1.9</i>	<i>1.1</i>



<u>FRAME TYPE</u>	<u>SINGLE PANE</u>	<u>DOUBLE PANE</u>	<u>SKYLIGHT</u>	
			<u>Single</u>	<u>Double</u>
<u>Nonmetal or metal clad</u>	<u>0.95</u>	<u>0.55</u>	<u>1.75</u>	<u>1.05</u>
<u>Glazed block</u>	<u>0.6</u>			

**TABLE 1112.1.5(2)**  
**DEFAULT DOOR U-FACTORS**

<u>DOOR TYPE</u>	<u>U-FACTOR</u>
<u>Uninsulated metal</u>	<u>1.2</u>
<u>Insulated metal</u>	<u>0.6</u>
<u>Wood</u>	<u>0.5</u>
<u>Insulated, nonmetal edge, max 45% glazing, any glazing double pane</u>	<u>0.35</u>

**TABLE 1112.1.5(3)**  
**DEFAULT GLAZED FENESTRATION SHGC**

<u>SINGLE GLAZED</u>		<u>DOUBLE GLAZED</u>		<u>GLAZED BLOCK</u>
<u>Clear</u>	<u>Tinted</u>	<u>Clear</u>	<u>Tinted</u>	
<u>0.8</u>	<u>0.7</u>	<u>0.7</u>	<u>0.6</u>	<u>0.6</u>

## **1112.2 Building thermal envelope.**

**1112.2.1 Insulation and fenestration criteria.** *The building thermal envelope shall meet the requirements of either Compliance Path #1 or Compliance Path #2 of Table 1112.2.1*

**1112.2.1.1 R-value computation.** *Insulation material used in layers, such as framing cavity insulation and insulating sheathing, shall be summed to compute the component R-value. The manufacturer's settled R-value shall be used for blown insulation. Computed R-values shall not include an R-value for other building materials or air films.*

**1112.2.1.2 U-factor alternative.** *An assembly with a U-factor equal to or less than that specified in Table 1112.2.1.2 shall be permitted as an alternative to the corresponding compliance path R-value in Table 1112.2.1.*

**1112.2.1.3 Total UA alternative.** *If the total building thermal envelope UA (sum of U-factor times assembly area) is less than or equal to the total UA resulting from using the U-factors in Table 1112.2.1.2, (multiplied by the same assembly area as in the proposed building), the building shall be considered in compliance with Table 1112.2.1. The UA calculation shall be done using a method consistent with the ASHRAE Handbook of Fundamentals and shall include the thermal bridging effects of framing*

materials. The SHGC requirements shall be met in addition to UA compliance.

**TABLE 1112.2.1  
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT<sup>a</sup>**

	<u>FENESTRATION U-FACTOR<sup>b</sup></u>	<u>SKYLIGHT<sup>b</sup> U-FACTOR</u>	<u>GLAZED FENESTRATION SHGC<sup>b,c</sup></u>	<u>CEILING R-VALUE</u>	<u>WOOD FRAME WALL R-VALUE</u>	<u>MASS WALL R-VALUE<sup>i</sup></u>	<u>FLOOR R-VALUE</u>	<u>BASEMENT<sup>e</sup> WALL R-VALUE</u>	<u>SLAB<sup>d</sup> R-VALUE AND DEPTH</u>	<u>CRAWL SPACE<sup>c</sup> WALL R-VALUE</u>
<u>Compliance Path #1</u>	<u>0.32</u>	<u>0.60</u>	<u>NR</u>	<u>49</u>	<u>15 or 13 + 3<sup>h</sup></u>	<u>13/17</u>	<u>30<sup>g</sup></u>	<u>10/13 (minimum 4 feet)</u>	<u>10, 2 ft</u>	<u>10/13</u>
<u>Compliance Path #2</u>	<u>0.32</u>	<u>0.60</u>	<u>NR</u>	<u>49</u>	<u>13</u>	<u>13/17</u>	<u>30<sup>g</sup></u>	<u>10/13 (minimum 4 feet)</u>	<u>10, 2 ft</u>	<u>10/13</u>

- a. R-values are minimums. U-factors and solar heat gain coefficient (SHGC) are maximums. R-19 batts compressed in to nominal 2 x 6 framing cavity such that the R-value is reduced by R-1 or more shall be marked with the compressed batt R-value in addition to the full thickness R-value.
- b. The fenestration U-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
- c. "10/13" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.
- d. R-5 shall be added to the required slab edge R-values for heated slabs.
- e. Deleted.
- f. Deleted.
- g. Or insulation sufficient to fill the framing cavity, R-19 minimum.
- h. "13+3" means R-13 cavity insulation plus R-3 insulated sheathing. If structural sheathing covers 25% or less of the exterior, insulating sheathing is not required where structural sheathing is used.
- i. The second R-value applies when more than half the insulation is on the interior of the mass wall.
- j. Deleted.

