



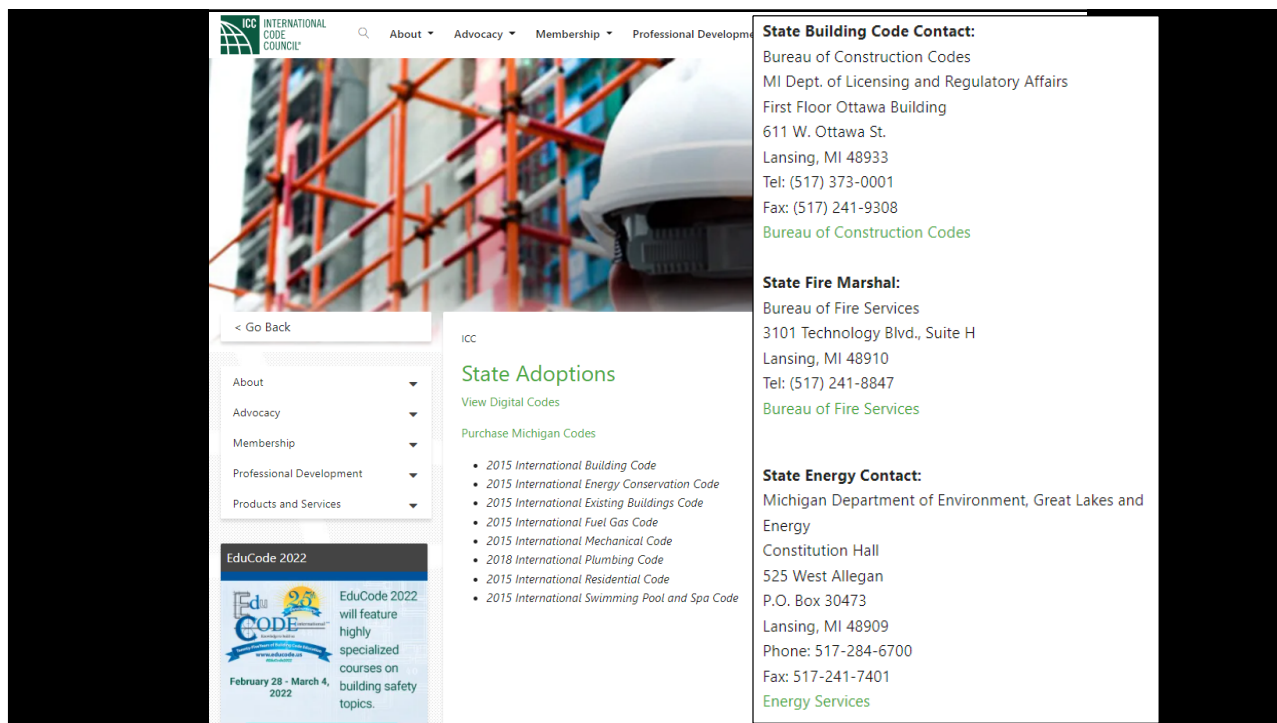

**Winter Technical Session**  
February 10, 2022  
Troy, Michigan

**2021 I-codes: Roofing-related changes**



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**State Building Code Contact:**  
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MI Dept. of Licensing and Regulatory Affairs  
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Lansing, MI 48933  
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[Bureau of Construction Codes](#)

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Lansing, MI 48909  
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EduCode 2022  
EduCode 2022 will feature highly specialized courses on building safety topics.  
February 28 - March 4, 2022


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### Prerequisites

- Intermediate- to advanced-level
- Some knowledge of code requirements
- General knowledge of 2018 I-codes
- Understand...I am the messenger
  - “...don't shoot the messenger...”

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### Some background

- 
- The I-codes are “model codes” developed by the International Code Council (ICC)
  - Model codes serve as the technical basis for state or local code adoption
  - The code provides the minimum legal requirements for building construction...and operation
  - The code is enforced by the “authority having jurisdiction” (AHJ)
  - Code enforcement occurs at the time of installation and occupancy/use
  - The code can also provide a basis for construction claims-related litigation

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## Code development process

The 2021 I-codes are the 8<sup>th</sup> edition

The 2021 I-codes present the code as originally published in 2000, with changes reflected in the 2003 through 2018 editions and further changes approved by the ICC Code Development Process through 2020. A new edition is promulgated every three years.

