

CHAPTER 4 [RE]

RESIDENTIAL ENERGY EFFICIENCY

User note:

About this chapter: Chapter 4 provides requirements for the thermal envelope of a building, including minimum insulation values for walls, ceiling and floors; maximum fenestration U-factors; minimum fenestration solar heat gain coefficients; and methods for determining building assembly and a total building U-factor. A performance alternative and an energy rating alternative are also provided to allow for energy code compliance other than by the prescriptive method.

SECTION R401 GENERAL

R401.1 Scope. This chapter applies to *residential buildings*.

R401.2 Compliance. Projects shall comply with one of the following:

1. Sections R401 through R404. In addition, *dwelling units* and *sleeping units* in a *residential building* shall comply with Section R406.
2. Section R405. In addition, *dwelling units* and *sleeping units* in a *residential building* shall comply with Section R406.
3. Section R407.

R401.3 Certificate. A permanent certificate shall be completed by the builder or other approved party and posted on a wall in the space where the furnace is located, a utility room, or an approved location inside the building. When 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 list the predominant *R*-values of insulation installed in or on ceiling/roof, walls, foundation (slab, *below-grade wall*, and/or floor) and ducts outside conditioned spaces; *U*-factors for fenestration and the solar heat gain coefficient (SHGC) of fenestration; the results from any required duct system and building envelope air leakage testing done on the building; and the results from the whole-house mechanical ventilation system flow rate test. 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, whole-house mechanical ventilation, and service water heating appliances. Where a gas-fired unvented room heater, electric furnace, 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 baseboard heaters.

The code *official* may require that documentation for any required test results include an electronic record of the time, date and location of the test. A date-stamped smart phone photo or air leakage testing software may be used to satisfy this requirement.

SECTION R402 BUILDING THERMAL ENVELOPE

R402.1 General (Prescriptive). The *building thermal envelope* shall meet the requirements of Sections R402.1.1 through R402.1.6.

Exception: The following buildings, or portions thereof, separated from the remainder of the building by building thermal envelope assemblies complying with this code shall be exempt from the building thermal envelope provisions of this code:

1. Those with a peak design rate of energy usage less than 3.4 Btu/h • ft² (10.7 W/m²) or 1.0 watt/ft² of floor area for space conditioning purposes.
2. Those that do not contain conditioned space.
3. Greenhouses isolated from any conditioned space and not intended for occupancy.

R402.1.1 Insulation and fenestration criteria. The *building thermal envelope* shall meet the requirements of Table R402.1.1 based on the climate zone specified in Chapter 3.

**TABLE R402.1.1
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT^a**

CLIMATE ZONE 5 AND MARINE 4	
FENESTRATION <i>U</i> -FACTOR ^b	0.30
SKYLIGHT ^b <i>U</i> -FACTOR	0.50
CEILING <i>R</i> -VALUE ^c	49
WOOD FRAME WALL ^{g, h} <i>R</i> -VALUE	21 int
FLOOR <i>R</i> -VALUE	30
BELOW-GRADE ^{c, h} WALL <i>R</i> -VALUE	10/15/21 int + 5TB
SLAB ^{d, f} <i>R</i> -VALUE & DEPTH	10, 2 ft

For SI: 1 foot = 304.8 mm, ci = continuous insulation, int = intermediate framing.

- a. *R*-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the compressed *R*-value of the insulation from Appendix Table A101.4 shall not be less than the *R*-value specified in the table.
- b. The fenestration *U*-factor column excludes skylights.
- c. “10/15/21 + 5TB” means R-10 continuous insulation on the exterior of the wall, or R-15 continuous insulation on the interior of the wall, or R-21 cavity insulation plus a thermal break between the slab and the basement wall at the interior of the basement wall. “10/15/21 + 5TB” shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the wall. “5TB” means R-5 thermal break between floor slab and basement wall.
- d. R-10 continuous insulation is required under heated slab on grade floors. See Section R402.2.9.1.
- e. For single rafter- or joist-vaulted ceilings, the insulation may be reduced to R-38 if the full insulation depth extends over the top plate of the exterior wall.
- f. R-7.5 continuous insulation installed over an existing slab is deemed to be equivalent to the required perimeter slab insulation when applied to existing slabs complying with Section R503.1.1. If foam plastic is used, it shall meet the requirements for thermal barriers protecting foam plastics.
- g. For log structures developed in compliance with Standard ICC 400, log walls shall meet the requirements for *climate zone 5* of ICC 400.
- h. Int. (intermediate framing) denotes framing and insulation as described in Section A103.2.2 including standard framing 16 inches on center, 78 percent of the wall cavity insulated and headers insulated with a minimum of R-10 insulation.

R402.1.2 *R*-value computation. Insulation *R*-value shall be determined as specified in Section R303.1.4. 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 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 R402.1.1, the manufacturer’s labeled *R*-value for insulated siding shall be reduced by R-0.6.

R402.1.3 *U*-factor alternative. An assembly with a *U*-factor equal to or less than that specified in Table R402.1.3 shall be permitted as an alternative to the *R*-value in Table R402.1.1. *U*-factors shall be determined as specified in Section R402.1.5.

**TABLE R402.1.3
EQUIVALENT *U*-FACTORS^a**

CLIMATE ZONE 5 AND MARINE 4	
FENESTRATION <i>U</i> -FACTOR	0.30
SKYLIGHT <i>U</i> -FACTOR	0.50
CEILING <i>U</i> -FACTOR	0.026
ABOVE-GRADE WALL <i>U</i> -FACTOR	0.056
FLOOR <i>U</i> -FACTOR	0.029
SLAB ON GRADE <i>F</i> -FACTOR ^b	0.54
BELOW GRADE 2' DEPTH	
Wall <i>U</i> -factor	0.042
Slab <i>F</i> -factor	0.59
BELOW GRADE 3.5' DEPTH	
Wall <i>U</i> -factor	0.040
Slab <i>F</i> -factor	0.56
BELOW GRADE 7' DEPTH	
Wall <i>U</i> -factor	0.035
Slab <i>F</i> -factor	0.50

- a. *U*-factors or *F*-factors shall be obtained from measurement, calculation or an approved source, or as specified in Section R402.1.5.

R402.1.4 Total UA alternative. If the proposed *building thermal envelope UA* is less than or equal to the target UA, the building shall be considered in compliance with Table R402.1.1. The proposed UA shall be calculated in accordance with Equation 2. The target UA shall be calculated in accordance with Equation 1. *U*-factors shall be determined as specified in Section R402.1.5.

R402.1.5 U-factor reference and calculations. The *U*-factors for typical construction assemblies are included in Appendix A in chapter 51-11C WAC. These values shall be used for all calculations. Where proposed construction assemblies are not represented in Appendix A, values shall be calculated in accordance with the ASHRAE *Handbook of Fundamentals* using the framing factors listed in Appendix A where applicable and shall include the thermal bridging effects of framing materials. The SHGC requirements shall be met in addition to UA compliance. Fenestration *U*-factors shall comply with Section R303.1.3, Fenestration product rating.

R402.1.6 Vapor retarder. Wall assemblies in the *building thermal envelope* shall comply with the vapor retarder requirements of Section R702.7 of the *International Residential Code* or Section ((1405.3)) 1404.3 of the *International Building Code*, as applicable.

