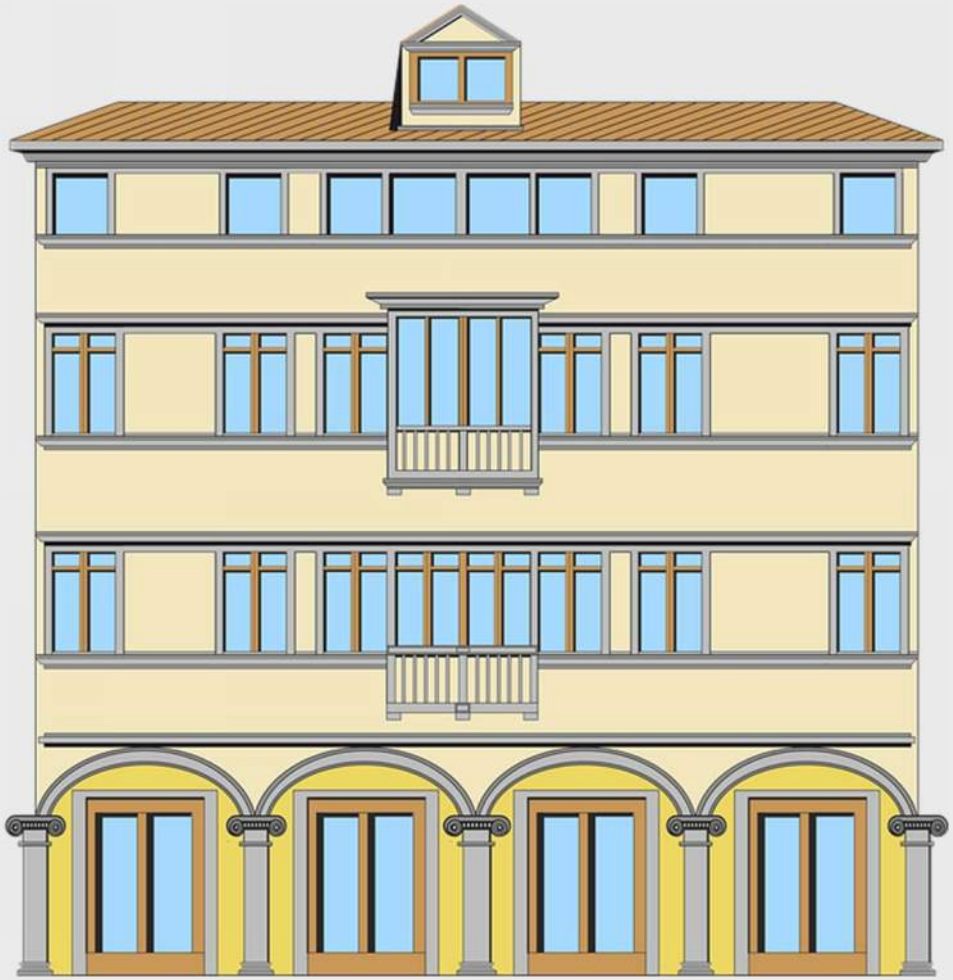
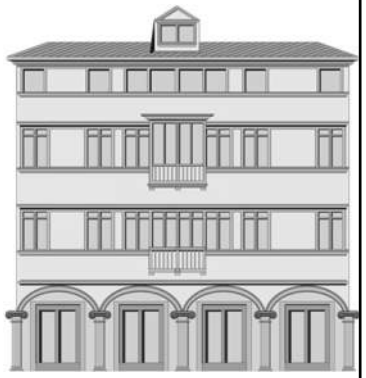
2021 IECC Multi-Family



2021 IECC Multi-Family



 1

1

Instructor

Gil Rossmiller

- In the construction industry for over 40 years
- ICC – IRC Plumbing & Mechanical Code Development Committee 2009/2012
- ICC- IECC Commercial Energy Code Development Committee 2015/2018
- ICC- IECC Residential Energy Code Development Committee 2021/2024
- Code Correlation Committee
- 2003-2016 Building Official

  Parker, Colorado

 2

2

Residential VS Commercial

Definition of Residential per IECC is different than that found in the IRC and IBC:

RESIDENTIAL BUILDING.

For this code, includes detached one and two family dwellings and multiple single family dwellings (townhouses) as well as R-2, R-3 and R-4 buildings three stories or less in height above grade plane.

COMMERCIAL BUILDING. For this code, all buildings that are not included in the definition of "Residential buildings." UPDATED

3

Podium Buildings

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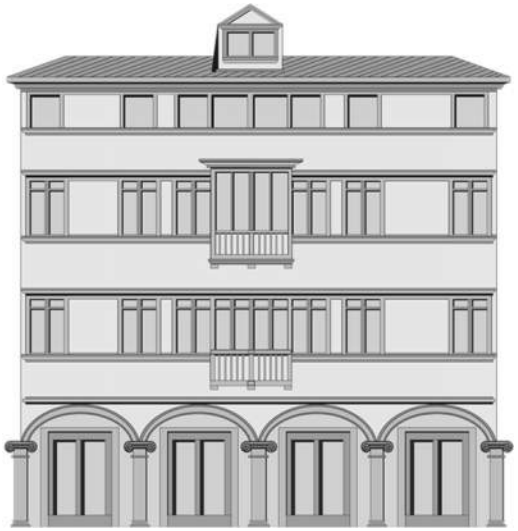

 7

7

The Look and Layout of the 2021 IECC

Commercial Section

Ch. C1 Scope and Application / Administrative and Enforcement
Ch. C2 Definitions
Ch. C3 General Requirements
Ch. C4 Commercial Energy Efficiency
Ch. C5 Existing Buildings
Ch. C6 Referenced Standards
Index

Residential Section

Ch. R1 Scope and Application / Administrative and Enforcement
Ch. R2 Definitions
Ch. R3 General Requirements
Ch. R4 Residential Energy Efficiency
Ch. R5 Existing Buildings
Ch. R6 Referenced Standards
Index

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8

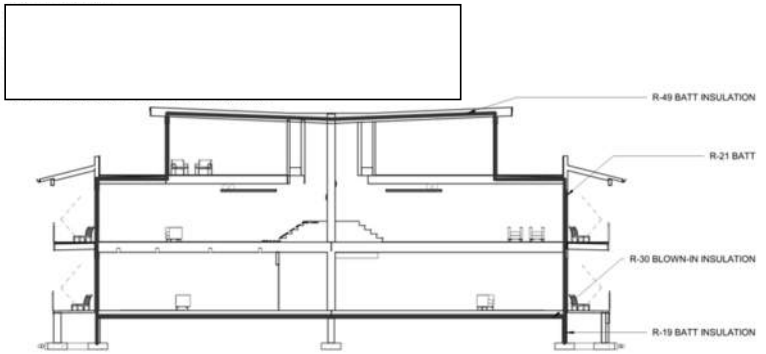
C103.2Information on construction documents

1.Energy compliance path.
2.Insulation materials and their R-values.
3.Fenestration U-factors and solar heat gain coefficients (SHGCs).
4.Area-weighted U-factor and solar heat gain coefficient (SHGC) calculations.
5.Mechanical system design criteria.
6.Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7.Economizer description.
8.Equipment and system controls.
9.Fan motor horsepower (hp) and controls.
10.Duct sealing, duct and pipe insulation and location.
11.Lighting fixture schedule with wattage and control narrative.
12.Location of daylight zones on floor plans.
13.Air barrier and air sealing details, including the location of the air barrier.

 9

9

C103.2.1 Building thermal envelope depiction



The building thermal envelope shall be represented on the construction drawings

 10

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Commercial Definitions to Note:

CAPTIVE KEY OVERRIDE. A lighting control that will not release the key that activates the override when the lighting is on.

 11

11

New Commercial Definitions to Note:

TESTING UNIT ENCLOSURE AREA. The area sum of all the boundary surfaces that define the dwelling unit, sleeping unit or occupiable conditioned space including top/ceiling, bottom/floor and all side walls. This does not include interior partition walls within the dwelling unit, sleeping unit, or occupiable conditioned space. Wall height shall be measured from the finished floor of the conditioned space to the finished floor or roof/ceiling air barrier above

 12

12

New Commercial Definitions to Note:

WALL, ABOVE-GRADE. A wall associated with the building thermal envelope that is more than 15 percent above grade and is on the exterior of the building or any wall that is associated with the building thermal envelope that is not on the exterior of the building. This includes, but is not limited to, between-floor spandrels, peripheral edges of floors, roof knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts

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IECC Commercial Compliance Options

C401.2.1International Energy Conservation Code
Commercial buildings shall comply with one of the following:
1.Prescriptive Compliance. The Prescriptive Compliance option requires compliance with Sections C402 through C406 and Section C408.
Dwelling units and sleeping units in Group R-2 buildings without systems serving multiple units shall be deemed to be in compliance with this chapter, provided that they comply with Section R406.

2.Total Building Performance. The Total Building Performance option requires compliance with Section C407.

Exception:Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter 5.

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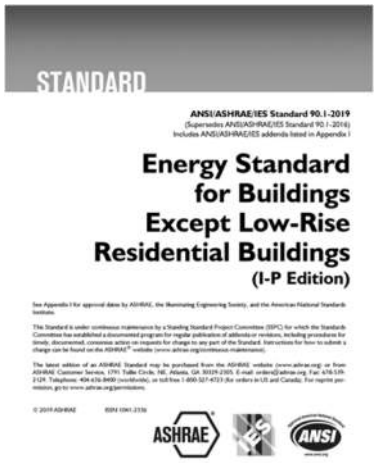
IECC Commercial Compliance Options

C401.2.2 ASHRAE 90.1
Commercial buildings shall comply with the requirements of ANSI/ASHRAE/IESNA 90.1.



 16

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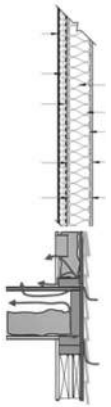
IECC Additional Efficiency Package Options
Section C406

- New buildings shall achieve a total of 10 credits
- Now based on occupancy
- More efficient HVAC performance
- Reduced lighting power density system
- Enhanced lighting controls
- On-site supply of renewable energy
- Dedicated outdoor air system
- More efficient SWH
- Enhanced envelope performance
- Reduced air infiltration
- Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
- Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
- Efficient kitchen equipment in accordance with Section C406.12.



17

Building Thermal Envelope Requirements

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402.1.3 Insulation component R-value-based method.

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	R-25ci	R-25ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings[3]	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-25 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-25 + R-11 + R-11 LS	R-25 + R-11 + R-11 LS
Attic and other	R-38	R-38	R-38	R-38	R-38	R-38	R-49	R-49	R-49	R-49	R-49	R-49	R-60	R-60	R-60	R-60
Walls, above grade																
Mass[i]	R-6.7ci[f]	R-6.7ci[f]	R-5.7ci[f]	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci
Metal building	R-13 + R-6.5ci	R-13 + R-6.5ci	R12 + R-6.5ci	R-13 + R-13ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-17ci	R-13 + R-19.5ci	R-13 + R-19.5ci	R-13 + R-19.5ci
Metal framed	R-13 + R-6ci	R-13 + R-6ci	R-13 + R-6ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-10ci	R-13 + R-10ci	R-13 + R-12.5ci	R-13 + R-12.5ci	R-13 + R-12.5ci	R-13 + R-15.6ci	R-13 + R-18.8ci	R-13 + R-18.8ci
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-7.5ci or R20 + R3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-18.8ci	R-13 + R-18.8ci
Walls, below grade																
Below-grade wall[h]	NR	NR	NR	NR	NR	NR	R-7.5ci	R-10ci	R-7.5ci	R-10ci	R-10ci	R-15ci	R-15ci	R-15ci	R-15ci	R-15ci
Floors																
Mass[e]	NR	NR	R-6.3ci	R-8.3ci	R-10ci	R-10ci	R-14.6ci	R-16.7ci	R-14.6ci	R-16.7ci	R-16.7ci	R-16.7ci	R-20.9ci	R-20.9ci	R-23ci	R-23ci
Joist/framing	R-13	R-13	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-38	R-38	R-38	R-38	R-38	R-38
Slab-on-grade floors																
Unheated slabs	NR	NR	NR	NR	NR	R-10 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 24" below	R-20 for 24" below	R-20 for 24" below	R-20 for 40" below	R-20 for 24" below	R-20 for 40" below	R-20 for 40" below	R-25 for 40" below
Heated slabs[d]	R-7.5 for 12" below + R-5 full slab	R-7.5 for 12" below + R-5 full slab	R-7.5 for 12" below + R-5 full slab	R-7.5 for 12" below+ R-5 full slab	R-10 for 24" below + R-5 full slab	R-10 for 24" below + R-5 full slab	R-15 for 24" below + R-5 full slab	R-15 for 24" below + R-5 full slab	R-15 for 36" below + R-5 full slab	R-15 for 36" below + R-5 full slab	R-15 for 36" below + R-5 full slab	R-20 for 40" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab

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C402.1.4 Assembly U-factor, C-factor or F-factor-based method.

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039	U-0.039	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.028	U-0.028	U-0.028	U-0.028
Metal buildings	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.031	U-0.029	U-0.029	U-0.029	U-0.026	U-0.026
Attic and other	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.017	U-0.017	U-0.017	U-0.017
Walls, above grade																
Mass[f]	U-0.151	U-0.151	U-0.151	U-0.123	U-0.123	U-0.104	U-0.104	U-0.090	U-0.090	U-0.080	U-0.080	U-0.071	U-0.071	U-0.071	U-0.037	U-0.037
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	U-0.079	U-0.052	U-0.052	U-0.050	U-0.050	U-0.050	U-0.050	U-0.050	U-0.044	U-0.039	U-0.039	U-0.039
Metal framed	U-0.077	U-0.077	U-0.077	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.055	U-0.055	U-0.049	U-0.049	U-0.049	U-0.042	U-0.037	U-0.037
Wood framed and other[c]	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.032	U-0.032
Walls, below grade																
Below-grade wall[c]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-0.119	C-0.092	C-0.119	C-0.092	C-0.092	C-0.063	C-0.063	C-0.063	C-0.063	C-0.063
Floors																
Mass[d]	U-0.322[e]	U-0.322[e]	U-0.107	U-0.087	U-0.074	U-0.074	U-0.057	U-0.051	U-0.057	U-0.051	U-0.051	U-0.051	U-0.042	U-0.042	U-0.038	U-0.038
Joist/framing	U-0.066[e]	U-0.066[e]	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027
Slab-on-grade floors																
Unheated slabs	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.54	F-0.52	F-0.52	F-0.52	F-0.51	F-0.51	F-0.434	F-0.51	F-0.434	F-0.434	F-0.424
Heated slabs	F-0.69	F-0.69	F-0.69	F-0.69	F-0.66	F-0.66	F-0.62	F-0.62	F-0.62	F-0.62	F-0.62	F-0.602	F-0.602	F-0.602	F-0.602	F-0.602
Opaque doors																
Nonswinging door	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31
Swinging door[g]	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Garage door < 14% glazing[h]	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31

20

What about COMcheck?

C402.1.5 Component performance alternative. (**Must use Version 4.1.1.0 or later**)

Building envelope values and fenestration areas determined in accordance with Equation 4-2 shall be an alternative to compliance with the U-, F- and C-factors in Tables C402.1.3, C402.1.4 and C402.4 and the maximum allowable fenestration areas in Section C402.4.1. Fenestration shall meet the applicable SHGC requirements of Section C402.4.3.

A + B + C + D + E £ Zero (Equation 4-2)

THIS IS ONLY FOR THE THERMAL ENVELOPE! Trade offs are allowed in the envelope.

The mechanical and lighting portions of ComCheck are compliance reports only and do not allow any trade-offs within them. These reports are a convenient way to show compliance.