### **1112.2.2 Specific insulation requirements.**

**1112.2.2.1 Ceilings with attic spaces.** When Section 1112.2.1 would require R-49 in the ceiling, R-38 shall be deemed to satisfy the requirement for R-49 wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the U-factor alternative approach in Section 1112.2.1.2 and the Total UA alternative in Section 1112.2.1.3.

**1112.2.2.2 Ceilings without attic spaces.** Where Section 1112.2.1 would require insulation levels above R-30 and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation for such roof/ceiling assemblies shall be R-30. This reduction of insulation from the requirements of Section 1112.2.1 shall be limited to 500 square feet (46 m<sup>2</sup>) or twenty per cent of the total insulated ceiling area, whichever is less. This reduction shall not apply to the U-factor alternative approach in Section 1112.2.1.2 and the Total UA alternative in Section 1112.2.1.3.

**1112.2.2.3 Access hatches and doors.** *Access doors from conditioned spaces to unconditioned spaces (e.g., attics and crawl spaces) shall be weatherstripped and insulated to a level equivalent to the insulation on the surrounding surfaces. Access shall be provided to all equipment which prevents damaging or compressing the insulation. A wood framed or equivalent baffle or retainer is required to be provided when loose fill insulation is installed, the purpose of which is to prevent the loose fill insulation from spilling into the living space when the attic access is opened and to provide a permanent means of maintaining the installed R-value of the loose fill insulation.*

**1112.2.2.4 Mass walls.** *Mass walls, for the purposes of this section, shall be considered above-grade walls of concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth (adobe, compressed earth block, rammed earth) and solid timber/logs.*

**1112.2.2.5 Steel-frame ceilings, walls and floors.** *Steel-frame ceilings, walls and floors shall meet the insulation requirements of Table 1112.2.2.5 or shall meet the U-factor requirements in Table 1112.2.1.2. The calculation of the U-factor for a steel-frame envelope assembly shall use a series-parallel path calculation method.*

**1112.2.2.6 Floors.** *Floor insulation shall be installed to maintain permanent contact with the underside of the subfloor decking.*

**1112.2.2.7 Basement walls.** *Exterior walls associated with conditioned basements shall be insulated from the top of the basement wall as specified in Table 1112.2.1. Walls associated with unconditioned basements shall meet this requirement unless the floor overhead is insulated in accordance with Sections 1112.2.1 and 1112.2.2.6.*

**1112.2.2.8 Slab-on-grade floors.** *Slab-on-grade floors with a floor surface less than 12 inches below grade shall be insulated in accordance with Table 1112.2.1. The insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall. Insulation located below grade shall be extended the distance provided in Table 1112.2.1 by any combination of vertical insulation, insulation extending under the slab or insulation extending protected by pavement or by a minimum of 10 inches (254 mm) of soil. The top edge of the insulation installed between the exterior wall and the edge of the interior slab shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the exterior wall. Slab-edge*

*insulation is not required in jurisdictions designated by the building official as having a very heavy termite infestation.*

**TABLE 1112.2.1.2**  
**EQUIVALENT U-FACTORS<sup>a</sup>**

	<u>FENESTRATION U-FACTOR</u>	<u>SKYLIGHT U-FACTOR</u>	<u>CEILING U-FACTOR</u>	<u>FRAME WALL U-FACTOR</u>	<u>MASS WALL U-FACTOR<sup>b</sup></u>	<u>FLOOR U-FACTOR</u>	<u>BASEMENT WALL U-FACTOR</u>	<u>CRAWL SPACE WALL U-FACTOR</u>
<i>Compliance Path #1</i>	<u>0.32</u>	<u>0.60</u>	<u>0.026</u>	<u>0.077</u>	<u>0.082</u>	<u>0.033</u>	<u>0.059</u> <i>(minimum 4 feet)</i>	<u>0.065</u>
<i>Compliance Path #2</i>	<u>0.32</u>	<u>0.60</u>	<u>0.026</u>	<u>0.082</u>	<u>0.082</u>	<u>0.033</u>	<u>0.059</u> <i>(minimum 4 feet)</i>	<u>0.065</u>