**EQUATION 1 — GROUP R OCCUPANCY
TARGET UA**

$$UA_T = U_W A_W + U_{BGW} A_{BGW} + U_{VG} A_{VG} + U_{OG} A_{OG} + U_F A_F + U_{RC} A_{RC} + U_D A_D + F_S P_S + F_{BGS} P_{BGS}$$

Where:

- UA_T = the target combined thermal transmittance of the gross exterior wall, floor and roof/ceiling area.
- U_W = the thermal transmittance value of the opaque above grade wall found in Table R 402.1.3.
- A_W = opaque above grade wall area.
- U_{BGW} = the thermal transmittance value of the below grade opaque wall found in Table R 402.1.3.
- A_{BGW} = opaque below grade wall area.
- U_{VG} = the thermal transmittance value of the fenestration found in Table R 402.1.3.
- A_{VG} = (a) The proposed glazing area; where proposed fenestration glazing area is less than 15% of the conditioned floor area, minus A_{OG} .
(b) 15% of the conditioned floor area; where the proposed fenestration glazing area is 15% or more of the conditioned floor area, minus A_{OG} .
- U_{OG} = the thermal transmittance value of the skylight glazing found in Table R 402.1.3.
- A_{OG} = skylight glazing area (if the proposed A_{OG} exceeds 15 percent, the target A_{OG} shall be 15 percent of the total floor area of the conditioned space).
- U_F = the thermal transmittance value of the floor found in Table R 402.1.3.
- A_F = floor area over unconditioned space.
- U_{RC} = the thermal transmittance value of the ceiling found in Table R 402.1.3.
- A_{RC} = roof/ceiling area.
- U_D = the thermal transmittance value of the fenestration found in Table R 402.1.3.
- A_D = opaque door area.
- F_S = concrete slab on grade component F-factor found in Table R 402.1.3.
- P_S = lineal ft. of concrete slab on grade perimeter.
- F_{BGS} = concrete below grade slab component F-factor found in Table R 402.1.3.
- P_{BGS} = lineal ft. of concrete below grade slab perimeter.

**EQUATION 2 — GROUP R OCCUPANCY
PROPOSED UA**

$$U_A = U_W A_W + U_{BGW} A_{BGW} + U_{VG} A_{VG} + U_{OG} A_{OG} + U_F A_F + U_{RC} A_{RC} + U_D A_D + F_S P_S + F_{BGS} P_{BGS}$$

Where:

- U_A = the combined thermal transmittance of the gross exterior wall, floor and roof/ceiling assembly area.
- U_W = the thermal transmittance of the opaque above grade wall area.
- A_W = opaque above grade wall area.
- U_{BGW} = the thermal transmittance value of the below grade opaque wall.
- A_{BGW} = opaque below grade wall area.
- U_{VG} = the thermal transmittance value of the fenestration glazing.
- A_{VG} = fenestration glazing area, including windows in exterior doors.

U_{OG} = the thermal transmittance value of the skylight glazing.

A_{OG} = skylight glazing area.

U_F = the thermal transmittance of the floor.

A_F = floor area over unconditioned space.

U_{RC} = the thermal transmittance of the ceiling.

A_{RC} = ceiling area.

U_D = the thermal transmittance value of the opaque door area.

A_D = opaque door area.

F_S = concrete slab on grade component F-factor.

P_S = lineal ft. of concrete slab on grade perimeter.

F_{BGS} = concrete below grade slab component F-factor.

P_{BGS} = lineal ft. of concrete below grade slab perimeter.

NOTE: Where more than one type of wall, window, roof/ceiling, door and skylight is used, the U and A terms for those items shall be expanded into sub-elements as:

$$U_{W1}A_{W1} + U_{W2}A_{W2} + U_{W3}A_{W3} + \dots \text{ etc.}$$

NOTE: Below Grade Walls: The wall is assumed to extend from the slab upward to the top of the mud sill for the distance specified in Table A104.1, with 6 inches of concrete wall extending above grade. This will be calculated separately from above grade walls using the wall height that best describes the system.

R402.2 Specific insulation requirements. In addition to the requirements of Section R402.1, insulation shall meet the specific requirements of Sections R402.2.1 through R402.2.11.

R402.2.1 Ceilings with attic spaces. Where Section R402.1.1 would require R-49 in the ceiling, installing R-38 over 100 percent of the ceiling area requiring insulation 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 R402.1.3 and the total UA alternative in Section R402.1.4.

R402.2.1.1 Loose insulation in attic spaces. Open-blown or poured loose fill insulation may be used in attic spaces where the slope of the ceiling is not more than 3 feet in 12 and there is at least 30 inches of clear distance from the top of the bottom chord of the truss or ceiling joist to the underside of the sheathing at the roof ridge.

R402.2.2 Reserved.

R402.2.3 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 to 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.

R402.2.4 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 that 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.

Exception: Vertical doors that provide access from conditioned to unconditioned spaces shall be permitted to meet the fenestration requirements of Table R402.1.1.

R402.2.5 Mass walls. Mass walls, where used as a component of the thermal envelope of a building shall be one of the following:

1. Constructed of above-grade walls of concrete block, concrete, insulated concrete form, masonry cavity, brick but not brick veneer adobe, compressed earth block, rammed earth, mass timber, solid timber, or solid logs.
2. Any wall having a heat capacity greater than or equal to 6 Btu/ft² x °F (123 kJ/m³ x K).

R402.2.6 Steel-frame ceilings, walls, and floors. Steel-frame ceilings, walls, and floors shall comply with the U -factor requirements of Table R402.1.3.

R402.2.7 Floors. Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of the subfloor decking. Insulation supports shall be installed so spacing is no more than 24-inches on center. Foundation vents shall be placed so that the top of the vent is below the lower surface of the floor insulation.

Exceptions:


1. The floor framing cavity insulation shall be permitted to 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 R-value in Table R402.1.1 and extends from the bottom to the top of all perimeter floor framing members.
2. When foundation vents are not placed so that the top of the vent is below the lower surface of the floor insulation, a permanently attached baffle shall be installed at an angle of 30° from horizontal, to divert air flow below the lower surface of the floor insulation.
3. Substantial contact with the surface being insulated is not required in enclosed floor/ceiling assemblies containing ducts where full R-value insulation is installed between the duct and the exterior surface.

R402.2.8 Below-grade walls. Below-grade exterior wall insulation used on the exterior (cold) side of the wall shall extend from the top of the below-grade wall to the top of the footing and shall be approved for below-grade use. Above-grade insulation shall be protected. Insulation used on the interior (warm) side of the wall shall extend from the top of the below-grade wall to the below-grade floor level and shall include R-5 rigid board providing a thermal break between the concrete wall and the slab.

R402.2.9 Slab-on-grade floors. The minimum thermal resistance (*R*-value) of the insulation around the perimeter of unheated or heated slab-on-grade floors shall be as specified in Table R402.1.1. The insulation shall be placed on the outside of the foundation or on the inside of the foundation wall. The insulation shall extend downward from the top of the slab for a minimum distance as shown in the table or to the top of the footing, whichever is less, or downward to at least the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table. A two-inch by two-inch (maximum) pressure treated nailer may be placed at the finished floor elevation for attachment of interior finish materials. Insulation extending away from the building shall be protected by pavement or by a minimum of 10 inches (254 mm) of soil.

R402.2.9.1 Heated slab-on-grade floors. The entire area of a heated slab-on-grade floor shall be thermally isolated from the soil with a minimum of R-10 insulation. The insulation shall be an approved product for its intended use. If a soil gas control system is present below the heated slab-on-grade floor, which results in increased convective flow below the heated slab-on-grade floor, the heated slab-on-grade floor shall be thermally isolated from the sub-slab gravel layer. R-10 heated slab-on-grade floor insulation is required for all compliance paths.

R402.2.10 Masonry veneer. Insulation shall not be required on the horizontal portion of the foundation that supports a masonry veneer.

R402.3 Fenestration. In addition to the requirements of Section R402, fenestration shall comply with Sections R402.3.1 through R402.3.5. 

R402.3.1 U-factor. An area-weighted average of fenestration products shall be permitted to satisfy the *U*-factor requirements.

R402.3.2 Glazed fenestration SHGC. An area-weighted average of fenestration products more than 50 percent glazed shall be permitted to satisfy the SHGC requirements.

R402.3.3 Glazed fenestration exemption. Up to 15 square feet (1.4 m²) of glazed fenestration per dwelling unit shall be permitted to be exempt from *U*-factor and SHGC requirements in Section R402.1.1. This exemption shall not apply to the *U*-factor alternative approach in Section R402.1.3 and the total UA alternative in Section R402.1.4.

R402.3.4 Opaque door exemption. One side-hinged opaque door assembly up to 24 square feet (2.22 m²) in area is exempted from the *U*-factor requirement in Section R402.1.1. This exemption shall not apply to the *U*-factor alternative approach in Section R402.1.3 and the total UA alternative in Section R402.1.4.

R402.3.5 Reserved. 

R402.4 Air leakage. The building thermal envelope shall be constructed to limit air leakage in accordance with the requirements of Sections R402.4.1 through R402.4.4.

R402.4.1 Building thermal envelope. The *building thermal envelope* shall comply with Sections R402.4.1.1 and R402.4.1.2. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.