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Vertical Fenestration Requirement C402.4.1Maximum area

Percentage of Vertical Fenestration Area to Gross Wall Area

- ✓Allowed up to 30% maximum of above grade wall
  - ✓In Climate Zones 0-6, up to 40% maximum of above grade wall with daylighting controls

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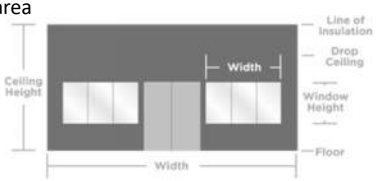
Vertical Fenestration Requirement
Section C402.4.1

Based on above-grade wall area *(gross)*

- ✓Includes walls between conditioned space and unconditioned space or the great outdoors
  - Includes walls that are > 15% above grade

Total fenestration area *(includes frame and glazing*)

- ✓Does not include opaque door area



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Up to 40% vertical fenestration area allowed in Climate Zones 1-6, provided

40%
- No less than 50% of the conditioned floor area is within a daylight zone
- in buildings 2 stories and less above grade

40%
- No less than 25% of the net floor area is within a daylight zone
- in building ≥ 3 stories above grade

40%
- Daylight responsive controls are installed in daylight zones
- VT of vertical fenestration is ≥ 1.1 times SHGC

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Skylight maximum area
Section C402.4.1 Prescriptive

- ✓Limited to ≤ 3% of Roof Area
- ✓Up to 6% allowed if automatic daylighting controls installed in daylight zones under skylights

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Fenestration

CLIMATE ZONE	6
Vertical fenestration	
***U*-factor**	
Fixed fenestration	0.34
Operable fenestration	0.42
Entrance doors	0.63
SHGC	
	Fixed / Operable
PF < 0.2	0.38 / 0.34
0.2 ≤ PF < 0.5	0.46 / 0.41
PF ≥ 0.5	0.61 / 0.54
Skylights	
U-factor	0.50
SHGC	0.40

Projections Matter

 26

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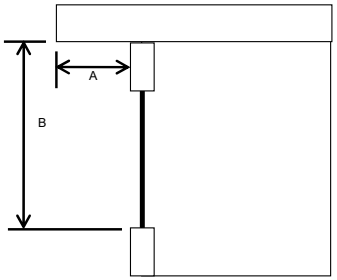
C402.4.3 Projection Factor Equation 4-5

- PF = A/B
  - where:
  - PF = Projection factor (decimal).
  - A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the glazing.
  - B = Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or permanently attached shading device.



PF= A/B

PF = 30”/84”

PF = 0.36

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C402.4.2 Minimum skylight fenestration area

Skylights shall be provided in enclosed spaces greater2,500 square feet in floor area, directly under a roof with not less than 75 percent of the ceiling area with a ceiling height greater than 15 feet

- Used as an office, lobby, atrium, concourse, corridor, storage space, gymnasium/exercise center, convention center, automotive service area, space where manufacturing occurs, nonrefrigerated warehouse, retail store, distribution/sorting area, transportation depot or workshop, the total toplit daylight zone shall be not less than half the floor area and shall provide one of the following:

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IECC Commercial Envelopes

- Air Leakage
- Air barriers
- Fenestration air leakage
- Rooms Containing Fuel-burning Appliances
- Air intakes, exhaust openings, stairways and shafts
- Vestibules
- Recessed lighting

 29

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2021 IECC – Air Leakage

C402.5 Air leakage—thermal envelope

- Comply with Sections C402.5.1 through C402.5.11.1

OR

- Test in accordance with Section C402.5.2 or C402.5.3
- Where testing then also comply with Sections C402.5.7, C402.5.8 and C402.5.9

Testing Approach

https://www.buildings.com/feature/article/10188194/air-leakage-testing-a-hot-button-or-hot-air

 30

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C402.5 - Comply with Sections C402.5.1 through C402.5.11.1

2021 Approach

C402.5.1 Air barriers.

A continuous air barrier shall be provided throughout the building thermal envelope. The continuous air barriers shall be located on the inside or outside of the building thermal envelope, located within the assemblies composing the building thermal envelope, or any combination thereof. The air barrier shall comply with Sections C402.5.1.1, and C402.5.1.2.

Exception: Air barriers are not required in buildings located in Climate Zone 2B.

 31

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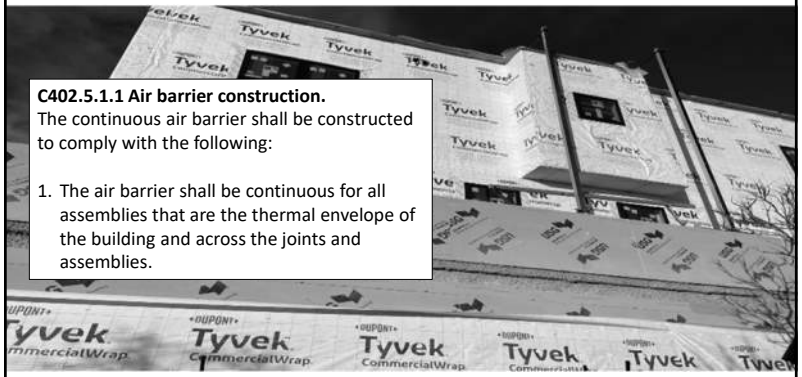
C402.5 - Comply with C402.5.1 through C402.5.8(2015 & 2018) or C402.5.11.1(2021)

2021 Approach



C402.5.1.1 Air barrier construction.
The continuous air barrier shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.

 32

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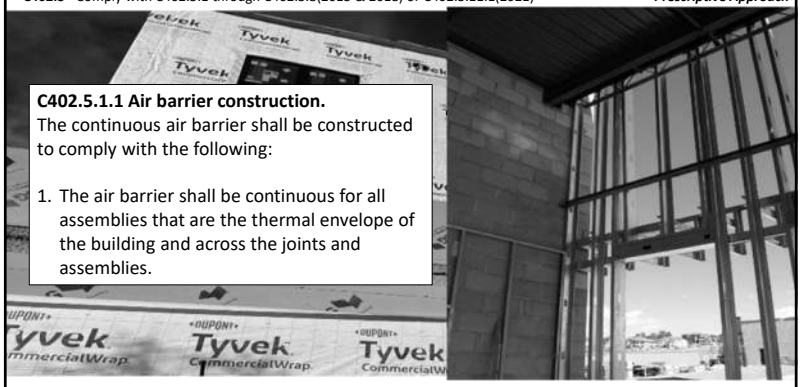
C402.5 - Comply with C402.5.1 through C402.5.8(2015 & 2018) or C402.5.11.1(2021) ***Prescriptive Approach***



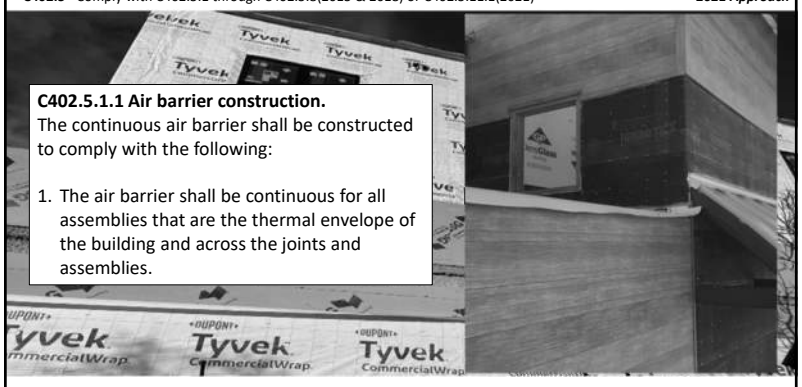
C402.5.1.1 Air barrier construction.
The continuous air barrier shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.

 33

33

C402.5 - Comply with C402.5.1 through C402.5.8(2015 & 2018) or C402.5.11.1(2021) ***2021 Approach***



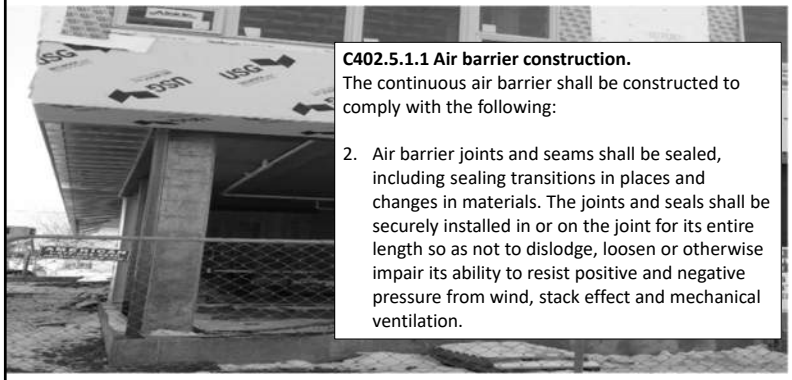
C402.5.1.1 Air barrier construction.
The continuous air barrier shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.

 34

34

C402.5 - Comply with C402.5.1 through C402.5.8(2015 & 2018) or C402.5.11.1(2021) ***2021 Approach***



C402.5.1.1 Air barrier construction.
The continuous air barrier shall be constructed to comply with the following:

2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.

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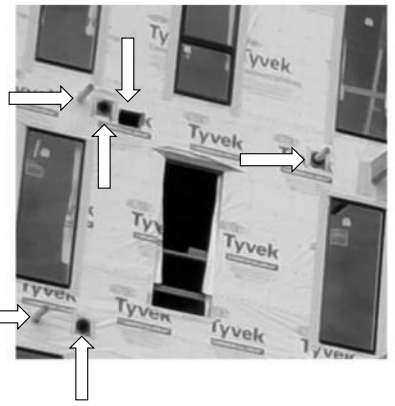
C402.5.1.1 Air barrier construction.
The continuous air barrier shall be constructed to comply with the following

3. Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Joints and seams associated with penetrations shall be sealed in the same manner or taped. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.



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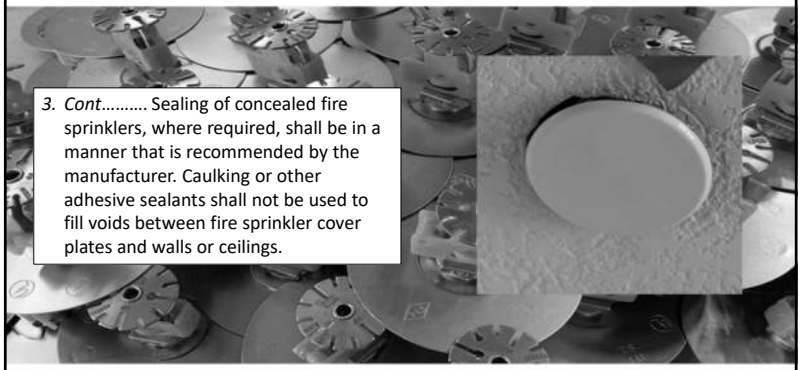

3. *Cont*……. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.

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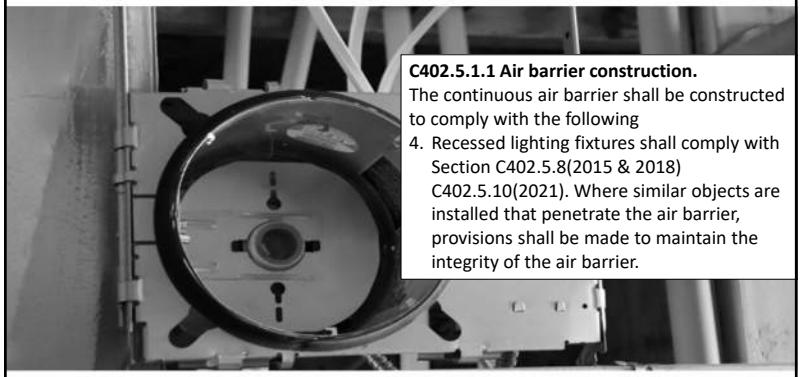

C402.5.1.1 Air barrier construction.
The continuous air barrier shall be constructed to comply with the following

4. Recessed lighting fixtures shall comply with Section C402.5.8(2015 & 2018) C402.5.10(2021). Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.

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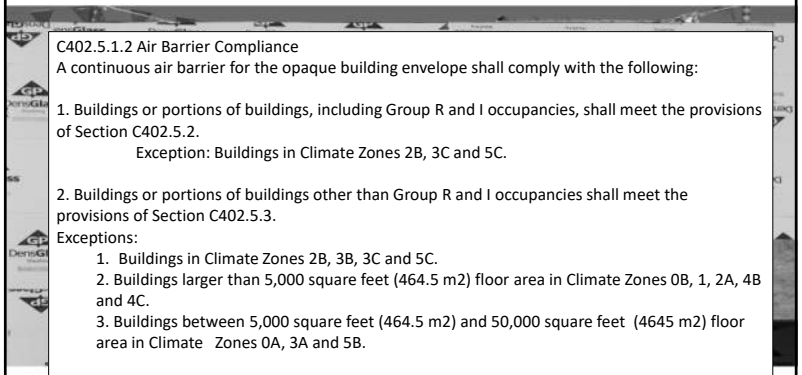
C402.5 - Comply with Sections C402.5.1 through C402.5.11.1



C402.5.1.2 Air Barrier Compliance
A continuous air barrier for the opaque building envelope shall comply with the following:

1. Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.
Exception: Buildings in Climate Zones 2B, 3C and 5C.

2. Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.
Exceptions:
1. Buildings in Climate Zones 2B, 3B, 3C and 5C.
2. Buildings larger than 5,000 square feet (464.5 m2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.
3. Buildings between 5,000 square feet (464.5 m2) and 50,000 square feet (4645 m2) floor area in Climate Zones 0A, 3A and 5B.

3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.

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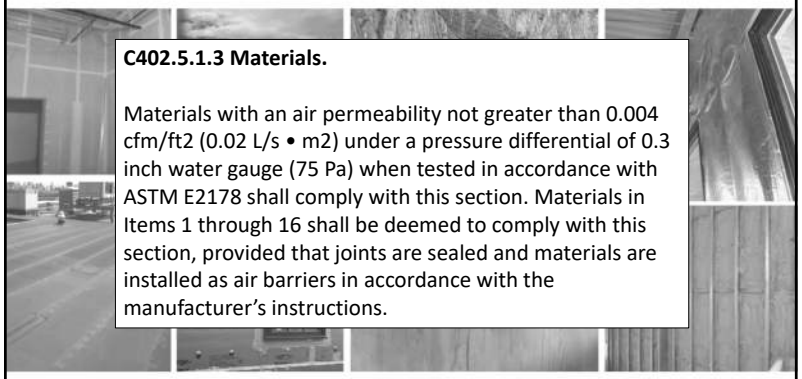

C402.5.1.3 Materials.

Materials with an air permeability not greater than 0.004 cfm/ft2 (0.02 L/s • m2) under a pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with ASTM E2178 shall comply with this section. Materials in Items 1 through 16 shall be deemed to comply with this section, provided that joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

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Material	Thickness (minimum)
Plywood	3/8 in.
Oriented strand board	3/8 in.
Extruded polystyrene insulation board	½ in.
Foil-faced urethane insulation board	½ in.
Closed cell spray foam minimum density of 1.5 pcf	1-1/2 in.
Open cell spray foam density between 0.4 and 1.5 pcf	4.5 in.
Exterior gypsum sheathing or interior gypsum board	½ in.
Cement board	½ in.
Built up roofing membrane	
Modified bituminous roof membrane	
Fully adhered single-ply roof membrane	
A Portland cement/sand parge, stucco, or gypsum plaster	5/8 in.
Cast-in-place and precast concrete	
Sheet metal or aluminum	
Solid or hollow masonry constructed of clay or shale masonry units	

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C402.5.1.4 Assemblies.

Assemblies of materials and components with an average air leakage not greater than 0.04 cfm/ under a pressure differential of 0.3 inch of water gauge (w.g.)(75 Pa) when tested in accordance with ASTM E2357, ASTM E1677, ASTM D8052 or ASTM E283 shall comply with this section. Assemblies listed in Items 1 through 3 shall be deemed to comply, provided that joints are sealed and the requirements of Section C402.5.1.1 are met.

1. Concrete masonry walls coated with either one application of block filler or two applications of a paint or sealer coating.
2. Masonry walls constructed of clay or shale masonry units with a nominal width of 4 inches or more.
3. A Portland cement/sand parge, stucco or plaster not less than 1/2 inch in thickness.

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2021 Approach

C402.5 - Comply with Sections C402.5.1 through C402.5.11.1

C402.5.1.5 Building envelope performance verification.

The installation of the continuous air barrier shall be verified by the *code official*, a *registered design professional* or *approved* agency in accordance with the following:

1. A review of the construction documents and other supporting data shall be conducted to assess compliance with the requirements in Section C402.5.1.
2. Inspection of continuous air barrier components and assemblies shall be conducted during construction while the air barrier is still accessible for inspection and repair to verify compliance with the requirements of Sections C402.5.1.3 and C402.5.1.4.
3. A final commissioning report shall be provided for inspections completed by the *registered design professional* or *approved* agency. The commissioning report shall be provided to the building owner or owner's authorized agent and the *code official*. The report shall identify deficiencies found during the review of the construction documents and inspection and details of corrective measures taken.

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C402.5 - Comply with Sections C402.5.1 through C402.5.11.1

C402.5.2 Dwelling and sleeping unit enclosure testing.