- a. *Nonfenestration U-factors shall be obtained from measurement, calculation or approved referenced publications approved in accordance with this code.*
- b. *When more than half the insulation is on the interior, the mass wall U-factors shall be the same as the frame wall U-factor.*

**TABLE 1112.2.2.5**  
**STEEL-FRAME CEILING, WALL AND FLOOR INSULATION (R-VALUE)**

<u>WOOD FRAME R-VALUE REQUIREMENT</u>	<u>COLD-FORMED STEEL EQUIVALENT R-VALUE<sup>a</sup></u>
<b><u>Steel Truss Ceilings<sup>a</sup></u></b>	
<u>R-30</u>	<u>R-38 or R-30 + 3 or R-26 + 5</u>
<u>R-38</u>	<u>R-49 or R-38 + 3</u>
<u>R-49</u>	<u>R-38 + 5</u>
<b><u>Steel Joist Ceilings<sup>b</sup></u></b>	
<u>R-30</u>	<u>R-38 in 2 x 4 or 2 x 6 or 2 x 8 R-49 in any framing</u>
<u>R-38</u>	<u>R-49 in 2 x 4 or 2 x 6 or 2 x 8 or 2 x 10</u>
<b><u>Steel Framed Wall</u></b>	
<u>R-13</u>	<u>R-13 + 5 or R15 + 4 or R-21 + 3 or R-0 + 10</u>
<u>R-15 or R-13+3</u>	<u>R-0 + 11.2 or R-13 + 6.1 or R-15 + 5.7 or R-19 + 5.0 or R-21 + 4.7</u>
<u>R-19</u>	<u>R-13 + 9 or R-19 + 8 or R-25 + 7</u>
<u>R-21</u>	<u>R-13 + 10 or R-19 + 9 or R-25 + 8</u>
<b><u>Steel Joist Floor</u></b>	
<u>R-13</u>	<u>R-19 in 2 x 6, R-19 + 6 in 2 x 8 or 2 x 10</u>
<u>R-19</u>	<u>R-19 + 6 in 2 x 6, R-19 + 12 in 2 x 8 or 2 x 10</u>
<u>R-30</u>	<u>R-19 + 6 in 2 x 6, R-19 + 12 in 2 x 8 or 2 x 10</u>

*For SI: 1 inch = 25.4 mm.*

- a. *Cavity insulation R-value is listed first, followed by continuous insulation R-value.*
- b. *Insulation exceeding the height of the framing shall cover the framing.*

**1112.2.2.9 Crawl space walls.** *As an alternative to insulating floors over crawl spaces, insulation of crawl space walls shall be permitted when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the floor to the finished grade level and then vertically and/or horizontally for at least an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder. All joints of the vapor retarder shall overlap by 6 inches (152 mm) and be sealed or taped. The edges of the vapor retarder shall extend at least 6 inches (152 mm) up the stem wall and shall be attached to the stem wall.*

**1112.2.2.10 Masonry veneer.** *Insulation shall not be required on the horizontal portion of the foundation that supports a masonry veneer.*

**1112.2.2.11 Thermally isolated sunroom insulation.** *The minimum ceiling insulation R-values shall be R-24. The minimum wall R-value shall be R-13. New wall(s) separating the sunroom from conditioned space shall meet the building thermal envelope requirements.*

### **1112.2.3 Fenestration.**

**1112.2.3.1 U-factor.** *An area-weighted average of fenestration products shall be permitted to satisfy the U-factor requirements.*

**1112.2.3.2 Glazed fenestration SHGC.** *An area-weighted average of fenestration products more than 50 percent glazed shall be permitted to satisfy the solar heat gain coefficient (SHGC) requirements.*

**1112.2.3.3 Glazed fenestration exemption.** *Up to 15 square feet (1.4 m<sup>2</sup>) of glazed fenestration per dwelling unit shall be permitted to be exempt from U-factor and SHGC requirements in Section 1112.2.1. This exemption shall not apply to the U-factor alternative approach in Section 1112.2.1.2 and the Total UA alternative in Section 1112.2.1.3.*

**1112.2.3.4 Opaque door exemption.** *One side-hinged opaque door assembly up to 24 square feet (2.22 m<sup>2</sup>) in area is exempted from the U-factor requirement in Section 1112.2.1. This exemption shall not apply to the U-factor alternative approach in Section 1112.2.1.2 and the Total UA alternative in Section 1112.2.1.3.*

**1112.2.3.5 Thermally isolated sunroom U-factor.** *The maximum fenestration U-factor shall be 0.50 and the maximum skylight U-factor shall*

be 0.75. New windows and doors separating the sunroom from conditioned space shall meet the building thermal envelope requirements.