R402.4.1.1 Installation. The components of the *building thermal envelope* as listed in Table R402.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria listed in Table R402.4.1.1, as applicable to the method of construction. Where required by the *code official*, an *approved* third party shall inspect all components and verify compliance.

**TABLE R402.4.1.1
AIR BARRIER AND INSULATION INSTALLATION**

COMPONENT	AIR BARRIER CRITERIA ^a	INSULATION CRITERIA ^a
General requirements	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Cavity insulation installation		All cavities in the thermal envelope shall be filled with insulation. The density of the insulation shall be at the manufacturers' product recommendation and said density shall be maintained for all volume of each cavity. Batt type insulation will show no voids or gaps and maintain an even density for the entire cavity. Batt insulation shall be installed in the recommended cavity depth. Where an obstruction in the cavity due to services, blocking, bracing or other obstruction exists, the batt product will be cut to fit the remaining depth of the cavity. Where the batt is cut around obstructions, loose fill insulation shall be placed to fill any surface or concealed voids, and at the manufacturers' specified density. Where faced batt is used, the installation tabs must be stapled to the face of the stud. There shall be no compression to the batt at the edges of the cavity due to inset stapling installation tabs. Insulation that upon installation readily conforms to available space shall be installed filling the entire cavity and within the manufacturers' density recommendation.
Ceiling/attic	The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier sealed. Access openings, drop down stair or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier Batt insulation installed in attic roof assemblies may be compressed at exterior wall lines to allow for required attic ventilation.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and top of exterior walls shall be sealed. Knee walls shall be sealed.	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 minimum. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between window/door jambs and framing and skylights and framing shall be sealed.	
Rim joists	Rim joists shall include the air barrier.	Rim joists shall be insulated.
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	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 shall extend from the bottom to the top of all perimeter floor framing members.
Crawl space walls	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.	Crawl space insulation, where provided instead of floor insulation, shall be permanently attached to the walls.
Shafts, penetrations	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.	—
Narrow cavities	—	Batts in narrow cavities shall be cut to fit and installed to the correct density without any voids or gaps or compression, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	—
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be sealed to the finished surface.	Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.

**TABLE R402.4.1.1—continued
AIR BARRIER AND INSULATION INSTALLATION**

COMPONENT	AIR BARRIER CRITERIA ^a	INSULATION CRITERIA ^a
Plumbing and wiring	—	Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls. There shall be no voids or gaps or compression where cut to fit. Insulation that on installation readily conforms to available space shall extend behind piping and wiring.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the showers and tubs.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior wall	The air barrier shall be installed behind electrical or communication boxes or air sealed boxes shall be installed.	—
HVAC register boots	HVAC supply and return register boots shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	When 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.	—

IC = insulation contact

a. In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

R402.4.1.2 Testing. The building or dwelling unit shall be tested and verified as having an air leakage rate of not exceeding 5 air changes per hour. Testing shall be conducted with a blower door at a pressure of 0.2 inches w.g. (50 Pascals). For this test only, the volume of the home shall be the conditioned floor area in ft² (m²) multiplied by 8.5 feet (2.6 m). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope*. Once visual inspection has confirmed sealing (see Table R402.4.1.1), operable windows and doors manufactured by *small business* shall be permitted to be sealed off at the frame prior to the test.

Exception: For dwelling units that are accessed directly from the outdoors, other than detached one family dwellings and townhouses, an air leakage rate not exceeding 0.4 cfm per square foot of the dwelling unit enclosure area shall be an allowable alternative. Testing shall be conducted with a blower door at a pressure of 0.2 inches w.g. (50 Pascals) in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827. For the purpose of this test only, enclosure area to be calculated as the perimeter of the dwelling unit, measured to the outside face of the exterior walls, and the centerline of party walls, times 8.5 feet, plus the ceiling and floor area. Doors and windows of adjacent dwelling units (including top and bottom units) shall be open to the outside during the test. This exception is not permitted for dwelling units that are accessed from corridors or other enclosed common areas.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weather-stripping 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, if installed at the time of the test, shall be open, access hatches to conditioned crawl spaces and conditioned attics shall be open.
4. Exterior or interior terminations for continuous ventilation systems and heat recovery ventilators shall be sealed.
5. Heating and cooling systems, if installed at the time of the test, shall be turned off.
6. Supply and return registers, if installed at the time of the test, shall be fully open.

Exceptions:

1. Additions less than 500 square feet of conditioned floor area.
2. Additions tested with the existing home having a combined maximum air leakage rate of 7 air changes per hour. To qualify for this exception, the date of construction of the existing house must be prior to the 2009 Washington State Energy Code.

R402.4.2 Fireplaces. New wood-burning fireplaces shall have tight-fitting flue dampers or doors and outdoor combustion air. When 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. When using tight-fitting doors on masonry fireplaces, the doors shall be listed and labeled in accordance with UL 907.

R402.4.2.1 Gas fireplace efficiency. All gas fireplace heaters rated to ANSI Z21.88 shall be listed and labeled with a fireplace efficiency (FE) rating of 50 percent or greater in accordance with CSA P.4.1. Vented gas fireplaces (decorative appliances) certified to ANSI Z21.50 shall be listed and labeled, including their FE ratings, in accordance with CSA P.4.1.

R402.4.3 Air leakage of fenestration. Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm per square foot (1.5 L/s/m²), and swinging doors no more than 0.5 cfm per square foot (2.6 L/s/m²), when tested according to NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 by an accredited, independent laboratory and *listed* and *labeled* by the manufacturer.

Exceptions:

1. Field-fabricated fenestration products (windows, skylights and doors).
2. Custom exterior fenestration products manufactured by a small business provided they meet the applicable provisions of Chapter 24 of the *International Building Code*. Once visual inspection has confirmed the presence of a gasket, operable windows and doors manufactured by *small business* shall be permitted to be sealed off at the frame prior to the test.

R402.4.4 Combustion air openings. Where open combustion air ducts provide combustion air to open combustion, space conditioning fuel burning appliances, the appliances and combustion air openings shall be located outside of the building thermal envelope, or enclosed in a room isolated from inside the thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table R402.1.1, where the walls, floors and ceilings shall meet the minimum of the below-grade 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 R403. The combustion air duct shall be insulated where it passes through conditioned space to a minimum of R-8.

Exceptions:

1. Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.
2. Fireplaces and stoves complying with Section R402.4.2 and Section R1006 of the International Residential Code.

R402.4.5 Recessed lighting. Recessed luminaires installed in the *building thermal envelope* shall be Type IC-rated and certified under ASTM E283 as having an air leakage rate not more than 2.0 cfm (0.944 L/s) when tested at a 1.57 psf (75 Pa) pressure differential and shall have a label attached showing compliance with this test method. All recessed luminaires shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.

R402.5 Maximum fenestration U-factor. The area-weighted average maximum fenestration *U*-factor permitted using tradeoffs from Section R402.1.4 or R405 shall be 0.48 for vertical fenestration, and 0.75 for skylights.

SECTION R403 SYSTEMS

R403.1 Controls. At least one thermostat shall be provided for each separate heating and cooling system.

R403.1.1 Programmable or connected thermostat. Where the primary heating system is a forced-air furnace, at least one thermostat per dwelling unit shall be Energy Star certified and capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. The thermostat shall allow for, at a minimum, a 5-2 programmable schedule (weekdays/weekends) and be capable of providing at least two programmable setback/setup periods per day. This thermostat shall include the capability to set back, set up 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 by the manufacturer 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). The thermostat and/or control system shall have an adjustable deadband of not less than 10°F.

Exceptions:

1. Systems controlled by an occupant sensor that is capable of shutting the system off when no occupant is sensed for a period of up to 30 minutes.
2. Systems controlled solely by a manually operated timer capable of operating the system for no more than two hours.
3. Ductless mini-split heat pump systems that have an integral proprietary thermostat.

R403.1.2 Heat pump supplementary heat. Unitary air cooled heat pumps shall include controls that minimize supplemental heat usage during start-up, set-up, and defrost conditions. These controls shall anticipate need for heat and use compression heating as the first stage of heat. Controls shall indicate when supplemental heating is being used through visual means (e.g., LED indicators). Heat pumps equipped with supplementary heaters shall be installed with controls that prevent supplemental heater operation above 40°F. At final inspection the auxiliary heat lock out control shall be set to 35°F or less.