The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed 0.30 cfm/ft^2 of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

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C402.5.3 Building thermal envelope testing.
The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed 0.40 cfm/ft^2 (2.0 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire envelope area of all stories that have any spaces directly under a roof.
2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.
3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

Exception: Where the measured air leakage rate exceeds 0.40 cfm/ft^2 (2.0 L/s × m^2) but does not exceed 0.60 cfm/ft^2 (3.0 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where such sealing can be made without destruction of existing building components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the code official and the building owner, and shall be deemed to comply with the requirements of this section.

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C402.5.5 Rooms containing fuel-burning appliances.
In *Climate Zones* 3 through 8, where combustion air is supplied through openings in an exterior wall to a room or space containing a space-conditioning fuel-burning appliance, one of the following shall apply:

1.The room or space containing the appliance shall be located outside of the *building thermal envelope*.

2.The room or space containing the appliance shall be enclosed and isolated from conditioned spaces inside the *building thermal envelope*. Such rooms shall comply with all of the following:

2.1.The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be insulated to be not less than equivalent to the insulation requirement of below-grade walls as specified in Table C402.1.3 or Table C402.1.4.

2.2.The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be sealed in accordance with Section C402.5.1.1.

2.3.The doors into the enclosed room or space shall be fully gasketed.

2.4.Water lines and ducts in the enclosed room or space shall be insulated in accordance with Section C403.

2.5.Where an air duct supplying combustion air to the enclosed room or space passes through *conditioned space*, the duct shall be insulated to an *R*-value of not less than R-8.

Exception:
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

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C402.5.6 Loading dock weatherseals.

Cargo door openings and loading door openings shall be equipped with weatherseals that restrict infiltration and provide direct contact along the top and sides of vehicles that are parked in the doorway.

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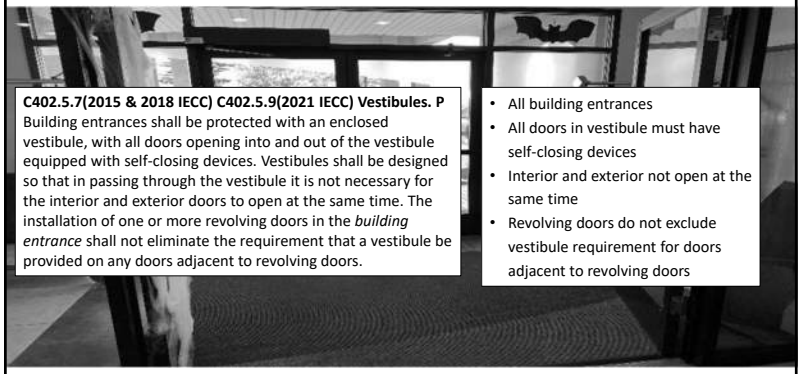
C402.5 - Comply with C402.5.1 through C402.5.8(2015 & 2018) or C402.5.11.1(2021) ***2021 Approach***



C402.5.7(2015 & 2018 IECC) C402.5.9(2021 IECC) Vestibules. P
Building entrances shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. The installation of one or more revolving doors in the *building entrance* shall not eliminate the requirement that a vestibule be provided on any doors adjacent to revolving doors.

- All building entrances
- All doors in vestibule must have self-closing devices
- Interior and exterior not open at the same time
- Revolving doors do not exclude vestibule requirement for doors adjacent to revolving doors

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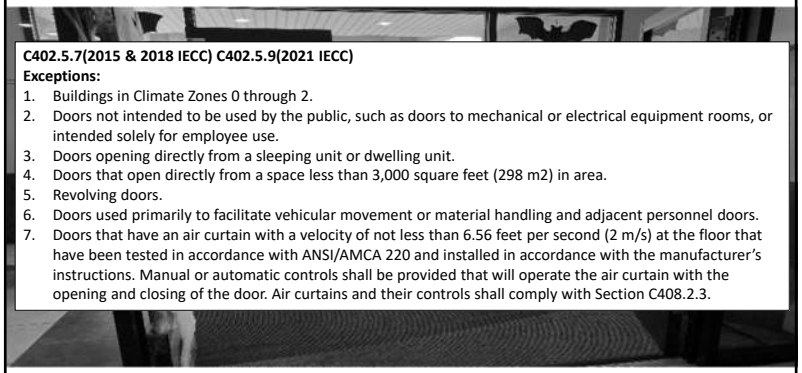
C402.5 - Comply with C402.5.1 through C402.5.8(2015 & 2018) or C402.5.11.1(2021) ***2021 Approach***



C402.5.7(2015 & 2018 IECC) C402.5.9(2021 IECC)
Exceptions:
1. Buildings in Climate Zones 0 through 2.
2. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use.
3. Doors opening directly from a sleeping unit or dwelling unit.
4. Doors that open directly from a space less than 3,000 square feet (298 m2) in area.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.
7. Doors that have an air curtain with a velocity of not less than 6.56 feet per second (2 m/s) at the floor that have been tested in accordance with ANSI/AMCA 220 and installed in accordance with the manufacturer's instructions. Manual or automatic controls shall be provided that will operate the air curtain with the opening and closing of the door. Air curtains and their controls shall comply with Section C408.2.3.

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C402.5.11 Operable openings interlocking (New)

Where occupancies utilize operable openings to the outdoors that are larger than 40 square feet in area, such openings shall be interlocked with the heating and cooling system so as to raise the cooling setpoint to 90°F and lower the heating setpoint to 55°F whenever the operable opening is open. The change in heating and cooling setpoints shall occur within 10 minutes of opening the operable opening.

Exceptions:
1.Separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.
2.Warehouses that utilize overhead doors for the function of the occupancy, where approved by the code official.
3.The first entrance doors where located in the exterior wall and are part of a vestibule system

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2021 IECC Mechanical Systems

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~~(Mandatory? Prescriptive?)~~.....Provisions IECC

Provisions Applicable to ALL Mechanical Systems

- ✓Piping Insulation
- ✓Air System Design and Control
- ✓Heating Outside a Building
- ✓Refrigeration Equipment Performance
- ✓Walk-in Coolers and Freezers, Refrigerated Warehouse Coolers and Freezers
- ✓Walk-in Coolers and Walk-in Freezers
- ✓Duct and Plenum Insulation and Sealing
- ✓Enclosed parking garage ventilation controls
- ✓Kitchen exhaust systems
- ✓Automatic control of HVAC systems in guestrooms
- ✓Shutoff dampers
- ✓ Calculation of heating and cooling loads
- ✓ Data Centers
- ✓ Zone isolation required
- ✓ Ventilation
- ✓ Equipment sizing
- ✓ HVAC equipment performance requirements
- ✓ Heating and cooling system controls
- ✓ Heated or Cooled Vestibules
- ✓ Economizer fault detection
- ✓ Demand Control Ventilation

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TABLE C407.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE	
SECTION[a]	**TITLE**
Envelope	
C402.5	Air leakage—thermal envelope
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4, except C403.4.3, C403.4.4 and C403.4.5	Heating and cooling system controls
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.11, except C403.11.3	Refrigeration equipment performance
C403.12	Construction of HVAC system elements
C403.13	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C408	Maintenance information and system commissioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

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HVAC Performance IECC
Section C403.3 Heating and cooling equipment efficiencies

Heating and cooling equipment installed in mechanical systems shall be sized in accordance with Section C403.3.1 and shall be not less efficient in the use of energy than as specified in Section C403.3.2

TABLE C403.3.2(1)
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS[a, d]

EQUIPMENT TYPE	SIZE CATEGORY	HEADING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[e]
Air conditioners, air cooled	< 65,000 Btu/h[b]	All	Split system, three phase and applications outside US single phase[b]	13.0 SEER before 1/1/2023 13.4 SEER2 after 1/1/2023	AHRI 210/240—2017 before 1/1/2023 AHRI 210/240—2023 after 1/1/2023
			Single-package, three phase and applications outside US single phase[b]	14.0 SEER before 1/1/2023 13.4 SEER2 after 1/1/2023	

b. Single-phase, US air-cooled air conditioners less than 65,000 Btu/h are regulated as consumer products by the US Department of Energy Code of Federal Regulations DOE 10 CFR 430.
SEER and SEER2 values for single-phase products are set by the US Department of Energy.

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C403.3.1 Equipment sizing

The output capacity of heating and cooling equipment shall be not greater than that of the smallest available equipment size that exceeds the loads calculated in accordance with Section C403.1.1.

A single piece of equipment providing both heating and cooling shall satisfy this provision for one function with the capacity for the other function as small as possible, within available equipment options.

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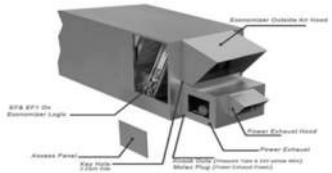
C403.5: Economizers Reorganized the mechanical section of the code to put all economizer requirements in one location, making clarifications. Also making more consistent with ASHRAE 90.1.



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C403.5 Economizers

Economizers shall comply with Sections C403.5.1 through C403.5.5. An air or water economizer shall be provided for the following cooling systems:

1.Chilled water systems with a total cooling capacity, less cooling capacity provided with air economizers, as specified in Table C403.5(1).

2.Individual fan systems with cooling capacity greater than or equal to 54,000 Btu/h in buildings having other than a Group R occupancy, The total supply capacity of all fan cooling units not provided with economizers shall not exceed 20 percent of the total supply capacity of all fan cooling units in the building or 300,000 Btu/h, whichever is greater.

3.Individual fan systems with cooling capacity greater than or equal to 270,000 Btu/h in buildings having a Group R occupancy

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C403.4 Heating and cooling system controls

C403.4.1 Thermostatic controls

The supply of heating and cooling energy to each zone shall be controlled by individual thermostatic controls capable of responding to temperature within the zone. Where humidification or dehumidification or both is provided, not fewer than one humidity control device shall be provided for each humidity control system.

Exception: Independent perimeter systems that are designed to offset only building envelope heat losses, gains or both serving one or more perimeter zones also served by an interior system provided that both of the following conditions are met:

1. The perimeter system includes not fewer than one thermostatic control zone for each building exposure having exterior walls facing only one orientation (within ±45 degrees) for more than 50 contiguous feet.

2. The perimeter system heating and cooling supply is controlled by thermostats located within the zones served by the system

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C403.4 Heating and cooling system controls

C403.4.1.1 Heat pump supplementary heat

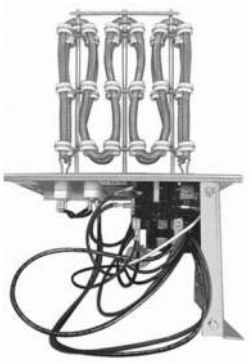
Heat pumps having supplementary electric resistance heat shall have controls that limit supplemental heat operation to only those times when one of the following applies:

1.The vapor compression cycle cannot provide the necessary heating energy to satisfy the thermostat setting.

2.The heat pump is operating in defrost mode.

3.The vapor compression cycle malfunctions.

4.The thermostat malfunctions.



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C403.7.4 Energy recovery systems

C403.7.4.1 Nontransient dwelling units

Nontransient dwelling units shall be provided with outdoor air energy recovery ventilation systems with an *enthalpy recovery ratio* of not less than 50 percent at cooling design condition and not less than 60 percent at heating design condition.

Exceptions:

1. Nontransient dwelling units in Climate Zone 3C.

2. Nontransient dwelling units with not more than 500 square feet (46 m2) of conditioned floor area in Climate Zones 0, 1, 2, 3, 4C and 5C.

3. Enthalpy recovery ratio requirements at heating design condition in Climate Zones 0, 1 and 2.

4. Enthalpy recovery ratio requirements at cooling design condition in Climate Zones 4, 5, 6, 7 and 8.

ENTHALPY RECOVERY RATIO

Change in the enthalpy of the outdoor air supply divided by the difference between the outdoor air and entering exhaust air enthalpy, expressed as a percentage

The enthalpy (H) of a thermodynamic system is defined as the sum of its internal energy and the product of its pressure and volume

 60

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C403.7.6 Automatic control of HVAC systems serving guestrooms

Automatic control of HVAC systems serving guest rooms in Group R-1 buildings containing over 50 guests rooms.

C403.7.6.1Temperature setpoint controls.

Controls shall be provided on each HVAC system that are capable of and configured with three modes of temperature control:

1. When the guestroom is rented but unoccupied, the controls shall automatically raise the cooling setpoint and lower the heating setpoint by not less than 4°F from the occupant setpoint within 30 minutes after the occupants have left the guestroom.

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C403.7.6 Automatic control of HVAC systems serving guestrooms

Automatic control of HVAC systems serving guest rooms in Group R-1 buildings containing over 50 guests rooms.

2. When the guestroom is unrented and unoccupied, the controls shall automatically raise the cooling setpoint not higher than 60°F to not lower than 80°F and lower the heating setpoint to. Unrented and unoccupied guestroom mode shall be initiated within 16 hours of the guestroom being continuously occupied or where a *networked guestroom control system* indicates that the guestroom is unrented and the guestroom is unoccupied for more than 20 minutes. A *networked guestroom control system* that is capable of returning the thermostat setpoints to default occupied setpoints 60 minutes prior to the time a guestroom is scheduled to be occupied is not precluded by this section. Cooling that is capable of limiting relative humidity with a setpoint not lower than 65-percent relative humidity during unoccupied periods is not precluded by this section

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C403.7.6 Automatic control of HVAC systems serving guestrooms

Automatic control of HVAC systems serving guest rooms in Group R-1 buildings containing over 50 guests rooms.

3. When the guestroom is occupied, HVAC setpoints shall return to their occupied setpoints once occupancy is sensed.

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C403.8.5 Low-capacity ventilation fans (New)

Mechanical ventilation system fans with motors less than 1/12 hp (0.062 kW) in capacity shall meet the efficacy requirements of Table C403.8.5 at one or more rating points.

Exceptions:

1.Where ventilation fans are a component of a listed heating or cooling appliance.

2.Dryer exhaust duct power ventilators, domestic range hoods and domestic range booster fans that operate intermittently.

FAN LOCATION	AIRFLOW RATE MINIMUM (CFM)	MINIMUM EFFICACY (CFM/WATT)	AIRFLOW RATE MAXIMUM (CFM)
HRV or ERV	Any	1.2 cfm/watt	Any
In-line fan	Any	3.8 cfm/watt	Any
Bathroom, utility room	10	2.8 cfm/watt	< 90
Bathroom, utility room	90	3.5 cfm/watt	Any

a. Airflow shall be tested in accordance with HVI 916 and listed. Efficacy shall be listed or shall be derived from listed power and airflow. Fan efficacy for fully ducted HRV, ERV, balanced and in-line fans shall be determined at a static pressure not less than 0.2 inch w.c. Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure not less than 0.1 inch w.c.

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C403.12.1 Duct and plenum insulation and sealing

Supply and return air ducts and plenums shall be insulated with not less than R-6 insulation where located in unconditioned spaces and where located outside the building with not less than R-8 insulation in Climate Zones 0 through 4 and not less than R-12 insulation in Climate Zones 5 through 8. Ducts located underground beneath buildings shall be insulated as required in this section or have an equivalent thermal distribution efficiency. Underground ducts utilizing the *thermal distribution efficiency* method shall be listed and labeled to indicate the R-value equivalency. Where located within a building envelope assembly, the duct or plenum shall be separated from the building exterior or unconditioned or exempt spaces by not less than R-8 insulation in Climate Zones 0 through 4 and not less than R-12 insulation in Climate Zones 5 through 8

THERMAL DISTRIBUTION EFFICIENCY (TDE). The resistance to changes in air heat as air is conveyed through a distance of air duct. TDE is a heat loss calculation evaluating the difference in the heat of the air between the air duct inlet and outlet caused by differences in temperatures between the air in the duct and the duct material. TDE is expressed as a percent difference between the inlet and outlet heat in the duct

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C403.12.3 Piping insulation

Piping serving as part of a heating or cooling system shall be thermally insulated in accordance with Table C403.12.3.

Exceptions:

1. Factory-installed piping within HVAC equipment tested and rated in accordance with a test procedure referenced by this code.
2. Factory-installed piping within room fan-coils and unit ventilators tested and rated according to AHRI 440 (except that the sampling and variation provisions of Section 6.5 shall not apply) and AHRI 840, respectively.
3. Piping that conveys fluids that have a design operating temperature range between 60°F (15°C) and 105°F (41°C).
4. Piping that conveys fluids that have not been heated or cooled through the use of fossil fuels or electric power.
5. Strainers, control valves, and balancing valves associated with piping 1 inch (25 mm) or less in diameter.
6. Direct buried piping that conveys fluids at or below 60°F (15°C).
7. In radiant heating systems, sections of piping intended by design to radiate heat.