**1112.2.3.6 Replacement fenestration.** Where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for U-factor and solar heat gain coefficient (SHGC) in Table 1112.2.1

#### **1112.2.4 Air leakage.**

**1112.2.4.1 Building thermal envelope.** The building thermal envelope shall be durably sealed to limit infiltration. The sealing methods between dissimilar materials shall allow for differential expansion and contraction. The following shall be caulked, gasketed, weatherstripped or otherwise sealed with an air barrier material, suitable film or solid material.

1. All joints, seams and penetrations.
2. Site-built fenestration products.
3. Openings between window and door assemblies and their respective jambs and framing
4. Utility penetrations.
5. Dropped ceilings or chases adjacent to the thermal envelope.
6. Knee walls.
7. Walls and ceilings separating the garage from conditioned spaces. Behind tubs and showers on exterior walls.
8. Common walls between dwelling units. Attic access openings. Rim joists junction.
9. Other sources of infiltration.

**1112.2.4.2 Air sealing and insulation.** Building envelope air tightness and insulation installation shall be demonstrated to comply with Section 1112.2.4.2.1.

**1112.2.4.2.1 Testing.** Tested air leakage is less than 5 ACH when tested with a blower door at a pressure of 50 pascals (0.007 psi). Testing shall occur after rough in and after installation of penetrations of the building envelope, including penetrations for utilities, plumbing, electrical, ventilation and combustion appliances.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed;

2. Dampers shall be closed, but not sealed; including exhaust, intake, makeup air, back draft, and flue dampers;
3. Interior doors shall be open;
4. Exterior openings for continuous ventilation systems and heat recovery ventilators shall be closed and sealed;
5. Heating and cooling system(s) shall be turned off;
6. HVAC ducts shall not be sealed; and
7. Supply and return registers shall not be sealed.

**1112.2.4.2.1.1 Sampling.** Where groups of seven or more buildings of similar design and construction are completed and are issued occupancy permits during a 120 day period, testing of less than 100 percent, but not less than 1 in 7 or 15 percent, of the buildings from a specific builder and/or contractor or of dwelling units to be tested shall be selected by the code official. If any tested building fails to comply with the maximum air leakage requirement in Section 1112.2.4.2.1 then all buildings shall be tested until a minimum of three consecutive buildings comply from that specific builder and/or contractor before the code official may permit sampling to resume.

**1112.2.4.3 Fireplaces.** New wood-burning fireplaces shall have doors or tight-fitting flue dampers and outdoor combustion air. If using tight-fitting doors on UL 127 fireplaces, they must be tested and listed for the fireplace.

**1112.2.4.4 Fenestration air leakage.** Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cubic foot per minute per square foot [1.5(L/s)/m<sup>2</sup>], and swinging doors no more than 0.5 cubic foot per minute per square foot [2.5(L/s)/m<sup>2</sup>], when tested according to NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/ A440 by an approved agency, and listed and labeled by the manufacturer.

**Exception:** Site-built fenestration products.

**1112.2.4.5 Recessed lighting.** Recessed luminaires installed in the building thermal envelope shall be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and labeled as meeting ASTM E 283 when tested at 1.57 psf (75 Pa) pressure differential with no more than 2.0 cfm (0.944 L/s) of air movement from the conditioned space to the ceiling cavity. All recessed luminaires shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.