R403.1.3 Continuously burning pilot lights. The natural gas systems and equipment listed below are not permitted to be equipped with continuously burning pilot lights.

1. Fan-type central furnaces.
2. Household cooking appliances.

Exception: Household cooking appliances without electrical supply voltage connections and in which each pilot light consumes less than 150 Btu/hr.

3. Pool heaters.
4. Spa heaters.
5. Fireplaces

Exception: Any fireplace with on-demand, intermittent or interrupted ignition (as defined in ANSI Z21.20) is not considered continuous.

R403.2 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 temperature setback control that lowers the boiler water temperature based on the outdoor temperature.

R403.3 Ducts. Ducts and air handlers shall be installed in accordance with Sections R403.3.1 through R403.3.7.

R403.3.1 Insulation. Ducts outside the building thermal envelope shall be insulated to a minimum of R-8. Ducts within a concrete slab or in the ground shall be insulated to R-10 with insulation designed to be used below grade.

Exception: Ducts or portions thereof located completely inside the *building thermal envelope*. Ducts located in crawl spaces do not qualify for this exception.

R403.3.2 Sealing. Ducts, air handlers, and filter boxes shall be sealed. Joints and seams shall comply with either the *International Mechanical Code* or *International Residential Code*, as applicable.

Exceptions:

1. Air-impermeable spray foam products shall be permitted to be applied without additional joint seals.
2. For ducts having a static pressure classification of less than 2 inches of water column (500 Pa), additional closure systems shall not be required for continuously welded joints and seams, and locking-type joints and seams of other than the snap-lock and button-lock types.

R403.3.2.1 Sealed air handler. Air handlers shall have a manufacturer's designation for an air leakage of no more than 2 percent of the design air flow rate when tested in accordance with ASHRAE 193.

R403.3.3 Duct testing. Ducts shall be leak tested in accordance with WSU RS-33, using the maximum duct leakage rates specified.

Exceptions:

1. The total leakage test or leakage to the outdoors is not required for ducts and air handlers located entirely within the building thermal envelope. For forced air ducts, a maximum of 10 linear feet of return ducts and 5 linear feet of supply ducts may be located outside the conditioned space. All metallic ducts located outside the conditioned space must have both transverse and longitudinal joints sealed with mastic. If flex ducts are used, they cannot contain splices. Flex duct connections must be made with nylon straps and installed using a plastic strapping tensioning tool. Ducts located in crawl spaces do not qualify for this exception.
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 shall be signed by the party conducting the test and provided to the code official.

R403.3.4 Duct leakage. The total leakage of the ducts, where measured in accordance with Section R403.3.3, shall be as follows:

1. Rough-in test: Total leakage shall be less than or equal to 4 cfm (113.3 L/min) per 100 square feet (9.29 m²) of conditioned floor area when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure. All registers shall be taped or otherwise sealed during the test. If the air handler is not installed at the time of the test, total leakage shall be less than or equal to 3 cfm (85 L/min) per 100 square feet (9.29 m²) of conditioned floor area.
2. Postconstruction test: Leakage to outdoors shall be less than or equal to 4 cfm (113.3 L/min) per 100 square feet (9.29 m²) of conditioned floor area or total leakage shall be less than or equal to 4 cfm (113.3 L/min) per 100 square feet (9.29 m²) of conditioned floor area when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. All register boots shall be taped or otherwise sealed during the test.

R403.3.5 Building cavities. Building framing cavities shall not be used as ducts or plenums. Installation of ducts in exterior walls, floors or ceilings shall not displace required envelope insulation.

R403.3.6 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 ducts 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*-value 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.

Exception: Sections of the supply duct that are less than 3 feet (914 mm) from the supply outlet shall not be required to comply with these requirements.

R403.3.6.1 Effective *R*-value of deeply buried ducts. Where using a simulated energy performance analysis, sections of ducts that are: installed in accordance with Section R403.3.6; 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.

R403.3.7 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. All duct systems shall be located completely within the continuous air barrier and within the building thermal envelope.
2. All heating, cooling and ventilation system components shall be installed inside the conditioned space including, but not limited to, forced air ducts, hydronic piping, hydronic floor heating loops, convectors and radiators. Combustion equipment shall be direct vent or sealed combustion.
3. For forced air ducts, a maximum of 10 linear feet of return ducts and 5 linear feet of supply ducts is permitted to be located outside the conditioned space, provided they are insulated to a minimum of R-8.
 - 3.1. Metallic ducts located outside the conditioned space must have both transverse and longitudinal joints sealed with mastic.
 - 3.2. If flex ducts are used, they cannot contain splices. Flex duct connections must be made with nylon straps and installed using a plastic strapping tensioning tool.

R403.4 Mechanical system piping insulation. Mechanical system piping capable of carrying fluids above 105°F (41°C) or below 55°F (13°C) shall be insulated to a minimum of R-6.

Exception: Up to 200 feet of hydronic system piping installed within the conditioned space may be insulated with a minimum of 1/2-inch insulation with a *k* value of 0.28.

R403.4.1 Protection of piping insulation. Piping insulation exposed to weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance, and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be permitted.

R403.5 Service hot water systems. Energy conservation measures for service hot water systems shall be in accordance with Sections R403.5.1 through R403.5.5. Service water-heating equipment shall meet the requirements of DOE 10 CFR Part 430 Uniform Energy Factor or the equipment shall meet the requirements of Section C404.2.

R403.5.1 Heated water circulation and temperature maintenance system. Heated water circulation systems shall be in accordance with Section R403.5.1.1. Heat trace temperature maintenance systems shall be in accordance with Section R403.5.1.2. Automatic controls, temperature sensors and pumps shall be *accessible*. Manual controls shall be *readily accessible*.

R403.5.1.1 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 thermo-syphon 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.

R403.5.1.2 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.

R403.5.2 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).

R403.5.3 Hot water pipe insulation. Insulation for hot water pipe, both within and outside the conditioned space, shall have a minimum thermal resistance (*R*-value) of R-3.

Exception: Pipe insulation is permitted to be discontinuous where it passes through studs, joists or other structural members and where the insulated pipes pass other piping, conduit or vents, provided the insulation is installed tight to each obstruction.

R403.5.4 Drain water heat recovery units. Drain water heat recovery units shall comply with CSA 55.2 or IAPMO PS 92. Drain water heat recovery units shall be in accordance with CSA 55.1 or IAPMO IGC 346-2017.

R403.5.5 Electric water heater insulation. All electric water heaters in unconditioned spaces, or on concrete floors in conditioned spaces, shall be placed on an insulated surface with a minimum thermal resistance of R-10, and a minimum compressive strength of 40 psi or engineered to support the appliance.

R403.6 Mechanical ventilation. The building shall be provided with ventilation that meets the requirements of the *International Residential Code* or *International Mechanical Code*, as applicable, 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.

R403.6.1 Whole-house mechanical ventilation system fan efficacy. Mechanical ventilation system fans shall meet the efficacy requirements of Table R403.6.1.

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

**TABLE R403.6.1
MECHANICAL VENTILATION SYSTEM FAN EFFICACY**

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

R403.7 Equipment sizing and efficiency rating. 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. The output capacity of heating and cooling equipment shall not be greater than that of the smallest available equipment size that exceeds the loads calculated, including allowable oversizing limits. Equipment shall meet the minimum federal efficiency standards as referenced in Tables C403.3.2(1), C403.3.2(2), C403.3.2(3), C403.3.2(4), C403.3.2(5), C403.3.2(6), C403.3.2(7), C403.3.2(8) and C403.3.2(9) and tested and rated in accordance with the applicable test procedure.

R403.7.1 Electric resistance zone heated units. All detached one- and two-family dwellings and multiple single-family dwellings (townhouses) up to three stories in height above grade plan using electric zonal heating as the primary heat source shall install an inverter-driven ductless mini-split heat pump in the largest zone in the dwelling. Building permit drawings shall specify the heating equipment type and location of the heating system.

Exception: Total installed heating capacity of 2 kW per dwelling or less.

R403.8 Systems serving multiple dwelling units. Systems serving multiple dwelling units shall comply with Sections C403 and C404 of the WSEC—Commercial Provisions in lieu of Section R403.