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Heating Outside a Building IECC

Section C403.13.1

Systems are to be radiant systems

Controlled by an occupancy sensing device or timer switch

- ✓So system is automatically deenergized when no occupants are present

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Controls IECC

Section C403.13.2 Snow Melt Systems

Photo courtesy of Ken Baker, K energy

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
- ✓an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F

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C403.14 Operable opening interlocking controls (New)

The heating and cooling systems shall have controls that will interlock these mechanical systems to the set temperatures of 90° F for cooling and 55° F for heating when the conditions of Section C402.5.8 exist. The controls shall configure to shut off the systems entirely when the outdoor temperatures are below 90°For above 55° F

C402.5.8 Loading Dock Seals

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Service Water Heating IECC *Section C404*

Table C404.2 Minimum Performance of Water-Heating Equipment

Water Heater Types Covered

- Electric Storage
- Gas and Oil Storage
- Instantaneous Water Heaters – Gas and Oil
- Hot water boilers – gas and oil
- Pool heaters
- Unfired storage tanks

Heat Traps *(C404.3)*

Piping Insulation *(C404.4)*

Efficient Piping*(C404.5)*

Circulation & Temperature Maintenance *(C404.6)*

Demand Recirculation *(C404.7)*

Drain Heat Recovery*(C404.8)*

Pools and Spas *(C404.9)*

Portable Spas *(C404.10)*

SWH Commissioning*(C404.11)*

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C404.2 Service water-heating equipment performance efficiency

Water-heating equipment and hot water storage tanks shall meet the requirements of Table C404.2. The efficiency shall be verified through data furnished by the manufacturer of the equipment or through certification under an approved certification program. Water-heating equipment intended to be used to provide space heating shall meet the applicable provisions of Table C404.2.

TABLE C404.2MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

EQUIPMENT TYPE	SIZE CATEGORY (input)	SUBCATEGORY OR RATING CONDITION	PERFORMANCE REQUIRED[a, b]	TEST PROCEDURE
Water heaters, electric	≤ 12 kW[c]	Tabletop[d], ≥ 20 gallons and ≤ 120 gallons	0.93 – 0.00132V, EF	DOE 10 CFR Part 430
		Resistance ≥ 20 gallons and ≤ 55 gallons	0.960 – 0.0003V, EF	
		Grid-enabled[e] > 75 gallons and ≤ 120 gallons	1.061 – 0.0016BV, EF	
	> 12 kW	Resistance	$(0.3 + 27/V_m)$, %/h	ANSI Z21.10.3
	≤ 24 amps and ≤ 250 volts	Heat pump > 55 gallons and ≤ 120 gallons	2.057 – 0.00113V, EF	DOE 10 CFR Part 430
Storage water heaters, gas	≤ 75,000 Btu/h	≥ 20 gallons and ≤ 55 gallons	0.675 – 0.0015V, EF	DOE 10 CFR Part 430
		> 55 gallons and ≤ 100 gallons	0.8012 – 0.0007BV, EF	
	> 75,000 Btu/h and ≤ 155,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V_r})$, Btu/h	ANSI Z21.10.3
	> 155,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V_r})$, Btu/h	

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C404.4 Insulation of piping

Piping from a water heater to the termination of the heated water fixture supply pipe shall be insulated in accordance with Table C403.12.3.

On both the inlet and outlet piping of a storage water heater or heated water storage tank, the piping to a heat trap or the first 8 feet of piping, whichever is less, shall be insulated.

Piping that is heat traced shall be insulated in accordance with Table C403.12.3 or the heat trace manufacturer's instructions.

Tubular pipe insulation shall be installed in accordance with the insulation manufacturer's instructions.

Pipe insulation shall be continuous except where the piping passes through a framing member.

The minimum insulation thickness requirements of this section shall not supersede any greater insulation thickness requirements necessary for the protection of piping from freezing temperatures or the protection of personnel against external surface temperatures on the insulation.

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TABLE C403.12.3MINIMUM PIPE INSULATION THICKNESS (in inches)

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY		NOMINAL PIPE OR TUBE SIZE (inches)				
	Conductivity Btu × in./(h × ft² × °F)[b]	Mean Rating Temperature, °F	< 1	1 to < 1½	1½ to < 4	4 to < 8	> 8
> 350	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251–350	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201–250	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141–200	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105–140	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40–60	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
< 40	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

k-value is the rate of heat flow through a homogeneous material

Simple conversion from K to R value
Insulation thickness divided by your k-value at 75°F Mean Temperature

Thermal conductivity

Mean Temperature °F	k*	Mean Temperature °C	λ*
50	0.22	10	0.032
75	0.23	25	0.034
100	0.24	50	0.037
150	0.27	100	0.043
200	0.29	125	0.047
250	0.32	150	0.051
300	0.35	175	0.056
350	0.39	200	0.062
400	0.43	225	0.068
450	0.48	250	0.075
500	0.54	275	0.082

http://commercial.owenscorning.com/assets/0/321/401/a0d67fd7-c5f6-4eda-8a95-9de806fe3541.pdf

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C404.6 Heated-water circulating and temperature maintenance systems

Heated-water circulation systems shall be in accordance with Section C404.6.1.

Heat trace temperature maintenance systems shall be in accordance with Section C404.6.2.

Controls for hot water storage shall be in accordance with Section C404.6.3.

Automatic controls, temperature sensors and pumps shall be in a location with access.

Manual controls shall be in a location with ready access.

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C404.6.1 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.

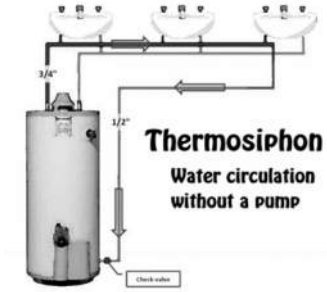
Gravity and thermo-syphon circulation systems shall be prohibited.

Controls for circulating hot water system pumps shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is not a demand for hot water.

The controls shall limit the temperature of the water entering the cold water piping to not greater than 104°F

~~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 not a demand for hot water.~~



https://activerain.com/blogsview/4513274/tired-of-waiting-for-hot-water--hot-water-recirculation-loops-

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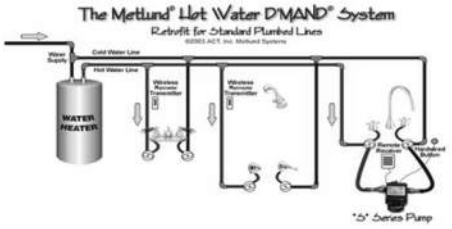
C404.6.1 Demand recirculation controls

Demand recirculation water systems shall have controls that 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.~~



https://www.builditsolar.com/Projects/Conservation/RecircEnergy.htm

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C404.8 Drain water heat recovery units

Drain water heat recovery units shall comply with CSA B55.2.

Potable water-side pressure loss shall be less than 10 psi at maximum design flow.

For Group R occupancies, the efficiency of drain water heat recovery unit efficiency shall be in accordance with CSA B55.1.

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C404.8 Energy consumption of pools and permanent spas

C404.8.1 Heaters

The electric power to all heaters shall be controlled by an 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 of the heater in a location with ready access

Operation of such switch shall not change the setting of the heater thermostat.

Such switches shall be in addition to a circuit breaker for the power to the heater.

Gas-fired heaters shall not be equipped with continuously burning ignition pilots

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C404.8 Energy consumption of pools and permanent spas

C404.8.2 Time switches

Time switches or other control methods that can automatically turn off and on heaters and pump motors 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 in compliance with this section.

Exceptions:

1.Where public health standards require 24-hour pump operation.

2.Pumps that operate solar- and waste-heat-recovery pool heating systems

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C404.8 Energy consumption of pools and permanent spas

C404.8.3 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 fewer than 3 calendar months, is from a heat pump or an on-site renewable energy system, covers or other vapor-retardant means shall not be required

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Power and Lighting Systems

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What's Covered Under Electrical Power and Lighting Systems Requirements? IECC

- Interior Lighting requirements
  - Required Controls
  - Wattage/Efficiency Limits
- Interior Lighting Power Allowances (watts/ft^2)
- Exterior Lighting Controls
  - Required Controls
  - Lamp Efficiency
- Exterior Lighting Power Allowances (watts/ft^2)
- Electric Metering
- Electrical Transformers and Motors
- Vertical and Horizontal Transportation Systems and Equipment

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C405.1.1 Lighting for dwelling units

No less than 90 percent of the permanently installed lighting serving dwelling units, excluding kitchen appliance lighting, shall be provided by lamps with an efficacy of not less than 65 lm/W or luminaires with an efficacy of not less than 45 lm/W, or shall comply with Sections C405.2.4 and C405.3.

C405.2.4 Daylighting Controls
C405.3 Interior Lighting Power

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Exterior Lighting and Building Lighting Power
Sections C405.5

Connected Exterior Lighting Power must not exceed Exterior Lighting Power Allowance except where approved because of historical, safety, signage or emergency considerations:

1. Calculate exterior lighting power allowance
   - Lighting power densities by exterior function and by applicable lighting zone
2. Calculate proposed connected lighting power
   - Wattage calculation "rules"
   - Exempted lighting
3. Compare values: proposed wattage must be less than or equal to allowed wattage

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Exemptions from Exterior Calculation
Section C405.4.1

The following lighting does not need to be included in the proposed lighting calculation:

1. Lighting approved because of safety considerations.
2. Emergency lighting automatically off during normal business operation.
3. Exit signs.
4. Specialized signal, directional and marker lighting associated with transportation.
5. Advertising signage or directional signage.
6. Integral to equipment or instrumentation and installed by its manufacturer.
7. Theatrical purposes, including performance, stage, film production and video production.
8. Athletic playing areas.
9. Temporary lighting.
10. Industrial production, material handling, transportation sites and associated storage areas.
11. Theme elements in theme/amusement parks.
12. Used to highlight features of art, public monuments, and the national flag.
13. Lighting for water features and swimming pools.
14. Lighting controlled from within dwelling units, where the lighting complies with Section R404.1.

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Exterior Lighting Power Allowance
Section C405.5.2

1.Determine the Lighting Zone (LZ) for the building according to Table C405.5.2(1), unless otherwise specified by the code official.

2.For each exterior area that is to be illuminated by lighting that is powered through the energy service for the building, determine the applicable area type from Table C405.5.2(2). For area types not listed, select the area type that most closely represents the proposed use of the area.

3.Determine the total area or length of each area type and multiply by the value for the area type in Table C405.5.2(2) to determine the lighting power (watts) allowed for each area type.

4.The total exterior lighting power allowance (watts) is the sum of the base site allowance determined according to Table C405.5.2(2), plus the watts from each area type.

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Exterior Lighting Zones IECC
Table C405.5.2(1)

Power allowances are listed by lighting zone

Lighting Zone	Description
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed use areas
3	All other areas no classified as lighting zone 1, 2 or 4
4	High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority

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Exterior Lighting Zones IECC *Table C405.5.2(2)*

LIGHTING ZONES				
Zone 1	**Zone 2**	**Zone 3**	**Zone 4**	
Base Site Allowance	350 W	400 W	500 W	900 W
Uncovered Parking Areas				
Parking areas and drives	0.03 W/ft^2	0.04 W/ft^2	0.06 W/ft^2	0.08 W/ft^2
Building Grounds				
Walkways and ramps less than 10 feet wide	0.50 W/linear foot	0.50 W/linear foot	0.60 W/linear foot	0.70 W/linear foot
Walkways and ramps 10 feet wide or greater, plaza areas, special feature areas	0.10 W/ft^2	0.10 W/ft^2	0.11 W/ft^2	0.14 W/ft^2
Dining areas	0.65 W/ft^2	0.65 W/ft^2	0.75 W/ft^2	0.95 W/ft^2
Stairways	0.60 W/ft^2	0.70 W/ft^2	0.70 W/ft^2	0.70 W/ft^2
Pedestrian tunnels	0.12 W/ft^2	0.12 W/ft^2	0.14 W/ft^2	0.21 W/ft^2
Landscaping	0.03 W/ft^2	0.04 W/ft^2	0.04 W/ft^2	0.04 W/ft^2
Building Entrances and Exits				
Pedestrian and vehicular entrances and exits	14 W/linear foot of opening	14 W/linear foot of opening	21 W/linear foot of opening	21 W/linear foot of opening
Entry canopies	0.20 W/ft^2	0.25 W/ft^2	0.40 W/ft^2	0.40 W/ft^2
Loading docks	0.35 W/ft^2	0.35 W/ft^2	0.35 W/ft^2	0.35 W/ft^2
Sales Canopies				
Free-standing and attached	0.40 W/ft^2	0.40 W/ft^2	0.60 W/ft^2	0.70 W/ft^2
Outdoor Sales				
Open areas (including vehicle sales lots)	0.20 W/ft^2	0.20 W/ft^2	0.35 W/ft^2	0.50 W/ft^2
Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	7 W/linear foot	7 W/linear foot	21 W/linear foot

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TABLE C405.5.2(3)INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

LIGHTING ZONES				
	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
Building facades	No allowance	0.075 W/ft^2 of gross above-grade wall area	0.113 W/ft^2 of gross above-grade wall area	0.15 W/ft^2 of gross above-grade wall area
Automated teller machines (ATM) and night depositories	135 W per location plus 45 W per additional ATM per location			
Uncovered entrances and gatehouse inspection stations at guarded facilities	0.50 W/ft^2 of area			
Uncovered loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.35 W/ft^2 of area			
Drive-up windows and doors	200 W per drive through			
Parking near 24-hour retail entrances.	400 W per main entry			

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C405.12 Energy monitoring

New buildings with a gross conditioned floor area of 25,000 square feet or larger shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.12.1 through C405.12.5.

Exception: R-2 occupancies and individual tenant spaces are not required to comply with this section provided that the space has its own utility services and meters and has less than 5,000 square feet of conditioned floor area

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C405.12.1 Electrical energy metering

For all electrical energy supplied to the building and its associated site, including but not limited to site lighting, parking, recreational facilities and other areas that serve the building and its occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.12.2

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C405.12.2 End-use metering categories

Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.12.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured load for each of the end-use categories indicated in Table C405.12.2 shall be permitted to be from a load that is not within that category.

Exceptions:

1.HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.

2.End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.

3.End-use metering shall not be required for an individual tenant space having a floor area not greater than 2,500 square feet where a dedicated source meter complying with Section C405.12.3 is provided

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TABLE C405.12.2 ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Process load	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.

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IECC Additional Efficiency Package Options
Section C406

C406.1Additional energy efficiency credit requirements.

New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following

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TABLE C406.1(2)ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP R AND I OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	NA	1	1	1	1	2	1	2	2
C406.2.2: 5% cooling efficiency improvement	3	3	2	2	1	1	1	1	1	NA	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	1	1	2	2	1	3	2	3	4
C406.2.4: 10% cooling efficiency improvement	5	5	4	3	2	3	1	2	2	1	1	1	1	1	1	1	1
C406.3: Reduced lighting power	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C406.4: Enhanced digital lighting controls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.5: On-site renewable energy	8	8	8	8	7	8	8	7	7	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	2	NA	6	3	4	8	5	5	10	7	11	12
C406.7.2: Recovered or renewable water heating	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	5	4	4	1	4	3	3	4	5	3	5	4	6	6
C406.9: Reduced air infiltration	6	5	3	11	6	4	NA	7	3	3	9	5	1	13	6	8	3
C406.10: Energy monitoring	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.11: Fault detection and diagnostics system	1	1	1	1	1	1	NA	1	1	NA	1	1	NA	1	1	1	1

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C406 ADDITIONAL EFFICIENCY PACKAGE OPTIONS

More efficient HVAC performance in accordance with Section C406.2

C406.2 More efficient HVAC equipment performance

Equipment shall exceed the minimum efficiency requirements listed in the tables in Section C403.3.2. Variable refrigerant flow systems listed in the energy efficiency provisions of ANSI/ASHRAE/IES 90.1 in accordance with Section C406.2.1, C406.2.2, C406.2.3 or C406.2.4 shall also meet applicable requirements of Section C403. Energy efficiency credits for heating shall be selected from Section C406.2.1 or C406.2.3 and energy efficiency credits for cooling shall be selected from Section C406.2.2, C406.2.4 or C406.2.5. Selected credits shall include a heating or cooling energy efficiency credit or both. Equipment not listed in Tables C403.3.2(1) through C403.3.2(9) and variable refrigerant flow systems not listed in the energy efficiency provisions of ANSI/ASHRAE/IES 90.1 shall be limited to 10 percent of the total building system capacity for heating equipment where selecting Section C406.2.1 or C406.2.3 and cooling equipment where selecting Section C406.2.2, C406.2.4 or C406.2.5. 96

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C406 ADDITIONAL EFFICIENCY PACKAGE OPTIONS

Reduced lighting power in accordance with Section C406.3.