**1112.2.5 Maximum fenestration U-factor and SHGC.** *The area-weighted average maximum fenestration U-factor permitted using trade-offs from Section 1112.2.1.3 shall be 0.48 for vertical fenestration, and 0.75 for skylights.*

### **1112.3 Systems.**

**1112.3.1 Controls.** *At least one thermostat shall be installed for each separate heating and cooling system.*

**1112.3.1.1 Programmable thermostat.** *Where the primary heating system is a forced air furnace, at least one thermostat per dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed with a heating temperature set point no higher than 70°F (21°C) and a cooling temperature set point no lower than 78°F (26°C).*

**1112.3.1.2 Heat pump supplementary heat.** *Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.*

### **1112.3.2 Ducts.**

**1112.3.2.1 Insulation.** *Supply ducts in attics shall be insulated to a minimum of R-8. All other ducts shall be insulated to a minimum of R-6.*

**Exception:** *Ducts or portions thereof located completely inside the building thermal envelope.*

**1112.3.2.2 Sealing.** *Ducts, air handlers, filter boxes and building cavities used as ducts shall be sealed. Joints and seams shall comply with Section 1601.4. Duct tightness shall be verified by either of the following:*

- 1. Post-construction test:** *Post-construction duct tightness shall be verified to meet the values prescribed in Table 1112.3.2.2(a) by testing either the "Leakage to Outdoors" or the "Total Leakage" in accordance with the chosen compliance path. Testing shall be conducted at a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler end*



closure. All register boots shall be taped or otherwise sealed during the test.

**TABLE 1112.3.2.2(a)**  
**POST-CONSTRUCTION DUCT TIGHTNESS TESTING**

	<b><u>Leakage to Outdoors</u></b> <i>(per 100 ft<sup>2</sup> (9.29 m<sup>2</sup>) of conditioned floor area)</i>	<b><u>Total Leakage</u></b> <i>(per 100 ft<sup>2</sup> (9.29 m<sup>2</sup>) of conditioned floor area)</i>
<u>Compliance Path #1</u>	<u>≤ 6 cfm (2.83 L/s)</u>	<u>≤ 9 cfm (4.24 L/s)</u>
<u>Compliance Path #2</u>	<u>≤ 4 cfm (1.89 L/s)</u>	<u>≤ 6 cfm (2.83 L/s)</u>

2. Rough-in test: Rough-in duct tightness shall be verified to meet the values prescribed in Table 1112.3.2.2(b) by testing the “Total Leakage” in accordance with the chosen compliance path. Testing shall be conducted at a pressure differential of 0.1 inch w.g. (25 Pa) across the roughed in system, including the manufacturer’s air handler enclosure, if installed at the time of the test. All register boots shall be taped or otherwise sealed during the test.

**TABLE 1112.3.2.2(b)**  
**ROUGH-IN DUCT TIGHTNESS TESTING**

	<b><u>Total Leakage – with air handler installed</u></b> <i>(per 100 ft<sup>2</sup> (9.29 m<sup>2</sup>) of conditioned floor area)</i>	<b><u>Total Leakage – without air handler installed</u></b> <i>(per 100 ft<sup>2</sup> (9.29 m<sup>2</sup>) of conditioned floor area)</i>
<u>Compliance Path #1</u>	<u>≤ 6 cfm (2.83 L/s)</u>	<u>≤ 4 cfm (1.89 L/s)</u>
<u>Compliance Path #2</u>	<u>≤ 4 cfm (1.89 L/s)</u>	<u>≤ 3 cfm (1.41 L/s)</u>

**Exception:** Duct tightness test is not required if the air handler and all ducts are located within conditioned space.

**1112.3.2.3 Building cavities.** Building framing cavities shall not be used as supply ducts.

**1112.3.3 Circulating hot water systems.** The first five feet of circulating service hot water piping shall be insulated to at least R-2. Circulating hot water systems shall include an automatic or readily accessible manual switch that can turn off the hot water circulating pump when the system is not in use.

**1112.3.4 Mechanical ventilation.** Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

**1112.3.5 Equipment sizing.** *Heating and cooling equipment shall be sized as specified in Section 1401.3.*

**1112.3.6 Snow melt system controls.** *Snow-and ice-melting systems supplied through energy service to the building shall include automatic controls capable of shutting off the system when the pavement temperature is above 50°F (10°C) and no precipitation is falling and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F (5°C).*

**1112.4 Lighting systems.**

**1112.4.1 Lighting equipment.** *A minimum of 90 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps.*

Replaces: 4101:8-11-01  
Effective: 7/1/2019  
Five Year Review (FYR) Dates: 07/01/2024

CERTIFIED ELECTRONICALLY

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Certification

12/14/2018

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Date

Promulgated Under: 119.03  
Statutory Authority: 3781.10(A)(1)  
Rule Amplifies: 3781.01, 4740.14, 3791.04, 3781.11, 3781.10, 3781.06  
Prior Effective Dates: 01/01/2008, 01/01/2009, 01/01/2013, 07/01/2014