R403.9 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, and no precipitation is falling and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F.

R403.10 Pool and permanent spa energy consumption. Pools and permanent spas shall comply with Sections R403.10.1 through R403.10.4.2.

R403.10.1 Heaters. The electric power to heaters shall be controlled by a *readily accessible* on-off switch that is an integral part of the heater mounted on the exterior of the heater, or external to and within 3 feet (914 mm) of the heater. Operation of such switch shall not change the settings of the heater thermostat. Such switches shall be in addition to a circuit breaker for the power to the heater.

R403.10.2 Time switches. Time switches or other control method that can automatically turn off and on according to a preset schedule shall be installed for heaters and pump motors. Heaters and pump motors that have built in time switches shall be deemed in compliance with this requirement.

Exceptions:

1. Where public health standards require 24-hour pump operation.
2. Pumps that operate solar- and waste-heat-recovery pool heating systems.

R403.10.3 Covers. Outdoor heated pools and outdoor permanent spas shall be provided with a vapor-retardant cover or other approved vapor-retardant means.

Exception: Where more than 75 percent of the energy for heating, computed over an operating season of not less than three calendar months, is from a heat pump or on-site renewable energy system, covers or other vapor-retardant means shall not be required.

R403.10.4 Residential pool pumps. Pool pump motors may not be split-phase or capacitor start-induction run type.

R403.10.4.1 Two-speed capability.

1. Pump motors: Pool pump motors with a capacity of 1 hp or more shall have the capability of operating at two or more speeds with low speed having a rotation rate that is no more than one-half of the motor’s maximum rotation rate.
2. Pump controls: Pool pump motor controls shall have the capability of operating the pool pump with at least two speeds. The default circulation speed shall be the lowest speed, with a high speed override capability being for a temporary period not to exceed one normal cycle.

R403.10.4.2 Pump operation. Circulating water systems shall be controlled so that the circulation pump(s) can be conveniently turned off, automatically or manually, when the water system is not in operation.

R403.11 Portable spas. The energy consumption of electric-powered portable spas shall be controlled by the requirements of APSP-14.

R403.12 Residential pools and permanent residential spas. Residential swimming pools and permanent residential spas that are accessory to detached one- and two-family dwellings and townhouses three stories or less in height above grade plane and that are available only to the household and its guests shall be in accordance with APSP 15.

**SECTION R404
ELECTRICAL POWER AND LIGHTING SYSTEMS**

R404.1 Lighting equipment. Not less than 90 percent of lamps in permanently installed lighting fixtures shall be high-efficacy lamps.

R404.1.1 Lighting equipment. Fuel gas lighting systems shall not have continuously burning pilot lights.

**SECTION R405
SIMULATED PERFORMANCE ALTERNATIVE (PERFORMANCE)**

R405.1 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.

R405.2 Mandatory requirements. Compliance with this section requires compliance with those sections shown in Table R405.2. All supply and return ducts not completely inside the *building thermal envelope* shall be insulated to a minimum of R-8.

**TABLE R405.2
MANDATORY COMPLIANCE MEASURES FOR SIMULATED PERFORMANCE ALTERNATIVE**

SECTION	TITLE	COMMENTS
General		
R401.3	Certificate	
Envelope		
R402.4	Air leakage	
R402.5	Maximum fenestration U-factor	
Systems		
R403.1	Controls	
R403.1.2	Heat pump supplemental heat	
R403.3.2	Sealing	
R403.3.1	Equipment and system sizing	
R403.3.3	Duct testing	
R403.3.4	Duct leakage	

TABLE R405.2—continued
MANDATORY COMPLIANCE MEASURES FOR SIMULATED PERFORMANCE ALTERNATIVE

SECTION	TITLE	COMMENTS
R403.3.5	Building cavities	
R403.4	Mechanical system piping insulation	
R403.5.1	Heated water circulation and temperature maintenance system	
R403.6	Mechanical ventilation	
R403.7	Equipment sizing and efficiency rating	
R403.8	Systems serving multiple dwelling units	
R403.9	Snow melt system controls	
R403.10	Pool and permanent spa energy consumption	
R403.11	Portable spas	
Electrical Power and Lighting		
R404.1	Lighting equipment	
R404.1.1	Lighting equipment	
Other Requirements		
R406	Additional energy efficiency requirements	

R405.3 Performance-based compliance. Compliance based on simulated energy performance requires that a proposed residence (*proposed design*) be shown to have an annual energy consumption based on carbon emissions of the fuels and energy use in the proposed building. Carbon emissions for both the standard reference design and the proposed design shall be calculated using Table R405.3. Energy use derived from simulation analysis shall be expressed in pounds of carbon per square foot of *conditioned floor area* as follows:

1. For structures less than 1,500 square feet of conditioned floor area, the annual carbon emissions shall be less than or equal to 73 percent of the annual carbon emissions of the *standard reference design*.
2. For structures 1,500 to 5,000 square feet of conditioned floor area, the annual carbon emissions shall be no more than 56 percent of the *standard reference design*.
3. For structures over 5,000 square feet of conditioned floor area, the annual carbon emissions shall be no more than 50 percent of the *standard reference design*.
4. For structures serving Group R-2 occupancies, the annual carbon emissions shall be less than or equal to 70 percent of the annual carbon emissions of the *standard reference design*.

TABLE R405.3
CARBON EMISSIONS FACTORS

TYPE	CO ₂ e (lb/unit)	UNIT
Electricity	0.80	kWh
Natural gas	11.7	Therm
Oil	19.2	Gallon
Propane	10.5	Gallon
Other ^a	195.00	mmBtu
On-site renewable energy	0.00	

a. District energy systems may use alternative emission factors supported by calculations *approved* by the *code official*.

R405.4 Documentation. Documentation of the software used for the performance design and the parameters for the *building* shall be in accordance with Sections R405.4.1 through R405.4.3.

R405.4.1 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 *code official*.

R405.4.2 Compliance report. Compliance software tools shall generate a report that documents that the *proposed design* complies with Section R405.3. 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 code official before a certificate of occupancy is issued. Batch sampling of buildings to determine energy code compliance for all buildings in the batch shall be prohibited.

Compliance reports shall include information in accordance with Sections R405.4.2.1 and R405.4.2.2. Where the *proposed design* of a building could be built on different sites where the cardinal orientation of the building on each site is differ-

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ent, compliance of the *proposed design* for the purposes of the application for the building permit shall be based upon 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.

R405.4.2.1 Compliance report for permit application. A compliance report submitted with the application for building permit shall include all of the following:

1. Building street address, or other building site identification.
2. A statement indicating that the *proposed design* complies with Section R405.3.
3. An inspection checklist documenting the building component characteristics of the *proposed design* as indicated in Table R405.5.2(1). The inspection checklist shall show results for both the *standard reference design* and the *proposed design* with all user inputs to the compliance software to generate the results.
4. A site-specific energy analysis report that is in compliance with Section R405.3.
5. Name of the individual performing the analysis and generating the report.
6. Name and version of the compliance software tool.

R405.4.2.2 Compliance report for certificate of occupancy. A compliance report submitted for obtaining the certificate of occupancy shall include all of the following:

1. Building street address, or other building site identification.
2. A statement indicating that the as-built building complies with Section R405.3.
3. A certificate indicating that the building passes the performance matrix for code compliance and the energy saving features of the buildings.
4. A site-specific energy analysis report that is in compliance with Section R405.3.
5. Name of the individual performing the analysis and generating the report.
6. Name and version of the compliance software tool.

R405.4.3 Additional documentation. The *code 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 builder providing the building component characteristics of the *proposed design* as given in Table R405.5.2(1).
3. Documentation of the actual values used in the software calculations for the *proposed design*.

R405.5 Calculation procedure. Calculations of the performance design shall be in accordance with Sections R405.5.1 and R405.5.2.

R405.5.1 General. Except as specified by this section, the *standard reference design* and *proposed design* shall be configured and analyzed using identical methods and techniques.

R405.5.2 Residence specifications. The *standard reference design* and *proposed design* shall be configured and analyzed as specified by Table R405.5.2(1). Table R405.5.2(1) shall include by reference all notes contained in Table R402.1.1.