Buildings shall comply with Section C406.3.1 or C406.3.2, and dwelling units and sleeping units within the building shall comply with Section C406.3.3.

C406.3.1Reduced lighting power by more than 10 percent
The total connected interior lighting power calculated in accordance with Section C405.3.1 shall be less than 90 percent of the total lighting power allowance calculated in accordance with Section C405.3.2.

C406.3.2 Reduced lighting power by more than 15 percent
Where the total connected interior lighting power calculated in accordance with Section C405.3.1 is less than 85 percent of the total lighting power allowance calculated in accordance with Section C405.3.2, additional energy efficiency credits shall be determined based on Equation 4-13, rounded to the nearest whole number.

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C406.3.3 Lamp efficacy

Not less than 95 percent of the permanently installed lighting, excluding kitchen appliance light fixtures, serving dwelling units and sleeping units shall be provided by lamps with an efficacy of not less than 65 lumens per watt or luminaires with an efficacy of not less than 45 lumens per watt

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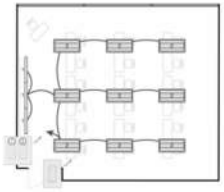
C406 ADDITIONAL EFFICIENCY PACKAGE OPTIONS

Enhanced lighting controls in accordance with Section C406.4.



- Enhanced digital lighting controls per C406.4, controls located and operated in accordance with Sections C405.2.1 through C405.2.3.
  - Luminaires shall be capable of continuous dimming
  - Luminaires shall be addressed individually OR a controlled group of ≤ 4 luminaires (Where individual addressability is not available for the luminaire class type)
  - ≤ 8 luminaires controlled together in a daylight zone
  - Fixtures controlled through digital control system that includes the following function:
    - Control reconfiguration based on digital addressability
    - Load shedding
    - Occupancy sensors capable of being reconfigured through the digital control system
  - Construction documents including submittal of Sequence of Operations including specs outlining each function of the fixture requirements above
  - Functional testing of controls comply with C408

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C406 ADDITIONAL EFFICIENCY PACKAGE OPTIONS

On-site supply of renewable energy in accordance with Section C406.5

C406.5.1 Basic renewable credit

The total minimum ratings of on-site renewable energy systems, not including systems used for credits under Sections C406.7.2, shall be one of the following:

1.Not less than 0.86 Btu/h per square foot or 0.25 watts per square foot of conditioned floor area.

2.Not less than 2 percent of the annual energy used within the building for building mechanical and service water-heating equipment and lighting regulated in Section C405.

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C406 ADDITIONAL EFFICIENCY PACKAGE OPTIONS

Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.

C406.6 Dedicated outdoor air system

- Be equipped with an independent ventilation system designed to provide ≤100% outdoor air to each occupied space
  - Ventilation system capable of total energy recovery
  - HVAC system include supply-air temperature controls that automatically reset the supply-air temp. in response to building loads or outdoor air temperatures
  - Controls reset the supply-air temperature at least 25% of the difference between design supply-air temp. and design room-air temp.

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What is a Dedicated Outdoor Air System?

- Consists of two parallel systems: A dedicated system for delivering outdoor air ventilation that handles both the latent and sensible loads of conditioning the ventilation air and a parallel system to handle mostly sensible loads generated by indoor sources and those that pass through the building enclosure
- Main purposes is to provide dedicated ventilation rather than ventilation as part of conditioned air.
- Improves indoor air quality and thermal comfort
- Provides a dedicated supply of 100% outdoor air rather than mixing it with the return air as is typical with VAV systems.
- Sized to meet ventilation requirements and does not require oversizing as with VAV systems
- Controls latent and sensible loads independently to avoid moisture related indoor air problems.

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C406 ADDITIONAL EFFICIENCY PACKAGE OPTIONS

Reduced energy use in service water heating C406.7

Buildings with the following types allowed to use this compliance method:

Group R-1: Boarding houses, hotels, or motels

Group I-2: Hospitals, psychiatric hospitals, and nursing homes

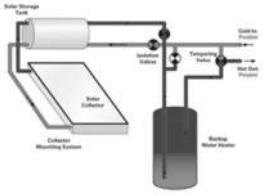
Group A-2: Restaurants and banquet halls or buildings containing food preparation areas

Group F: Laundries

Group R-2

Group A-3: Health clubs and spas

Buildings showing a service hot water load of >10% of total building energy loads as shown with an energy analysis per C407



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Reduced energy use in service water heating C406.7

C406.7.2 Recovered or renewable water heating

The building service water-heating system shall have one or more of the following that are sized to provide not less than 30 percent of the building's annual hot water requirements, or sized to provide 70 percent of the building's annual hot water requirements if the building is required to comply with Section C403.10.5:

1. Waste heat recovery from service hot water, heat-recovery chillers, building equipment or process equipment.
2. On-site renewable energy water-heating systems.

 104

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Reduced energy use in service water heating C406.7

C406.7.3 Efficient fossil fuel water heater

The combined input-capacity weighted-average equipment rating of all fossil fuel water-heating equipment in the building shall be not less than 95 percent Et or 0.95 EF. This option shall receive only half the listed credits for buildings required to comply with Section C404.2.1.

105

Reduced energy use in service water heating C406.7

C406.7.4 Heat pump water heater

Where electric resistance water heaters are allowed, all service hot water system heating requirements shall be met using heat pump technology with a combined input-capacity weighted-average EF of 3.0.

Air-source heat pump water heaters shall not draw conditioned air from within the building, except exhaust air that would otherwise be exhausted to the exterior.

 106

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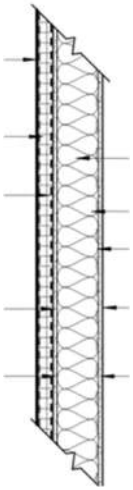
C406 ADDITIONAL EFFICIENCY PACKAGE OPTIONS

Enhanced envelope performance in accordance with Section C406.8

C406.8 Enhanced envelope performance

The total UA of the building thermal envelope as designed shall be not less than 15 percent below the total UA of the building thermal envelope in accordance with Section C402.1.5



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C406 ADDITIONAL EFFICIENCY PACKAGE OPTIONS

Reduced air infiltration in accordance with Section C406.9

C406.9 Reduced air infiltration.

Air infiltration shall be verified by whole-building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air-leakage rate of the building envelope shall not exceed 0.25 cfm/ft2 under a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

Exception: For buildings having over 250,000 square feet (25 000 m2) of conditioned floor area, air leakage testing need not be conducted on the whole building where testing is conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.

 108

108

C406 ADDITIONAL EFFICIENCY PACKAGE OPTIONS

C406.10 Energy monitoring

Buildings shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C406.10.1 through C406.10.5.

C406.11 Fault detection and diagnostics system

C406.12 Efficient kitchen equipment

 109

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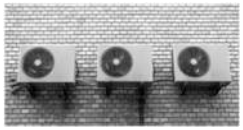
C408 MAINTENANCE INFORMATION AND SYSTEM COMMISSIONING

 110

110

C408.1 General

This section covers the provision of maintenance information and the commissioning of, and the functional testing requirements for, building systems



 111

111

C408.1.1 Building operations and maintenance information

The building operations and maintenance documents shall be provided to the owner and shall consist of:

- manufacturers' information, specifications and recommendations;
- programming procedures and data points; narratives; and other means of illustrating to the owner how the building, equipment and systems are intended to be installed, maintained and operated.
- Required regular maintenance actions for equipment and systems shall be clearly stated on a readily visible label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product

Building Operation and Maintenance Manual

Read this prior to any maintenance!

 112

112

C408.2 Mechanical systems and service water-heating systems commissioning and completion requirements

- Prior to the final mechanical and plumbing inspections
- Registered design professional or approved agency shall provide evidence of mechanical systems commissioning and completion in accordance with the provisions of this section

- Construction document notes shall clearly indicate:
- Provisions for commissioning and completion requirements in accordance with this section
- Copies of all documentation shall be given to the owner or owner's authorized agent and made available to the code official upon

113

C408.2 Mechanical systems and service water-heating systems commissioning and completion requirements

- Exceptions:
- Mechanical systems and service water heater systems in buildings where the total mechanical equipment capacity is less than:
- 480,000 Btu/h cooling capacity and 600,000 Btu/h combined service water-heating and space-heating capacity.
- Systems included in Section C403.5 (Economizers) that serve individual dwelling units and sleeping units

114

C408.2.1 Commissioning plan

- A commissioning plan shall be developed by a registered design professional and include the following items:
  - A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities
  - A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed
  - Functions to be tested including, but not limited to, calibrations and economizer controls
  - Conditions under which the test will be performed. Testing shall affirm winter and summer design conditions and full outside air conditions
  - Measurable criteria for performance

115

C408.2.2 Systems adjusting and balancing

- HVAC systems shall be balanced
- Accordance with generally accepted engineering standards
- Air and water flow rates shall be measured and adjusted to deliver final flow rates within the tolerances provided in the product specifications
- Test and balance activities shall include air system and hydronic system balancing

116

C408.2.2.1 Air systems balancing

- Supply air outlet and zone terminal device shall be equipped with means for air balancing in accordance with the requirements of Chapter 6 of the International Mechanical Code
- Exception: Fans with fan motors of 1 hp or less are not required to be provided with a means for air balancing

 117

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C408.2.2.2 Hydronic systems balancing

- Individual hydronic heating and cooling coils shall be equipped with means for balancing and measuring flow

Exception

- Pumps with pump motors of 5 hp or less

 118

118

C408.2.3 Functional performance testing

C408.2.3.1 Equipment

- Equipment functional performance testing
- Operation of components, systems, and system-to-system interfacing relationships in accordance with approved plans and specifications
- Operation, function, and maintenance serviceability for each of the commissioned systems is confirmed
- Testing shall include all modes and sequence of operation, including under full-load, part-load and emergency conditions

- C408.2.3.2 Controls
  - HVAC and service water-heating control systems shall be tested and adjusted and operate in accordance with approved plans and specifications
- C408.2.3.3 Economizers
  - Air economizers shall undergo a functional test to determine that they operate in accordance with manufacturer's specifications

 119

119

C408.2.4 Preliminary commissioning report

- The report shall be identified as "Preliminary Commissioning Report" shall include the completed Commissioning Compliance Checklist, Figure C408.2.4, and shall identify
  - Itemization of deficiencies found during testing that have not been corrected at the time of reporting
  - Deferred tests that cannot be performed at the time of report preparation because of climatic conditions (This would include any climatic conditions required for testing)
  - Report sent to Owner
  - Results of functional performance tests
  - Functional performance test procedures used during the commissioning process, including measurable criteria for test acceptance
  - Building Official can require a copy for their review

 120

120

Project Information: _____ Project Name:_____

Project Address: _____

Commissioning Authority: _____

Commissioning Plan (Section C408.2.1)

☐ Commissioning Plan was used during construction and includes all items required by Section C408.2.1

☐ Systems Adjusting and Balancing has been completed.

☐ HVAC Equipment Functional Testing has been executed. If applicable, deferred and follow-up testing is scheduled to be provided on:_____

☐ HVAC Controls Functional Testing has been executed. If applicable, deferred and follow-up testing is scheduled to be provided on:_____

☐ Economizer Functional Testing has been executed. If applicable, deferred and follow-up testing is scheduled to be provided on:_____

☐ Lighting Controls Functional Testing has been executed. If applicable, deferred and follow-up testing is scheduled to be provided on:_____

☐ Service Water Heating System Functional Testing has been executed. If applicable, deferred and follow-up testing is scheduled to be provided on:_____

☐ Manual, record documents and training have been completed or scheduled

☐ Preliminary Commissioning Report submitted to owner and includes all items required by Section C408.2.4

I hereby certify that the commissioning provider has provided me with evidence of mechanical, service water heating and lighting systems commissioning in accordance with the 2018 IECC.

Signature of Building Owner or Owner's Representative _____ Date_____

 121

121

C408.2.4 Preliminary commissioning report

C408.2.4.1 Acceptance of report

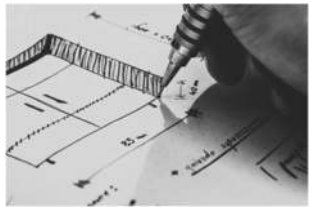
Buildings, or portions thereof, shall not be considered as acceptable for a final inspection pursuant to Section C105.2.6 until the code official has received the Preliminary Commissioning Report from the building owner or owner's authorized agent

 122

122

C408.2.5 Documentation requirements

- The construction documents shall specify that the documents described in this section be provided to the building owner or owner's authorized agent within 90 days of the date of receipt of the certificate of occupancy



 123

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C408.2.5.1 System balancing report

- A written report describing the activities and measurements completed in accordance with Section C408.2.2.

 124

124

C408.2.5.2 Final commissioning report

- A report of test procedures and results identified as "Final Commissioning Report" shall be delivered to the building owner or owner's authorized agent. The report shall be organized with mechanical system and service hot water system findings in separate sections to allow independent review. The report shall include the following:
- Results of functional performance tests
- Disposition of deficiencies found during testing, including details of corrective measures used or proposed
- Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance, provided herein for repeatability

Exception: Deferred tests that cannot be performed at the time of report preparation due to climatic conditions

 125

125

R101.4.1 Mixed residential and commercial buildings

Where a building includes both residential building and commercial building portions, each portion shall be separately considered and meet the applicable provisions of the IECC—Commercial Provisions or IECC—Residential Provisions.

 126

126

Residential VS Commercial

Definition of Residential per IECC is different than that found in the IRC and IBC:

RESIDENTIAL BUILDING

- For this code, includes detached one- and two family dwellings and multiple single-family dwellings (townhouses) as well as Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane

How is the IECC used for this type of building?

COMMERCIAL BUILDING. For this code, all buildings that are not included in the definition of "Residential buildings."

 127

127

R103.2 Information on construction documents

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

 128

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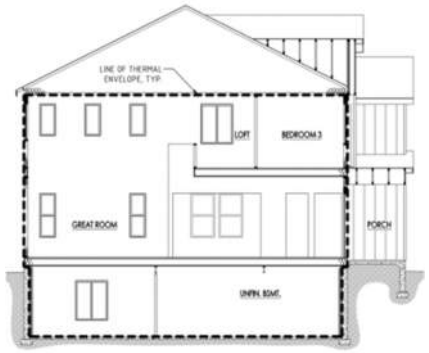
R103.2.1 Building thermal envelope depiction

The building thermal envelope shall be represented on the construction documents.



 129

129

Definitions

ABOVE-GRADE WALL

A wall more than 50 percent above grade and enclosing conditioned space. This includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts

 130

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Definitions

AIR BARRIER

One or more materials joined together in a continuous manner to restrict or prevent the passage of air through the building thermal envelope and its assemblies.

 131

131

Definitions

BUILDING THERMAL ENVELOPE

The basement walls, exterior walls, floors, ceiling, roofs and any other building element assemblies that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space

 132

132

Definitions

FENESTRATION. Products classified as either vertical fenestration or skylights.

Skylights

Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees from horizontal including unit skylights, tubular daylighting devices, and glazing materials in solariums, sunrooms, roofs and sloped walls.

Vertical fenestration

Windows that are fixed or operable, opaque doors, glazed doors, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of not less than 60 degrees from horizontal.

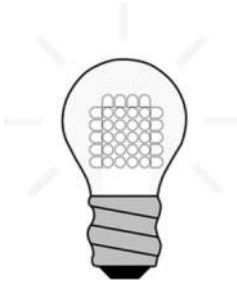
 133

133

Definitions

HIGH-EFFICACY LIGHT SOURCES

Any lamp with an efficacy of not less than 65 lumens per watt, or luminaires with an efficacy of not less than 45 lumens per watt.



 134

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Definitions

DWELLING UNIT ENCLOSURE AREA

The sum of the area of ceiling, floors, and walls separating a dwelling unit's conditioned space from the exterior or from adjacent conditioned or unconditioned spaces. Wall height shall be measured from the finished floor of the dwelling unit to the underside of the floor above.

 135

135

Definitions

CAVITY INSULATION

Insulating material located between framing members

 136

136

Definitions

CONTINUOUS INSULATION (ci)

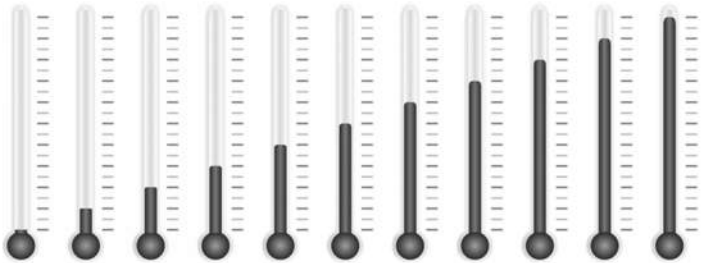
Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior, or is integral to any opaque surface, of the building envelope.