**TABLE R405.5.2(1)
SPECIFICATIONS FOR THE STANDARD REFERENCE DESIGN AND PROPOSED DESIGNS**

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Above-grade walls	Type: Mass wall if proposed wall is mass; otherwise wood frame.	As proposed
	Gross area: Same as proposed	As proposed
	<i>U</i> -factor: From Table R402.1.3	As proposed
	Solar absorptance = 0.75	As proposed
	Remittance = 0.90	As proposed
Below-grade walls	Type: Same as proposed	As proposed
	Gross area: same as proposed	As proposed
	<i>U</i> -factor: From Table R402.1.3, with insulation layer on interior side of walls.	As proposed
Above-grade floors	Type: Wood frame	As proposed
	Gross area: Same as proposed	As proposed
	<i>U</i> -factor: From Table R402.1.3	As proposed

**TABLE R405.5.2(1)—continued
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Ceilings	Type: Wood frame	As proposed
	Gross area: Same as proposed	As proposed
	U-factor: From Table R402.1.3	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 aperture = 1 ft ² per 300 ft ² ceiling area.	As proposed
Foundations	Type: Same as proposed foundation wall area above and below-grade	As proposed
	Soil characteristics: Same as proposed.	As proposed
Opaque Doors	Area: 40 ft ²	As proposed
	Orientation: North	As proposed
	U-factor: Same as fenestration from Table R402.1.3.	As proposed
Vertical fenestration other than opaque doors ^a	Total area ^h = (a) The proposed glazing area; where proposed glazing area is less than 15% of the conditioned floor area. (b) 15% of the conditioned floor area; where the proposed glazing area is 15% or more of the conditioned floor area.	As proposed
	Orientation: equally distributed to four cardinal compass orientations (N, E, S & W).	As proposed
	U-factor: From Table R402.1.3	As proposed
	SHGC: From Table R402.1.1 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
	Interior shade fraction: 0.92 - (0.21 × SHGC for the standard reference design)	0.92 - (0.21 × SHGC as proposed)
	External shading: None	As proposed
	Skylights	None
Air exchange rate	Air leakage rate of 5 air changes per hour at a pressure of 0.2 inches w.g. (50 Pa). The mechanical ventilation rate shall be in addition to the air leakage rate and 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 N_{br} = number of bedrooms Energy recovery shall not be assumed for mechanical ventilation.	As proposed ^a . The mechanical ventilation rate ^b shall be in addition to the air leakage rate and shall be as proposed.
Mechanical ventilation	None, except where mechanical ventilation is specified by the proposed design, in which case: Annual vent fan energy use: $kWh/yr = (1e_f) \times (0.0876 \times CFA + 65.7 \times (N_{br} + 1))$ where: e_f = the minimum exhaust fan efficacy from Table R403.6.1 corresponding to a flow rate of $0.01 \times CFA + 7.5 \times (N_{br} + 1)$ CFA = conditioned floor area N_{br} = number of bedrooms	As proposed
Internal gains	IGain = 17,900 + 23.8 × CFA + 4104 × Nbr (Btu/day per dwelling unit)	Same as standard reference design
Internal mass	An internal mass for furniture and contents of 8 pounds per square foot of floor area.	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element ^c but not integral to the building envelope or structure.

**TABLE R405.5.2(1)—continued
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS**

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Structural mass	For masonry floor slabs, 80% of floor area covered by R-2 carpet and pad, and 20% of floor directly exposed to room air.	As proposed
	For masonry basement walls, as proposed, but with insulation required by Table R402.1.3 located on the interior side of the walls.	As proposed
	For other walls, for ceilings, floors, and interior walls, wood frame construction.	As proposed
Heating systems ^{d,e}	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 C403 of the WSEC—Commercial Provisions. For all other systems, the same system type as proposed, and the same system efficiency required by prevailing minimum federal standard. Capacity: Sized in accordance with Section R403.6	As proposed
Cooling systems ^{d,f}	Same system type as proposed. Same system efficiency as required by prevailing minimum federal standard. Capacity: Sized in accordance with Section R403.6.	As proposed
Service water heating ^{d,e,f,g}	Same system type as proposed. Same system efficiency as required by prevailing minimum federal standard. Use: Same as proposed design	As proposed gal/day = 30 + (10 × N _{br})
Thermal distribution systems	Duct insulation: From Section R403.3.3 A thermal distribution system efficiency (DSE) of 0.93 shall be applied to both the heating and cooling system efficiencies for all systems. Exception: For non-ducted heating and cooling systems that do not have a fan, the standard reference design distribution system efficiency (DSE) shall be 1.	As specified in Table R405.5.2(2)
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F	Same as standard reference

For SI: 1 square foot = 0.93 m², 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m², 1 gallon (US) = 3.785 L, °C = (°F - 32)/1.8, 1 degree = 0.79 rad.

- a. Where required by the *code official*, testing shall be conducted by an *approved* party. 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 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 must be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or must 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 with 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 with 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 with the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For the case of 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 townhouses, the following formula shall be used to determine fenestration area:

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

Where:

AF = Total fenestration area.

A_s = Standard reference design total fenestration area.

FA = (Above-grade thermal boundary gross wall area)/(above-grade boundary wall area + 0.5 x below-grade boundary wall area).

F = (Above-grade thermal boundary wall area)/(above-grade thermal boundary wall area + common wall area) or 0.56, 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 R405.5.2(2)
DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED DESIGNS^a**

DISTRIBUTION SYSTEM CONFIGURATION AND CONDITION	DISTRIBUTION SYSTEM EFFICIENCY
Distribution system components located in unconditioned space	0.88
Distribution systems entirely located in conditioned space ^b	0.93
Zonal systems ^c	1.00

For SI: 1 cubic foot per minute = 0.47 L/s, 1 square foot = 0.093 m², 1 pound per square inch = 6895 Pa, 1 inch water gauge = 1250 Pa.

- Values given by this table are for distribution systems, which must still meet all prescriptive requirements for duct and pipe system insulation and leakage.
- 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. All components must be located on the interior side of the thermal envelope (inside the insulation) and also inside of the air barrier. Refrigerant compressors and piping are allowed to be located outside.
- Zonal systems are systems where the heat source is located within each room. 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. Hydronic systems do not qualify.

R405.6 Calculation software tools. Calculation software, where used, shall be in accordance with Sections R405.6.1 through R405.6.3.

R405.6.1 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:

- 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 R403.6.
- 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.
- Printed *code official* inspection checklist listing each of the *proposed design* component characteristics from Table R405.5.2(1) determined by the analysis to provide compliance, along with their respective performance ratings (e.g., R-value, U-factor, SHGC, HSPF, AFUE, SEER, EF, etc.).

R405.6.2 Specific approval. Performance analysis tools meeting the applicable sections of Section R405 shall be permitted to be *approved*. Tools are permitted to be *approved* based on meeting a specified threshold for a jurisdiction. The *code official* shall be permitted to approve tools for a specified application or limited scope.

R405.6.3 Input values. When calculations require input values not specified by Sections R402, R403, R404 and R405, those input values shall be taken from an *approved* source.

SECTION R406 ADDITIONAL ENERGY EFFICIENCY REQUIREMENTS

R406.1 Scope. This section establishes additional energy efficiency requirements for all new construction covered by this code, including additions subject to Section R502 and change of occupancy or use subject to Section R505 unless specifically exempted in Section R406. Credit from both Sections R406.2 and R406.3 are required.

R406.2 Carbon emission equalization. This section establishes a base equalization between fuels used to define the equivalent carbon emissions of the options specified. The permit shall define the base fuel selection to be used and the points specified in Table R406.2 shall be used to modify the requirements in Section R406.3. The sum of credits from Tables R406.2 and R406.3 shall meet the requirements of Section R406.3.

R406.3 Additional energy efficiency requirements. Each dwelling unit in a residential building shall comply with sufficient options from Table R406.2 so as to achieve the following minimum number of credits:

- Small Dwelling Unit: 3.0 credits
Dwelling units less than 1500 square feet in conditioned floor area with less than 300 square feet of fenestration area. Additions to existing building greater than 500 square feet of heated floor area but less than 1500 square feet.
- Medium Dwelling Unit: 6.0 credits
All dwelling units that are not included in #1, #3 or #4.
- Large Dwelling Unit: 7.0 credits
Dwelling units exceeding 5000 square feet of conditioned floor area.
- Dwelling units serving R-2 occupancies: 4.5 credits
- Additions less than or equal to 500 square feet: 1.5 credits

RESIDENTIAL ENERGY EFFICIENCY

The drawings included with the building permit application shall identify which options have been selected and the point value of each option, regardless of whether separate mechanical, plumbing, electrical, or other permits are utilized for the project.