 137

137

R302.1 Interior design conditions

The interior design temperatures used for heating and cooling load calculations shall be a maximum of 72°F for heating and minimum of 75°F for cooling.



 138

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Tables R301.2(1)

TABLE R301.2(1)
CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA

GROUND SNOW LOAD[a]	WIND DESIGN				SEISMIC DESIGN CATEGORY[e]	SUBJECT TO DAMAGE FROM			ICE BARRIER UNDERLAYMENT REQUIRED[g]	FLOOD HAZARDS[h]	AIR FREEZING INDEX[i]	MEAN ANNUAL TEMP[j]
	Speed[d] (mph)	Topographic Effects[i]	Special wind Region[f]	Windborne debris zone[f]		Weathering[c]	Frost line depth[b]	Termite[f]				
—	—	—	—	—	—	—	—	—	—	—	—	—

MANUAL J DESIGN CRITERIA[m]

Elevation	Altitude correction factor[n]	Summer design grains	Indoor winter design relative humidity	Indoor winter design dry bulb temperature	Outdoor winter design dry bulb temperature	Heating temperature difference
—	—	—	—	—	—	—
Latitude	**Daily range**	**Coincident wet bulb**	**Indoor summer design relative humidity**	**Indoor summer design dry bulb temperature**	**Outdoor summer design dry bulb temperature**	**Cooling temperature difference**
—	—	—	—	—	—	—

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R303.1.2 Insulation mark installation

Insulating materials shall be installed such that the manufacturer's R-value mark is readily observable at inspection. For insulation materials that are installed without an observable manufacturer's R-value mark, such as blown or draped products, an insulation certificate complying with Section R303.1.1 shall be left immediately after installation by the installer, in a conspicuous location within the building, to certify the installed R-value of the insulation material.

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R303.1.3 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.

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R303.1.5 Air-impermeable insulation

Insulation having an air permeability not greater than 0.004 cubic feet per minute per square foot under pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with ASTM E2178 shall be determined air-impermeable insulation.

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142

R303.3 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 visible label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.

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Compliance paths

R401.2.1 Prescriptive Compliance Option

The Prescriptive Compliance Option requires compliance with Sections R401 through R404.

U-factor, R-value alternative, Total UA

R401.2.2 Total Building Performance Option

The Total Building Performance Option requires compliance with Section R405.

R401.2.3 Energy Rating Index Option

The Energy Rating Index (ERI) Option requires compliance with Section R406

R401.2.4 Tropical Climate Region Option

The Tropical Climate Region Option requires compliance with Section R407.

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R401.2.5 Additional energy efficiency

This section establishes additional requirements applicable to all compliance approaches to achieve additional energy efficiency.

1. For buildings complying with Section R401.2.1, one of the additional efficiency package options shall be installed according to Section R408.2
2. For buildings complying with Section R401.2.2,the building shall meet one of the following:
   - 2.1. One of the additional efficiency package options in Section R408.2 shall be installed without including such measures in the proposed design under SectionR405; or
   - 2.2. The proposed design of the building under Section R405.2 shall have an annual energy cost that is less than or equal to 95 percent of the annual energy cost of the standard reference design.
3. For buildings complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified in Table R406.5.

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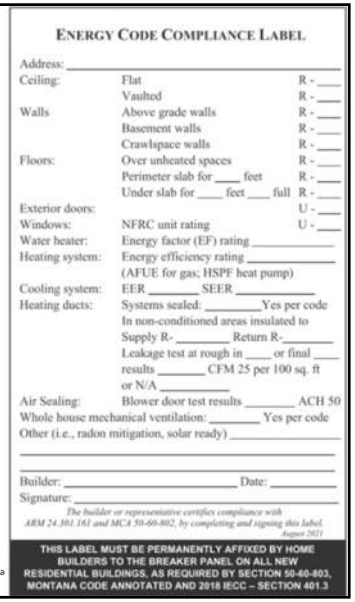
R401.3 Certificate

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. 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 following:



ENERGY CODE COMPLIANCE LABEL

Address: _____

Ceiling:	Flat	R - ___
	Vaulted	R - ___
Walls	Above grade walls	R - ___
	Basement walls	R - ___
	Crawlspace walls	R - ___
Floors:	Over unheated spaces	R - ___
	Perimeter slab for ___ feet	R - ___
	Under slab for ___ feet ___ full	R - ___
Exterior doors:		U - ___
Windows:	NFRC unit rating	U - ___
Water heater:	Energy factor (EF) rating _____	
Heating system:	Energy efficiency rating _____ (AFUE for gas; HSPF heat pump)	
Cooling system:	EER _____ SEER _____	
Heating ducts:	Systems sealed: _____Yes per code	
	In non-conditioned areas insulated to	
	Supply R- _____ Return R-_____	
	Leakage test at rough in ____ or final ____ results _____ CFM 25 per 100 sq. ft or N/A _____	
Air Sealing:	Blower door test results _____ ACH 50	

Whole house mechanical ventilation: _____ Yes per code

Other (i.e., radon mitigation, solar ready) _____

_____

_____

Builder: _____ Date: _____

Signature: _____

The builder or representative certifies compliance with ARM 24.301.161 and MCA 50-60-802, by completing and signing this label. August 2021

THIS LABEL MUST BE PERMANENTLY AFFIXED BY HOME BUILDERS TO THE BREAKER PANEL ON ALL NEW RESIDENTIAL BUILDINGS, AS REQUIRED BY SECTION 50-60-803, MONTANA CODE ANNOTATED AND 2018 IECC – SECTION 401.3

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R401.3 Certificate

1. The predominant R-values of insulation installed
2. U-factors of fenestration and the solar heat gain coefficient (SHGC) of fenestration
3. The results from any required duct system and building envelope air leakage testing performed on the building
4. The types, sizes and efficiencies of heating, cooling and service water-heating equipment
5. Where on-site photovoltaic panel systems have been installed, the array capacity, inverter efficiency, panel tilt and orientation shall be noted on the certificate
6. For buildings where an Energy Rating Index score is determined in accordance with Section R406, the Energy Rating Index score, both with and without any on-site generation, shall be listed on the certificate
7. The code edition under which the structure was permitted, and the compliance path used

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R402.1.1 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 1404.3 of the International Building Code, as applicable.

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R402 Building Thermal Envelope

R402.1.2 Insulation and fenestration criteria

The building thermal envelope shall meet the requirements of Table R402.1.2, based on the climate zone specified in Chapter 3. Assemblies shall have a U-factor equal to or less than that specified in Table R402.1.2. Fenestration shall have a U-factor and glazed fenestration SHGC equal to or less than that specified in Table R402.1.2.

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R402 Building Thermal Envelope

TABLE R402.1.2
MAXIMUM ASSEMBLY *U*-FACTORS[a] AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	FENESTRATION *U*-FACTOR[c]	SKYLIGHT *U*-FACTOR	GLAZED FENESTRATION SHGC[d, e]	CEILING *U*-FACTOR	WOOD FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
0	0.50	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
1	0.50	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.25	0.026	0.084	0.165	0.064	0.360	0.477
3	0.30	0.55	0.25	0.026	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.30	0.55	0.40	0.024	0.045	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	0.40	0.024	0.045	0.082	0.033	0.050	0.055
6	0.30	0.55	NR	0.024	0.045	0.060	0.033	0.050	0.055
7 and 8	0.30	0.55	NR	0.024	0.045	0.057	0.028	0.050	0.055

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R402 Building Thermal Envelope

a. Nonfenestration U-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall U-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In Warm Humid locations as defined by Figure R301.1 and Table R301.1, the basement wall U-factor shall not exceed 0.360.

d. The SHGC column applies to all glazed fenestration.

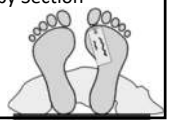
Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

e. There are no SHGC requirements in the Marine Zone.

f. A maximum U-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation above sea level, or

2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the International Residential Code.



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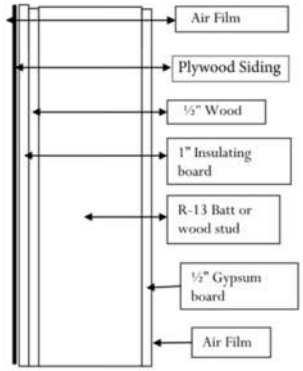
R402 Building Thermal Envelope



	R-value at Insulation	R-value at Stud
Air Film	00.17	00.17
Plywood Siding	00.59	00.59
½" Wood	00.81	00.81
1" Insulating board	03.57	03.57
R-13 Batt or wood stud	13.00	04.55
½" Gypsum board	00.45	00.45
Air Film	00.68	00.68
Totals	19.27	10.82

Assume a framing factor of 20% (The area of the wall that is wood)

Average R= (0.80 x 19.27) + (0.20 x 10.82) = 15.41 + 2.16 = 17.57

U-value = 1/17.57 = 0.057

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R402 Building Thermal Envelope

R402.1.3 R-value alternative

Assemblies with R-value of insulation materials equal to or greater than that specified in Table R402.1.3 shall be an alternative to the U-factor in Table R402.1.2

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153

R402 Building Thermal Envelope

TABLE R402.1.3
INSULATION MINIMUM *R*-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b, i]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[g]	MASS WALL *R*-VALUE[h]	FLOOR *R*-VALUE	BASEMENT[c, g] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c, g] WALL *R*-VALUE
0	NR	0.75	0.25	30	13 or 0&10ci	3/4	13	0	0	0
1	NR	0.75	0.25	30	13 or 0&10ci	3/4	13	0	0	0
2	0.40	0.65	0.25	49	13 or 0&10ci	4/6	13	0	0	0
3	.30	0.55	0.25	49	20 or 13&5ci[h] or 0&15ci[h]	8/13	19	5ci or 13[f]	10ci, 2 ft	5ci or 13[f]
4 except Marine	.30	0.55	0.40	60	30 or 20&5ci[h] or 13&10ci[h] or 0&20ci[h]	8/13	19	10ci or 13	10ci, 4 ft	10ci or 13
5 and Marine 4	0.30[f]	0.55	0.40	60	30 or 20&5ci[h] or 13&10ci[h] or 0&20ci[h]	13/17	30	15ci or 19 or 13&5ci	10ci, 4 ft	15ci or 19 or 13&5ci
6	0.30[f]	0.55	NR	60	30 or 20&5ci[h] or 13&10ci[h] or 0&20ci[h]	15/20	30	15ci or 19 or 13&5ci	10ci, 4 ft	15ci or 19 or 13&5ci
7 and 8	0.30[f]	0.55	NR	60	30 or 20&5ci[h] or 13&10ci[h] or 0&20ci[h]	19/21	38	15ci or 19 or 13&5ci	10ci, 4 ft	15ci or 19 or 13&5ci

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R402 Building Thermal Envelope

NR = Not Required. ci = continuous insulation.

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: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13&5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the 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 is not required in Warm Humid locations as defined by Figure R301.1 and Table R301.1.

g. 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.

h. Mass walls shall be in accordance with Section R402.2.5. The second R-value applies where more than half of the insulation is on the interior of the mass wall.

i. A maximum U-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation, or

2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the International Residential Code.

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R402.1.4 R-value computation

Cavity insulation alone shall be used to determine compliance with the cavity insulation R-value requirements in Table R402.1.3.

Where cavity insulation is installed in multiple layers, the R-values of the cavity insulation layers shall be summed to determine compliance with the cavity insulation R-value requirements.

The manufacturer's settled R-value shall be used for blown-in insulation.

Continuous insulation (ci) alone shall be used to determine compliance with the continuous insulation R-value requirements in Table R402.1.3. Where continuous insulation is installed in multiple layers, the R-values of the continuous insulation layers shall be summed to determine compliance with the continuous insulation R-value requirements.

Cavity insulation R-values shall not be used to determine compliance with the continuous insulation R-value requirements in Table R402.1.3.

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 R402.1.3, the manufacturer's labeled R-value for the insulated siding shall be reduced by R-0.6

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R402.1.5 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 R402.1.2 by the same assembly area as in the proposed building, the building shall be considered to be in compliance with Table R402.1.2. 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, the SHGC requirements of Table R402.1.2 and the maximum fenestration U-factors of Section R402.5 shall be met

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R402.2 Specific insulation requirements

R402.2.1 Ceilings with attics

Where Section R402.1.3 requires R-49 insulation in the ceiling or attic, installing R-38 over 100 percent of the ceiling or attic 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.

Where Section R402.1.3 requires R-60 insulation in the ceiling or attic, installing R-49 over 100 percent of the ceiling or attic area requiring insulation shall satisfy the requirement for R-60 insulation wherever the full height of uncompressed R-49 insulation extends over the wall top plate at the eaves.

This reduction shall not apply to the insulation and fenestration criteria in Section R402.1.2 and the Total UA alternative in Section R402.1.5

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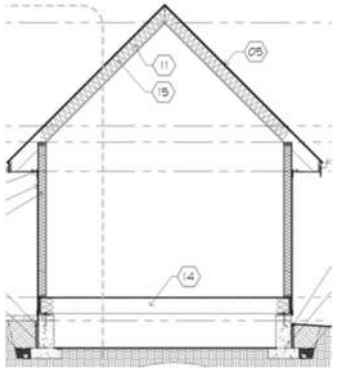
R402.2 Specific insulation requirements



R402.2.2 Ceilings without attics

Where Section R402.1.3 requires insulation R-values greater than R-30 in the interstitial space above a ceiling and below the structural roof deck, 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 R402.1.3 shall be limited to 500 square feet or 20 percent of the total insulated ceiling area, whichever is less.

This reduction shall not apply to the Total UA alternative in Section R402.1.5.

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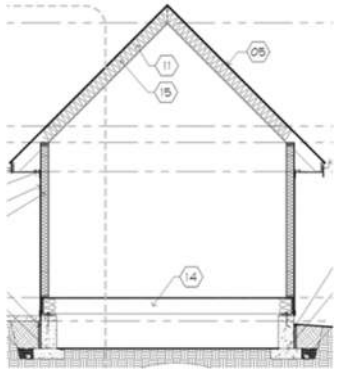
Montana Amendment

(e) Subsection R402.2.2, Ceilings Without Attics, is deleted and replaced with the following: "Where Table R402.1.3 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 Table R402.1.3, shall be limited to 250 square feet or ten percent of the total insulated ceiling area, whichever is less. This reduction shall not apply to the U-factor alternative approach in Section R402.1.4, and the total UA alternative in Section R402.1.5."



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R402.2 Specific insulation requirements

R402.2.3 Eave baffle

For air-permeable insulation in vented attics, a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain a net free area 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. The baffle shall be installed to the outer edge of the exterior wall top plate so as to provide maximum space for attic insulation coverage over the top plate.

Where soffit venting is not continuous, baffles shall be installed continuously to prevent ventilation air in the eave soffit from bypassing the baffle

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R402.2 Specific insulation requirements

R402.2.4 Access hatches and doors

Access hatches and doors from conditioned to unconditioned spaces such as attics and crawl spaces shall be insulated to the same R-value required by Table R402.1.3 for the wall or ceiling in which they are installed

Exceptions:

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R402.2 Specific insulation requirements

R402.2.4 Access hatches and doors

Exceptions:

1.Vertical doors providing access from conditioned spaces to unconditioned spaces that comply with the fenestration requirements of Table R402.1.3 based on the applicable climate zone specified in Chapter 3.

2.Horizontal pull-down, stair-type access hatches in ceiling assemblies that provide access from conditioned to unconditioned spaces in Climate Zones 0 through 4 shall not be required to comply with the insulation level of the surrounding surfaces provided the hatch meets all of the following:

2.1.The average U-factor of the hatch shall be less than or equal to U-0.10 or have an average insulation R-value of R-10 or greater.

2.2.Not less than 75 percent of the panel area shall have an insulation R-value of R-13 or greater.

2.3.The net area of the framed opening shall be less than or equal to 13.5 square feet (1.25 m2).

2.4.The perimeter of the hatch edge shall be weatherstripped.

The reduction shall not apply to the total UA alternative in Section R402.1.5.

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R402.2 Specific insulation requirements

R402.2.4.1 Access hatches and door insulation installation and retention

Vertical or horizontal access hatches and doors

from conditioned spaces to unconditioned spaces such as attics and crawl spaces shall be weatherstripped.