**TABLE R406.2
FUEL NORMALIZATION CREDITS**

SYSTEM TYPE	DESCRIPTION OF PRIMARY HEATING SOURCE	CREDITS	
		ALL OTHER	GROUP R-2
1	Combustion heating equipment meeting minimum federal efficiency standards for the equipment listed in Table C403.3.2(4) or C403.3.2(5)	0	0
2	For an initial heating system using a heat pump that meets federal standards for the equipment listed in Table C403.3.2(1)C or C403.3.2(2) or Air to water heat pump units that are configured to provide both heating and cooling and are rated in accordance with AHRI 550/590	1.0	1.0
3	For heating system based on electric resistance only (either forced air or Zonal)	-1.0	-1.0
4	For heating system based on electric resistance with a ductless mini-split heat pump system in accordance with Section R403.7.1 including the exception	0.5	N/A
5	All other heating systems	-1	-0.5

**TABLE R406.3
ENERGY CREDITS**

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2
1. EFFICIENT BUILDING ENVELOPE OPTIONS			
Only one option from Items 1.1 through 1.7 may be selected in this category.			
Compliance with the conductive UA targets is demonstrated using Section R402.1.4, Total UA alternative, where [1-(Proposed UA/Target UA)] > the required % UA reduction			
1.1	Prescriptive compliance is based on Table R402.1.1 with the following modifications: Vertical fenestration U = 0.24.	0.5	0.5
1.2	Prescriptive compliance is based on Table R402.1.1 with the following modifications: Vertical fenestration U = 0.20.	1.0	1.0
1.3	Prescriptive compliance is based on Table R402.1.1 with the following modifications: Vertical fenestration U = 0.28 Floor R-38 Slab on grade R-10 perimeter and under entire slab Below grade slab R-10 perimeter and under entire slab or Compliance based on Section R402.1.4: Reduce the Total conductive UA by 5%.	0.5	N/A
1.4	Prescriptive compliance is based on Table R402.1.1 with the following modifications: Vertical fenestration U = 0.25 Wall R-21 plus R-4 ci Floor R-38 Basement wall R-21 int plus R-5 ci Slab on grade R-10 perimeter and under entire slab Below grade slab R-10 perimeter and under entire slab or Compliance based on Section R402.1.4: Reduce the Total conductive UA by 15%.	1.0	1.0

**TABLE R406.3—continued
ENERGY CREDITS**

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2
1.5	<p>Prescriptive compliance is based on Table R402.1.1 with the following modifications:</p> <p>Vertical fenestration U = 0.22</p> <p>Ceiling and single-rafter or joist-vaulted R-49 advanced</p> <p>Wood frame wall R-21 int plus R-12 ci</p> <p>Floor R-38</p> <p>Basement wall R-21 int plus R-12 ci</p> <p>Slab on grade R-10 perimeter and under entire slab</p> <p>Below grade slab R-10 perimeter and under entire slab</p> <p>or</p> <p>Compliance based on Section R402.1.4: Reduce the Total conductive UA by 30%.</p>	2.0	1.5
1.6	<p>Prescriptive compliance is based on Table R402.1.1 with the following modifications:</p> <p>Vertical fenestration U = 0.18</p> <p>Ceiling and single-rafter or joist-vaulted R-60 advanced</p> <p>Wood frame wall R-21 int plus R-16 ci</p> <p>Floor R-48</p> <p>Basement wall R-21 int plus R-16 ci</p> <p>Slab on grade R-20 perimeter and under entire slab</p> <p>Below grade slab R-20 perimeter and under entire slab</p> <p>or</p> <p>Compliance based on Section R402.1.4: Reduce the Total conductive UA by 40%.</p>	3.0	2.0
1.7	<p>Advanced framing and raised heel trusses or rafters</p> <p>Vertical Glazing U-0.28</p> <p>R-49 Advanced (U-0.020) as listed in Section A102.2.1, <i>Ceilings below a vented attic</i></p> <p>and</p> <p>R-49 vaulted ceilings with full height of uncompressed insulation extending over the wall top plate at the eaves.</p>	0.5	0.5
<p>2. AIR LEAKAGE CONTROL AND EFFICIENT VENTILATION OPTIONS Only one option from Items 2.1 through 2.4 may be selected in this category.</p>			
2.1	<p>Compliance based on R402.4.1.2:</p> <p>Reduce the tested air leakage to 3.0 air changes per hour maximum at 50 Pascals</p> <p>or</p> <p>For R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.3 cfm/ft² maximum at 50 Pascals</p> <p>and</p> <p>All whole house ventilation requirements as determined by Section (M1507.3) <u>M1505.4</u> of the <i>International Residential Code</i> or Section (403.8) <u>403.4.4</u> of the <i>International Mechanical Code</i> shall be met with a high efficiency fan(s) (maximum 0.35 watts/cfm), not interlocked with the furnace fan (if present). Ventilation systems using a furnace including an ECM motor are allowed, provided that they are controlled to operate at low speed in ventilation only mode.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected, the maximum tested building air leakage, and shall show the qualifying ventilation system and its control sequence of operation.</p>	0.5	1.0

**TABLE R406.3—continued
ENERGY CREDITS**

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2
2.2	<p>Compliance based on Section R402.4.1.2: Reduce the tested air leakage to 2.0 air changes per hour maximum at 50 Pascals</p> <p>or</p> <p>For R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.25 cfm/ft² maximum at 50 Pascals</p> <p>and</p> <p>All whole house ventilation requirements as determined by Section ((M1507.3) <u>M1505.4</u> of the <i>International Residential Code</i> or Section ((403.8) <u>403.4.4</u> of the <i>International Mechanical Code</i> shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.65.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system.</p>	1.0	1.5
2.3	<p>Compliance based on Section R402.4.1.2: Reduce the tested air leakage to 1.5 air changes per hour maximum at 50 Pascals</p> <p>or</p> <p>For R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.25 cfm/ft² maximum at 50 Pascals</p> <p>and</p> <p>All whole house ventilation requirements as determined by Section ((M1507.3) <u>M1505.4</u> of the <i>International Residential Code</i> or Section ((403.8) <u>403.4.4</u> of the <i>International Mechanical Code</i> shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.75.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system.</p>	1.5	2.0
2.4	<p>Compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.6 air changes per hour maximum at 50 Pascals</p> <p>or</p> <p>For R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.15 cfm/ft² maximum at 50 Pascals</p> <p>and</p> <p>All whole house ventilation requirements as determined by Section ((M1507.3) <u>M1507.5</u> of the <i>International Residential Code</i> or Section ((403.8) <u>404.4</u> of the <i>International Mechanical Code</i> shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.80. Duct installation shall comply with Section R403.3.7.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system.</p>	2.0	2.5
3. HIGH EFFICIENCY HVAC EQUIPMENT OPTIONS			
Only one option from Items 3.1 through 3.6 may be selected in this category.			
3.1 ^a	<p>Energy Star rated (U.S. North) Gas or propane furnace with minimum AFUE of 95%</p> <p>or</p> <p>Energy Star rated (U.S. North) Gas or propane boiler with minimum AFUE of 90%.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.</p>	1.0	1.0
3.2 ^a	<p>Air-source centrally ducted heat pump with minimum HSPF of 9.5.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.</p>	1.0	N/A

**TABLE R406.3—continued
ENERGY CREDITS**

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2
3.3 ^a	<p>Closed-loop ground source heat pump; with a minimum COP of 3.3</p> <p>or</p> <p>Open loop water source heat pump with a maximum pumping hydraulic head of 150 feet and minimum COP of 3.6.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.</p>	1.5	1.0
3.4	<p>Ductless mini-split heat pump system, zonal control: In homes where the primary space heating system is zonal electric heating, a ductless mini-split heat pump system with a minimum HSPF of 10.0 shall be installed and provide heating to the largest zone of the housing unit.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.</p>	1.5	2.0
3.5 ^a	<p>Air-source, centrally ducted heat pump with minimum HSPF of 11.0.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency.</p>	1.5	N/A
3.6 ^a	<p>Ductless split system heat pumps with no electric resistance heating in the primary living areas. A ductless heat pump system with a minimum HSPF of 10 shall be sized and installed to provide heat to entire dwelling unit at the design outdoor air temperature.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected, the heated floor area calculation, the heating equipment type(s), the minimum equipment efficiency, and total installed heat capacity (by equipment type).</p>	2.0	3.0
4. HIGH EFFICIENCY HVAC DISTRIBUTION SYSTEM OPTIONS			
4.1	<p>All supply and return ducts located in an unconditioned attic shall be deeply buried in ceiling insulation in accordance with Section R403.3.7.</p> <p>For mechanical equipment located outside the conditioned space, a maximum of 10 linear feet of return duct and 5 linear feet of supply duct connections to the equipment may be outside the deeply buried insulation. All metallic ducts located outside the conditioned space must have both transverse and longitudinal joints sealed with mastic. If flex ducts are used, they cannot contain splices.</p> <p>Duct leakage shall be limited to 3 cfm per 100 square feet of conditioned floor area.</p> <p>Air handler(s) shall be located within the conditioned space.</p>	0.5	0.5
4.2	<p>HVAC equipment and associated duct system(s) installation shall comply with the requirements of Section R403.3.7.</p> <p>Locating system components in conditioned crawl spaces is not permitted under this option.</p> <p>Electric resistance heat and ductless heat pumps are not permitted under this option.</p> <p>Direct combustion heating equipment with AFUE less than 80% is not permitted under this option.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and shall show the location of the heating and cooling equipment and all the ductwork.</p>	1.0	N/A
5. EFFICIENT WATER HEATING OPTIONS			
Only one option from Items 5.2 through 5.6 may be selected in this category. Item 5.1 may be combined with any option.			
5.1	<p>A drain water heat recovery unit(s) shall be installed, which captures waste water heat from all and only the showers, and has a minimum efficiency of 40% if installed for equal flow or a minimum efficiency of 54% if installed for unequal flow. Such units shall be rated in accordance with CSA B55.1 or IAPMO IGC 346-2017 and be so labeled.</p> <p>To qualify to claim this credit, the building permit drawings shall include a plumbing diagram that specifies the drain water heat recovery units and the plumbing layout needed to install it. Labels or other documentation shall be provided that demonstrates that the unit complies with the standard.</p>	0.5	0.5
5.2	<p>Water heating system shall include one of the following:</p> <p>Energy Star rated gas or propane water heater with a minimum UEF of 0.80.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency.</p>	0.5	0.5

**TABLE R406.3—continued
ENERGY CREDITS**

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2
5.3	<p>Water heating system shall include one of the following: Energy Star rated gas or propane water heater with a minimum UEF of 0.91</p> <p>or</p> <p>Solar water heating supplementing a minimum standard water heater. Solar water heating will provide a rated minimum savings of 85 therms or 2000 kWh based on the Solar Rating and Certification Corporation (SRCC) Annual Performance of OG-300 Certified Solar Water Heating Systems</p> <p>or</p> <p>Water heater heated by ground source heat pump meeting the requirements of Option 3.3.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency and, for solar water heating systems, the calculation of the minimum energy savings.</p>	1.0	1.0
5.4	<p>Water heating system shall include one of the following: Electric heat pump water heater meeting the standards for Tier I of NEEA’s advanced water heating specification</p> <p>or</p> <p>For R-2 Occupancy, electric heat pump water heater(s), meeting the standards for Tier I of NEEA’s advanced water heating specification, shall supply domestic hot water to all units. If one water heater is serving more than one dwelling unit, all hot water supply and recirculation piping shall be insulated with R-8 minimum pipe insulation.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency.</p>	1.5	2.0
5.5	<p>Water heating system shall include one of the following: Electric heat pump water heater meeting the standards for Tier III of NEEA’s advanced water heating specification</p> <p>or</p> <p>For R-2 Occupancy, electric heat pump water heater(s), meeting the standards for Tier III of NEEA’s advanced water heating specification, shall supply domestic hot water to all units. If one water heater is serving more than one dwelling unit, all hot water supply and recirculation piping shall be insulated with R-8 minimum pipe insulation.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency.</p>	2.0	2.5
5.6	<p>Water heating system shall include one of the following: Electric heat pump water heater with a minimum UEF of 2.9 and utilizing a split system configuration with the air-to-refrigerant heat exchanger located outdoors. Equipment shall meet Section 4, requirements for all units, of the NEEA standard <i>Advanced Water Heating Specification</i> with the UEF noted above</p> <p>or</p> <p>For R-2 Occupancy, electric heat pump water heater(s), meeting the standards for Tier III of NEEA’s advanced water heating specification and utilizing a split system configuration with the air-to-refrigerant heat exchanger located outdoors, shall supply domestic hot water to all units. If one water heater is serving more than one dwelling unit, all hot water supply and recirculation piping shall be insulated with R-8 minimum pipe insulation.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency.</p>	2.5	3.0

TABLE R406.3—continued
ENERGY CREDITS

OPTION	DESCRIPTION	CREDIT(S)	
		All Other	Group R-2
6. RENEWABLE ELECTRIC ENERGY OPTION			
6.1	<p>For each 1200 kWh of electrical generation per housing unit provided annually by on-site wind or solar equipment a 1.0 credit shall be allowed, up to 3 credits. Generation shall be calculated as follows:</p> <p>For solar electric systems, the design shall be demonstrated to meet this requirement using the National Renewable Energy Laboratory calculator PVWATTs or approved alternate by the code official.</p> <p>Documentation noting solar access shall be included on the plans.</p> <p>For wind generation projects designs shall document annual power generation based on the following factors:</p> <p>The wind turbine power curve; average annual wind speed at the site; frequency distribution of the wind speed at the site and height of the tower.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall show the photovoltaic or wind turbine equipment type, provide documentation of solar and wind access, and include a calculation of the minimum annual energy power production.</p>	1.0	1.0
7. APPLIANCE PACKAGE OPTION			
7.1	<p>All of the following appliances shall be new and installed in the dwelling unit and shall meet the following standards:</p> <p>Dishwasher – Energy Star rated</p> <p>Refrigerator (if provided) – Energy Star rated</p> <p>Washing machine – Energy Star rated</p> <p>Dryer – Energy Star rated, ventless dryer with a minimum CEF rating of 5.2.</p> <p>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall show the appliance type and provide documentation of Energy Star compliance. At the time of inspection, all appliances shall be installed and connected to utilities. Dryer ducts and exterior dryer vent caps are not permitted to be installed in the dwelling unit.</p>	0.5	1.5

a. An alternative heating source sized at a maximum of 0.5 Watts/ft² (equivalent) of heated floor area or 500 Watts, whichever is bigger, may be installed in the dwelling unit.

**SECTION R407
CERTIFIED PASSIVE HOUSE**

R407.1 General. Projects shall comply with Section R407.2 or R407.3.

R407.2 Passive House Institute U.S. (PHIUS). Projects shall comply with PHIUS+ 2018 Passive Building Standard, including its USDOE Energy Star and Zero Energy Ready Home co-requisites, and performance calculations by PHIUS-approved software. Projects shall also comply with the provisions of Table R405.2.

R407.2.1 PHIUS documentation. Prior to the issuance of a building permit, the following items must be provided to the *code official*:

1. A list of compliance features.
2. A PHIUS precertification letter.

Prior to the issuance of a certificate of occupancy, the following item must be provided to the *code official*:

1. A PHIUS+ 2018 (or later) project certificate.

R407.3 Passive House Institute (PHI). Projects shall comply with Low Energy Building Standard, version 9f or later, including performance calculations by PHI-approved software. Projects shall also comply with the provisions of Section R401 through R404.

R407.3.1 PHI documentation. Prior to the issuance of a building permit, the following items must be provided to the *code official*:

1. A list of compliance features.

2. A statement from a passive house certifier that the modeled energy performance is congruent with the plans and specifications, and that the modeled performance meets said standard.

Prior to the issuance of a certificate of occupancy, the following item must be provided to the *code official*:

1. A PHI Low Energy Building project certificate.