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, retainer, or dam shall be installed to prevent loose-fill insulation from spilling into living space from higher to lower sections of the attic and from attics covering conditioned spaces to unconditioned spaces. The baffle or retainer shall provide a permanent means of maintaining the installed R-value of the loose-fill insulation

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R402.2 Specific insulation requirements

R402.2.7 Floors

Floor cavity insulation shall comply with one of the following:

1. Installation shall be installed to maintain permanent contact with the underside of the subfloor decking in accordance with manufacturer instructions to maintain required R-value or readily fill the available cavity space

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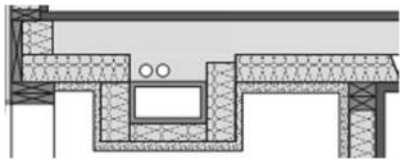
R402.2 Specific insulation requirements

2. Floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing separating the cavity and the unconditioned space below. Insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed



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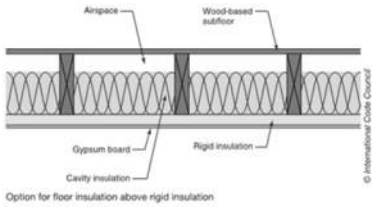
R402.2 Specific insulation requirements

3. A combination of cavity and continuous insulation shall be installed so that the cavity insulation is in contact with the top side of the continuous insulation that is installed on the underside of the floor framing separating the cavity and the unconditioned space below. The combined R-value of the cavity and continuous insulation shall equal the required R-value for floors. Insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed.



Option for floor insulation above rigid insulation

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R402.2 Specific insulation requirements

R402.2.8 Basement walls
Basement walls shall be insulated in accordance with Table R402.1.3.

Exception:

Basement walls associated with unconditioned basements where all of the following requirements are met:

Exception:

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R402.2 Specific insulation requirements

R402.2.8 Basement walls

Exception: Basement walls associated with unconditioned basements where all of the following requirements are met:

1.The floor overhead, including the underside stairway stringer leading to the basement, is insulated in accordance with Section R402.1.3 and applicable provisions of Sections R402.2 and R402.2.7.

2.There are no uninsulated duct, domestic hot water, or hydronic heating surfaces exposed to the basement.

3.There are no HVAC supply or return diffusers serving the basement.

4.The walls surrounding the stairway and adjacent to conditioned space are insulated in accordance with Section R402.1.3 and applicable provisions of Section R402.2.

5.The door(s) leading to the basement from conditioned spaces are insulated in accordance with Section R402.1.3 and applicable provisions of Section R402.2, and weatherstripped in accordance with Section R402.4.

6.The building thermal envelope separating the basement from adjacent conditioned spaces complies with Section R402.4.

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R402.2 Specific insulation requirements

R402.2.8.1 Basement wall insulation installation

Where basement walls are insulated, the insulation shall be installed from the top of the basement wall down to 10 feet below grade or to the basement floor, whichever is less.

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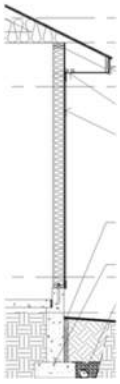
R402.2 Specific insulation requirements

R402.2.9 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 R402.1.3.

Exception

Slab-edge insulation is not required in jurisdictions designated by the code official as having a very heavy termite infestation



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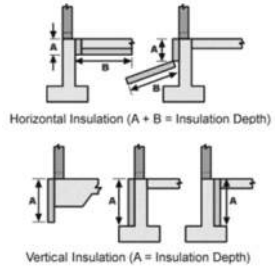
R402.2 Specific insulation requirements

R402.2.9.1 Slab-on-grade floor insulation installation

Where installed, 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 R402.1.3 or the distance of the proposed design, as applicable, 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 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 angle away from the exterior wall.



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R402.2 Specific insulation requirements

R402.2.10 Crawl space wall
Crawl space walls shall be insulated in accordance with Table R402.1.3.

Exception

Crawl space walls associated with a crawl space that is vented to the outdoors and the floor over-head is insulated in accordance with Table R402.1.3 and Section R402.2.7.

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R402.2 Specific insulation requirements

R402.2.10.1 Crawl space wall insulation installations

Where crawl space wall insulation is installed, it 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.

Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with the International Building Code or International Residential Code, as applicable.

Joints of the vapor retarder shall overlap by 6 inches and be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches up stem walls and shall be attached to the stem walls.

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R402.3 Fenestration

R402.3.5 Sunroom and heated garage fenestration

Sunrooms and heated garages enclosing conditioned space shall comply with the fenestration requirements of this code.

Exception

In Climate Zones 2 through 8, for sunrooms and heated garages 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.

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

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R402.4 Air leakage

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 R402.4.5.

R402.4.1 Building thermal envelope

The building thermal envelope shall comply with Sections R402.4.1.1 through R402.4.1.3. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.

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R402.4 Air leakage

R402.4.1.1 Installation

The components of the building thermal envelope as indicated in Table R402.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria indicated 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.

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R402.4 Air leakage

TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs 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.

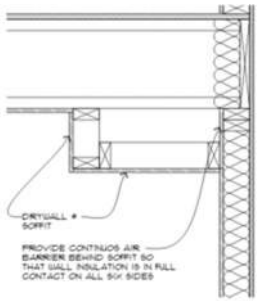

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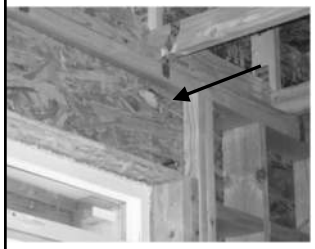
TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the 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, R-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.



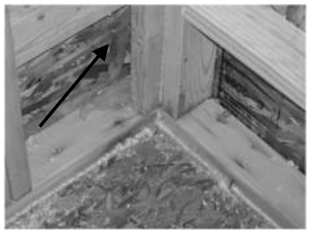


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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	—

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
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 extending from the bottom to the top of all perimeter floor framing members.

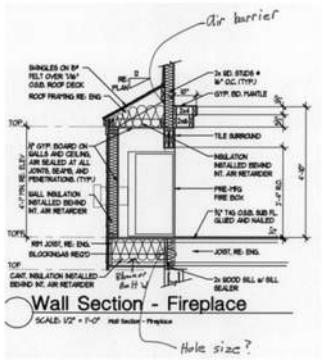

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10. Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the International Residential Code.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required R-value.

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	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.

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5.	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.

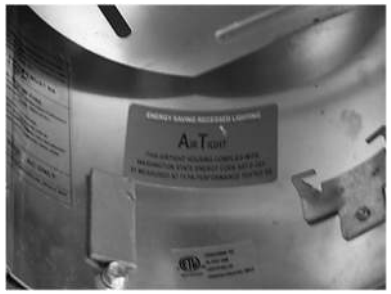

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required R-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. **Alternatively**, air-sealed boxes shall be installed.	—

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
HVAC register boots	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.	—

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TABLE R402.4.1.1
AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION [a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Concealed sprinklers	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.	—

a. Inspection of log walls shall be in accordance with the provisions of ICC 400.
b. Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

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R402.4 Air leakage

R402.4.1.2 Testing

The building or dwelling unit shall be tested for air leakage. The maximum air leak-age rate for any building or dwelling unit under any compliance path shall not exceed 5.0 air changes per hour **or** 0.28 cubic feet per minute (CFM) per square foot of dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals)

Exception….

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R402.4 Air leakage

Exception

For heated, attached private garages and heated, detached private garages accessory to one-and two-family dwellings and townhouses not more than three stories above grade plane in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified.

Where required by the code official, an approved third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, conditioned spaces in accordance with Sections R402.2.12 and R402.3.5, as applicable

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R402.4 Air leakage

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

When testing individual dwelling units, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure o0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:

1. Attached single and multiple-family building dwelling units.
2. Buildings or dwelling units that are 1,500 square feet or smaller.

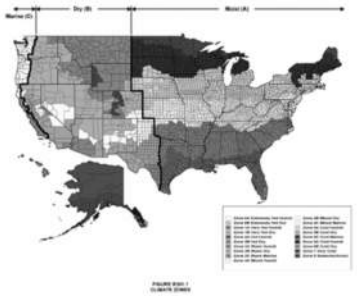
 196

196

R402.4 Air leakage

R402.4.1.3 Leakage rate

When complying with Section R401.2.1, the building or dwelling unit shall have an air leakage rate not exceeding 5.0 air changes per hour in Climate Zones 0, 1 and 2, **and** 3.0 air changes per hour in Climate Zones 3 through 8, when tested in accordance with Section R402.4.1.2.



 197

197

Montana Amendment

(g) Subsection R402.4.1.2, Testing, is deleted and replaced with the following: The building or dwelling unit shall be tested and verified as having an air leakage rate of not exceeding four air changes per hour in Climate Zone 6. Testing shall be conducted with a blower door at a pressure of 0.2 inches w.g. (50 Pascals).
Where required by the code official, testing shall be conducted by an approved 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.
During testing:
"(i) exterior windows and doors, fireplace and stove doors shall be closed, but not sealed;
"(ii) dampers shall be closed, but not sealed, including exhaust, intake, makeup air, back draft and flue
dampers;
"(iii) interior doors shall be open;
"(iv) exterior openings for continuous ventilation systems and heat recovery ventilators shall be closed and sealed;
"(v) heating and cooling system(s) shall be turned off;
"(vi) "B" or "L" vents, combustion air vents, and dryer vents shall be sealed; and
"(vii) supply and return registers, where installed at the time of test, shall by fully open.

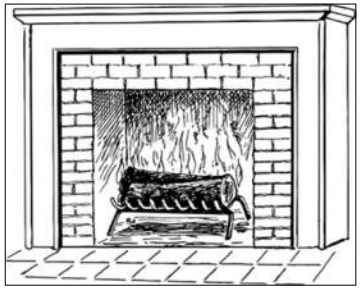
 198

198

R402.4 Air leakage

R402.4.2 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.



 199

199

R402.4 Air leakage

R402.4.3 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, and for swinging doors, not greater than 0.5 cfm per square foot, when tested in accordance with NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 by an accredited, independent laboratory and listed and labeled by the manufacturer

 200

200

R402.4 Air leakage

R402.4.4 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, isolated from inside the thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table R402.1.2, where the walls, floors and ceilings shall meet not less than 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 R403. The combustion air duct shall be insulated where it passes through conditioned space to a minimum of R-8.

 201

201

R402.4 Air leakage

R402.4.5 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 when tested in accordance with ASTM E283 at a pressure differential of 1.57 psf.

Recessed luminaires shall be sealed with a gasket or caulked between the housing and the interior wall or ceiling covering

 202

202

R402.4 Air leakage

R402.4.6 Electrical and communication outlet boxes (air-sealed boxes)

Electrical and communication outlet boxes installed in the building thermal envelope shall be sealed to limit air leakage between conditioned and unconditioned spaces. Electrical and communication outlet boxes shall be tested in accordance with NEMA OS 4 , Requirements for Air-Sealed Boxes for Electrical and Communication Applications, and shall have an air leak-age rate of not greater than 2.0 cubic feet per minute at a pressure differential of 1.57 psf (75 Pa).

Electrical and communication outlet boxes shall be marked “NEMA OS 4” or “OS 4” in accordance with NEMA OS 4.

Electrical and communication outlet boxes shall be installed per the manufacturer’s instructions and with any supplied components required to achieve compliance with NEMA OS 4

 203

203

R403.1 Controls

R403.1.1 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 day and different days of the week.

This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures of not less than 55°F to not greater than 85°F.

The thermostat shall be programmed initially by the manufacturer with a heating temperature setpoint of not greater than 70°F and a cooling temperature setpoint of not less than 78°F

 204

204

R403.1 Controls

R403.1.2 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

 205

205

R403.1 Controls

R403.2 Hot water boiler temperature reset

The manufacturer shall equip each gas, oil and electric boiler (other than a boiler equipped with a tankless domestic water heating coil) with automatic means of adjusting the water temperature supplied by the boiler to ensure incremental change of the inferred heat load will cause an incremental change in the temperature of the water supplied by the boiler. This can be accomplished with outdoor reset, indoor reset or water temperature sensing.

 206

206

R403.3 Ducts

R403.3.1 Ducts located outside conditioned space

Supply and return ducts located outside conditioned space shall be insulated to an R-value of not less than R-8 for ducts 3 inches in diameter and larger and not less than R-6 for ducts smaller than 3 inches in diameter.

Ducts buried beneath a building shall be insulated as required per this section or have an equivalent thermal distribution efficiency.

Underground ducts utilizing the thermal distribution efficiency method shall be listed and labeled to indicate the R-value equivalency.

 207

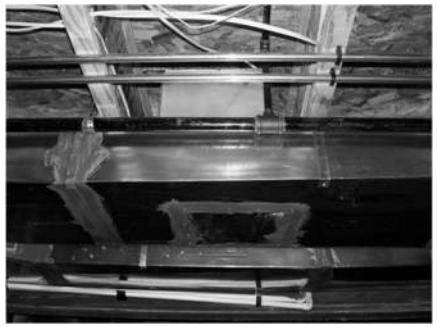
207

R403.3 Ducts

R403.3.2 Ducts located in conditioned space

For ductwork to be considered inside a conditioned space, it shall comply with one of the following:

1. The duct system shall be located completely within the continuous air barrier and within the building thermal envelope.



 208

208

R403.3 Ducts

2. Ductwork in ventilated attic spaces shall be buried within ceiling insulation in accordance with Section R403.3.3 and all of the following conditions shall exist:

2.1. The air handler is located completely within the continuous air barrier and within the building thermal envelope.

 209

209

R403.3 Ducts

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 R403.3.6, is less than or equal to 1.5 cubic feet per minute per 100 square feet 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.

 210

210

R403.3 Ducts

3. Ductwork in floor cavities located over unconditioned space shall comply with all of the following:

3.1. A continuous air barrier installed between unconditioned space and the duct.

3.2. Insulation installed in accordance with Section R402.2.7.

3.3. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.

 211

211

R403.3 Ducts

4. Ductwork located within exterior walls of the building thermal envelope shall comply with the following:

4.1. A continuous air barrier installed between unconditioned space and the duct.

4.2. Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.

4.3. The remainder of the cavity insulation shall be fully insulated to the drywall side.

 212

212

R403.3 Ducts

R403.3.4 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.

 213

213

R403.3 Ducts

R403.3.4.1 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.

 214

214

R403.3 Ducts

R403.3.5 Duct testing

Ducts shall be pressure tested in accordance with ANSI/RESNET/ICC 380 or ASTM E1554 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.

Exception: A duct air-leakage test shall not be required for ducts serving ventilation systems that are not integrated with ducts serving heating or cooling systems

 215

215

R403.3 Ducts

R403.3.6 Duct leakage

The total leakage of the ducts, where measured in accordance with Section R403.3.5, shall be as follows:

1. Rough-in test: The total leakage shall be less than or equal to 4.0 cubic feet per minute per 100 square feet 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 3.0 cubic feet per minute per 100 square feet of conditioned floor area.

2. Postconstruction test: Total leakage shall be less than or equal to 4.0 cubic feet per minute per 100 square feet of conditioned floor area.

3. Test for ducts within thermal envelope: Where all ducts and air handlers are located entirely within the building thermal envelope, total leakage shall be less than or equal to 8.0 cubic feet per minute per 100 square feet of conditioned floor area.

 216

216

R403.3 Ducts

R403.3.7 Building cavities

Building framing cavities shall not be used as ducts or plenums.

 217

217

Montana Amendment

(i) Subsection R403.3.7,
Exception: Building framing cavities may be used for return ducts if there is no atmospherically vented furnace, boiler, or water heater located in the house outside of a sealed and insulated room that is isolated from inside the thermal envelope and if the duct system has been tested as having a maximum total leakage not greater than 4 cfm/(100?)SF. The room walls, floor, and ceilings shall be insulated in accordance with the basement wall requirements of Table R402.1.3. A duct air leakage test shall not be required where the ducts and air handlers are located entirely within the building thermal envelope.

 218

218

R403.4 Mechanical system piping insulation

Mechanical system piping capable of carrying fluids greater than 105°F or less than 55°F shall be insulated to an R-value of not less than R-3

 219

219

R403.5 Service hot water systems

R403.5.1 Heated water circulation and temperature maintenance systems

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 in a location with access. Manual controls shall be in a location with ready access

 220

220

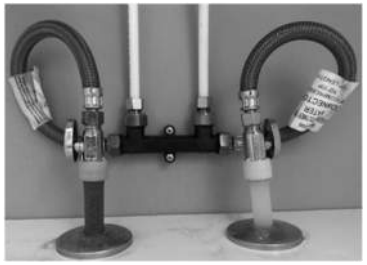
R403.5 Service hot water systems

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 thermosyphon circulation systems shall be prohibited.

Controls for circulating hot water system pumps 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.

The controls shall limit the temperature of the water entering the cold water piping to not greater than 104ºF .



 221

221

R403.5 Service hot water system

R403.5.1.1.1 Demand recirculation water systems

Where installed, demand recirculation water systems shall have controls that 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.

 222

222

R403.5 Service hot water system

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.

 223

223

R403.5 Service hot water systems

R403.5.2 Hot water pipe insulation

Insulation for service hot water piping with a thermal resistance, R-value, of not less than R-3 shall be applied to the following:

1. Piping 3/4 inch (19.1 mm) and larger in nominal diameter located inside the conditioned space.
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 circulation and recirculation systems other than cold water pipe return demand recirculation systems.

 224

224

R403.5 Service hot water systems

R403.5.3 Drain water heat recovery units

Where installed, 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 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 for individual units connected to three or more showers.

225

225

R403.6 Mechanical ventilation

The buildings complying with Section R402.4.1 shall be provided with ventilation that complies with the requirements of Section M1505 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.

226

226

R403.6 Mechanical ventilation

R403.6.1 Heat or energy recovery ventilation

Dwelling units shall be provided with a heat recovery or energy recovery ventilation system in Climate Zones 7 and 8.

The system shall be balanced with a minimum sensible heat recovery efficiency of 65 percent at 32°F at a flow greater than or equal to the design airflow.

227

227

R403.6 Mechanical ventilation

R403.6.2 Whole-dwelling mechanical ventilation system fan efficacy

Fans used to provide whole-dwelling mechanical ventilation shall meet the efficacy requirements of Table R403.6.2 at one or more rating points. Fans shall be tested in accordance with HVI 916 and listed. The airflow shall be reported in the product listing or on the label.

Fan efficacy shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing or on the label.

Fan efficacy for fully ducted HRV, ERC, balanced, and in-line fans shall be determined at a static pressure of not less than 0.2 inch w.c.

Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure of not less than 0.1 inch w.c.

TABLE R403.6.2
WHOLE-DWELLING MECHANICAL VENTILATION SYSTEM FAN EFFICACY[a]

FAN LOCATION	AIRFLOW RATE MINIMUM (CFM)	MINIMUM EFFICACY (CFM/WATT)
HRV, ERV	Any	1.2 cfm/watt
In-line supply or exhaust fan	Any	3.8 cfm/watt
Other exhaust fan	< 90	2.8 cfm/watt
Other exhaust fan	≥ 90	3.5 cfm/watt
Air-handler that is integrated to tested and *listed* HVAC equipment	Any	1.2 cfm/watt

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228

R403.6 Mechanical ventilation

R403.6.3 Testing

Mechanical ventilation systems shall be tested and verified to provide the minimum ventilation flow rates required by Section R403.6. Testing shall be performed according to the ventilation equipment manufacturer's instructions, or by using a flow hood or box, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals or grilles, outlet terminals or grilles, or in the connected ventilation ducts. 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.

Exception

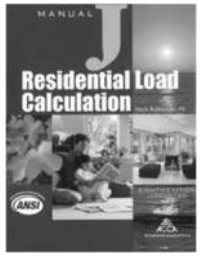
Kitchen range hoods that are ducted to the outside with 6-inch or larger duct and not more than one 90-degree elbow or equivalent in the duct run.

 229

229

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. 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.



 230

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R403.8 Systems serving multiple dwelling units

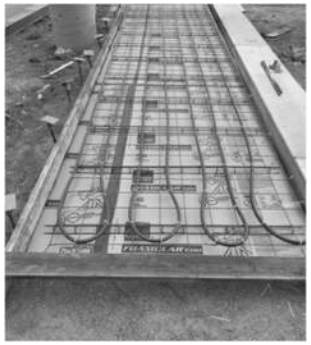
Systems serving multiple dwelling units shall comply with Sections C403 and C404 of the International Energy Conservation Code—Commercial Provisions instead of Section R403

 231

231

R403.9 Snow melt and ice 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 greater than 50°F and precipitation is not falling, and an automatic or manual control that will allow shutoff when the outdoor temperature is greater than 40°F



 232

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R403.10 Energy consumption of pools and spas

R403.10.1 Heaters

The electric power to heaters shall be controlled by an on-off switch that is an integral part of the heater mounted on the exterior of the heater in a location with ready access, or external to and within 3 feet of the heater. Operation of such switch shall not change the setting of the heater thermostat. Such switches shall be in addition to a circuit breaker for the power to the heater.

Gas-fired heaters shall not be equipped with continuously burning ignition pilots.

 233

233

R403.10 Energy consumption of pools and spas

R403.10.2 Time switches

Time switches or other control methods that can automatically turn heaters and pump motors 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 in compliance with this section.

Exceptions

1. Where public health standards require 24-hour pump operation.

2. Pumps that operate solar- and waste-heat-recovery pool heating systems.

 234

234

R403.10 Energy consumption of pools and spas

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 operation season of not fewer than 3 calendar months, is from a heat pump or an on-site renewable energy system, covers or other vapor-retardant means shall not be required.

 235

235

R403.10 Energy consumption of pools and spas

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

Where installed, the energy consumption of residential swimming pools and permanent residential spas shall be controlled in accordance with the requirements of APSP 15

 236

236

R404 Electrical Power and Lighting Systems

R404.1 Lighting equipment

All permanently installed lighting fixtures, excluding kitchen appliance lighting fixtures, shall contain only high-efficacy lighting sources.

 237

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R404 Electrical Power and Lighting Systems

R404.1.1 Exterior lighting

Connected exterior lighting for residential buildings shall comply with Section C405.5.

Exceptions:

1. Detached one- and two- family dwellings.
2. Townhouses.
3. Solar-powered lamps not connected to any electrical service.
4. Luminaires controlled by a motion sensor.
5. Lamps and luminaires that comply with Section R404.1

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R404 Electrical Power and Lighting Systems

R404.1.2 Fuel gas lighting equipment

Fuel gas lighting systems shall not have continuously burning pilot lights.

 239

239

R404 Electrical Power and Lighting Systems

R404.2 Interior lighting controls

Permanently installed lighting fixtures shall be controlled with either a dimmer, an occupant sensor control or other control that is installed or built into the fixture.

Exception

Lighting controls shall not be required for the following:

1. Bathrooms.
2. Hallways.
3. Exterior lighting fixtures.
4. Lighting designed for safety or security.

 240

240

R404 Electrical Power and Lighting Systems

R404.3 Exterior lighting controls

Where the total permanently installed exterior lighting power is greater than 30 watts, the permanently installed exterior lighting shall comply with the following:

1. Lighting shall be controlled by a manual on and off switch which permits automatic shut-off actions.

Exception

1. Lighting serving multiple dwelling units.

2. Lighting shall be automatically shut off when daylight is present and satisfies the lighting needs.

3. Controls that override automatic shut-off actions shall not be allowed unless the override automatically returns automatic control to its normal operation within 24 hours

 241

241

R405 Total Building Performance

R405.1 Scope

This section establishes criteria for compliance using total building performance analysis. Such analysis shall include heating, cooling, mechanical ventilation and service water heating energy only.

 242

242

R405 Total Building Performance

R405.2 Performance-based compliance

Compliance based on total building performance requires that a proposed design meets all of the following:

1. The requirements of the sections indicated within Table R405.2.

2. The building thermal envelope shall be greater than or equal to levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2009 International Energy Conservation Code.

3. 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 code official, such as the Department of Energy, Energy Information Administration's State Energy Data System Prices and Expenditures reports. Code 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 or Btu per square foot 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.

TABLE R405.2
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION*	TITLE
General	
R401.2.5	Additional energy efficiency
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installations
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration *U*-factor and SHGC
Mechanical	
R403.1	Controls
R403.3, including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls

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R405 Total Building Performance

R405.3.2.1 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. The name of the individual performing the analysis and generating the compliance report.

3. The name and version of the compliance software tool.

4. Documentation of all inputs entered into the software used to produce the results for the reference design and/or the rated home.

5. A certificate indicating that the proposed design complies with Section R405.3. The certificate shall document the building components' energy specifications that are included in the calculation including: component-level insulation R-values or U-factors; duct system and building envelope air leakage testing assumptions; and the type and rated efficiencies of proposed heating, cooling, mechanical ventilation and service water-heating equipment to be installed. If on-site renewable energy systems will be installed, the certificate shall report the type and production size of the proposed system.

6. Where a site-specific report is not generated, the proposed design shall be based on the worst-case orientation and configuration of the rated home.

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R405 Total Building Performance

R405.3.2.2 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. Declaration of the total building performance path on the title page of the energy report and the title page of the building plans.

3. A statement, bearing the name of the individual performing the analysis and generating the report, indicating that the as-built building complies with Section R405.3.

4. The name and version of the compliance software tool.

5. A site-specific energy analysis report that is in compliance with Section R405.3.

6. A final confirmed certificate indicating compliance based on inspection, and a statement indicating that the confirmed rated design of the built home complies with Section R405.3.

The certificate shall report the energy features that were confirmed to be in the home, including component-level insulation R-values or U-factors; results from any required duct system and building envelope air leakage testing; and the type and rated efficiencies of the heating, cooling, mechanical ventilation and service water-heating equipment installed.

7. When on-site renewable energy systems have been installed, the certificate shall report the type and production size of the installed system.

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TABLE R405.4.2(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
	U-factor: as specified in Table R402.1.2.	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
	U-factor: as specified in Table R402.1.2, 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
	U-factor: as specified in Table R402.1.2.	As proposed
Ceilings	Type: wood frame.	As proposed
	Gross area: same as proposed.	As proposed
	U-factor: as specified in Table R402.1.2.	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^2 per 300 ft^2 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^2.	As proposed
	Orientation: North.	As proposed
	U-factor: same as fenestration as specified in Table R402.1.2.	As proposed

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R406 Energy Rating Index Compliance Alternative

R406.1 Scope

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

R406.2 ERI compliance Compliance based on the ERI requires that the rated design meets all of the following:

1. The requirements of the sections indicated within Table R406.2.

2. Maximum ERI of Table R406.5.

TABLE R406.5
MAXIMUM ENERGY RATING INDEX

CLIMATE ZONE	ENERGY RATING INDEX
0-1	52
2	52
3	51
4	54
5	55
6	54
7	53
8	53

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R406 Energy Rating Index Compliance Alternative

TABLE R406.2
REQUIREMENTS FOR ENERGY RATING INDEX

SECTION[a]	TITLE
	General
R401.2.5	Additional efficiency packages
R401.3	Certificate
	Building Thermal Envelope
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
	Mechanical
R403.1	Controls
R403.3 except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water calculation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
	Electrical Power and Lighting Systems
R404.1	Lighting equipment
R404.2	Interior lighting controls
R406.3	Building thermal envelope

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R406 Energy Rating Index Compliance Alternative

R406.3.1 On-site renewables are not included

Where on-site renewable energy is not included for compliance using the ERI analysis of Section R406.4, the proposed total building thermal envelope UA, which is sum of U-factor times assembly area, shall be less than or equal to the building thermal envelope UA using the prescriptive U-factors from Table R402.1.2 multiplied by 1.15 in accordance with Equation 4-1. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

UA Proposed design = 1.15 × UA Prescriptive reference design (Equation 4-1)

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R406 Energy Rating Index Compliance Alternative

R406.3.2 On-site renewables are included

Where on-site renewable energy is included for compliance using the ERI analysis of Section R406.4, the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or Table R402.1.4 of the 2018 International Energy Conservation Code.

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R406 Energy Rating Index Compliance Alternative

R406.7.2.1 Proposed compliance report for permit Application

R406.7.2.2 Confirmed compliance report for a certificate of occupancy

Requirements similar to performance path


RESNET

2015 IECC R-406 Projected Energy Rating Index Report

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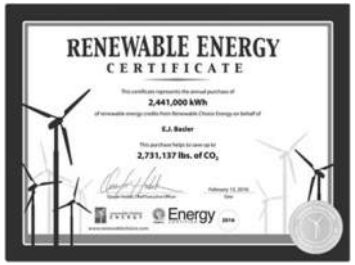
R406 Energy Rating Index Compliance Alternative

R406.7.3 Renewable energy certificate (REC) documentation

Where on-site renewable energy is included in the calculation of an ERI, one of the following forms of documentation shall be provided to the code official:

1. Substantiation that the RECs associated with the on-site renewable energy are owned by, or retired on behalf of, the homeowner.

2. A contract that conveys to the homeowner the RECs associated with the on-site renewable energy, or conveys to the homeowner an equivalent quantity of RECs associated with other renewable energy.



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R407 Tropical Climate Region Compliance Path

R407.1 Scope

This section establishes alternative criteria for residential buildings in the tropical region at elevations less than 2,400 feet above sea level.

1. Not more than one-half of the occupied space is air conditioned.
2. The occupied space is not heated.
3. Solar, wind or other renewable energy source supplies not less than 80 percent of the energy for service water heating.
4. Glazing in conditioned spaces has a solar heat gain coefficient (SHGC) of less than or equal to 0.40, or has an overhang with a projection factor equal to or greater than 0.30.
5. Permanently installed lighting is in accordance with Section R404.
6. The exterior roof surface complies with one of the options in Table C402.3 of the International Energy Conservation Code–Commercial Provisions or the roof or ceiling has insulation with an R-value of R-15 or greater. Where attics are present, attics above the insulation are vented and attics below the insulation are unvented.
7. Roof surfaces have a slope of not less than 1/4 unit vertical in 12 units horizontal (21-percent slope). The finished roof does not have water accumulation areas.
8. Operable fenestration provides a ventilation area of not less than 14 percent of the floor area in each room. Alternatively, equivalent ventilation is provided by a ventilation fan.
9. Bedrooms with exterior walls facing two different directions have operable fenestration on exterior walls facing two directions.
10. Interior doors to bedrooms are capable of being secured in the open position.
11. A ceiling fan or ceiling fan rough-in is provided for bedrooms and the largest space that is not used as a bedroom.

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R408 Additional Efficiency Package Options

R408.2.1 Enhanced envelope performance option

The total building thermal envelope UA, the sum of U-factor times assembly area, shall be less than or equal to 95 percent of the total UA resulting from multiplying the U-factors in Table R402.1.2 by the same assembly area as in the proposed building.

The UA calculation shall be performed in accordance with Section R402.1.5. The area-weighted average SHGC of all glazed fenestration shall be less than or equal to 95 percent of the maximum glazed fenestration SHGC in Table R402.1.2.

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R408 Additional Efficiency Package Options

R408.2.2 More efficient HVAC equipment performance option

Heating and cooling equipment shall meet one of the following efficiencies:

1. Greater than or equal to 95 AFUE natural gas furnace and 16 SEER air conditioner.

2. Greater than or equal to 10 HSPF/16 SEER air source heat pump.

3. Greater than or equal to 3.5 COP ground source heat pump. For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

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R408 Additional Efficiency Package Options

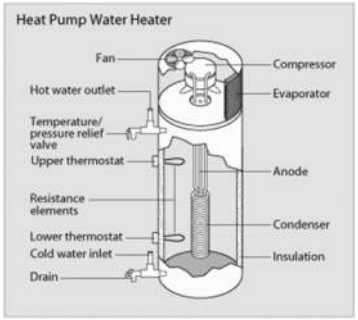
R408.2.3 Reduced energy use in service water-heating option

The hot water system shall meet one of the following efficiencies:

1. Greater than or equal to 0.82 EF fossil fuel service water-heating system.

2. Greater than or equal to 2.0 EF electric service water-heating system.

3. Greater than or equal to 0.4 solar fraction solar water-heating system.



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R408 Additional Efficiency Package Options

R408.2.4 More efficient duct thermal distribution system option

The thermal distribution system shall meet one of the following efficiencies:

1. 100 percent of ducts and air handlers located entirely within the building thermal envelope.

2. 100 percent of ductless thermal distribution system or hydronic thermal distribution system located completely inside the building thermal envelope.

3. 100 percent of duct thermal distribution system located in conditioned space as defined by Section R403.3.2.

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R408 Additional Efficiency Package Options

R408.2.5 Improved air sealing and efficient ventilation system option

The measured air leakage rate shall be less than or equal to 3.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed. Minimum HRV and ERV requirements, measured at the lowest tested net supply airflow, shall be greater than or equal to 75 percent Sensible Recovery Efficiency (SRE), less than or equal to 1.1 cubic feet per minute per watt and shall not use recirculation as a defrost strategy. In addition, the ERV shall be greater than or equal to 50 percent Latent Recovery/Moisture Transfer (LRMT).

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