2018 Group A: IBC Building Fire, Building General and Plumbing Committees

2019 Group B: IBC Structural, IECC-Commercial, IECC-Residential Committees

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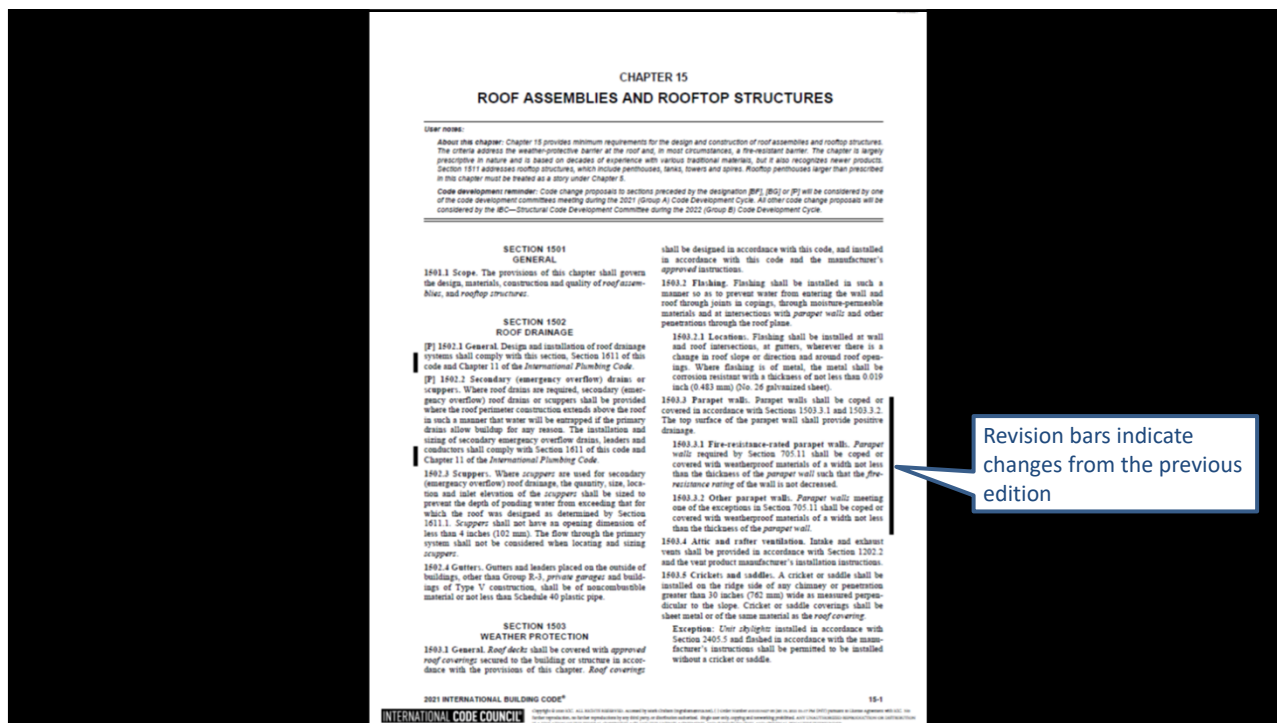
## 2021 I-codes



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## Edge metal testing

Changes in IBC 2021, Section 1504-Performance Requirements

**1504.6 Edge systems for low-slope roofs.** Metal edge systems, except gutters and counterflashing, installed on built-up, modified bitumen and single-ply roof systems having a slope less than 2 units vertical in 12 units horizontal (2:12) shall be designed and installed for wind *loads* in accordance with Chapter 16 and tested for resistance in accordance with Test Methods RE-1, RE-2 and RE-3 of ANSI/SPRI ES-1, except basic design *wind speed*, *V*, shall be determined from Figures 1609.3(1) through 1609.3(12) as applicable.

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## Gutter testing

Changes in IBC 2021, Section 1504-Performance Requirements

**1504.6 Edge systems for low-slope roofs.** Metal edge systems, except gutters and counterflashing, installed on built-up, modified bitumen and single-ply roof systems having a slope less than 2 units vertical in 12 units horizontal (2:12) shall be designed and installed for wind *loads* in accordance with Chapter 16 and tested for resistance in accordance with Test Methods RE-1, RE-2 and RE-3 of ANSI/SPRI ES-1, except basic design *wind speed*, *V*, shall be determined from Figures 1609.3(1) through 1609.3(12) as applicable.

**1504.6.1 Gutter securement for low-slope roofs.** Gutters that are used to secure the perimeter edge of the roof membrane on low-slope (less than 2:12 slope) built-up, modified bitumen, and single-ply roofs, shall be designed, constructed and installed to resist wind loads in accordance with Section 1609 and shall be tested in accordance with Test Methods G-1 and G-2 of SPRI GT-1.

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## ANSI/SPRI GT-1

ANSI/SPRI GT-1  
Test Standard for Gutter Systems  
Approved May 28, 2016

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1.6 Test Reporting ..... 2

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Figure 2. Test Set-up for SPRI Test G-1

Figure 3. Test Set-up for SPRI Test G-2

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www.spri.org  
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Disclaimer:  
This standard is for use by architects, engineers, roofing contractors and building owners when designing, installing or evaluating a building's gutter system. SPRI, its members and employees do not warrant that this standard is proper and/or applicable under all conditions.

[Link to access GT-1](#)

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## Aggregate surfacing

Changes in IBC 2021, Section 1504-Performance Requirements

**1504.9 Wind resistance of aggregate-surfaced roofs.** Parapets shall be provided for aggregate surfaced roofs and shall comply with Table 1504.9.

**TABLE 1504.9**  
**MINIMUM REQUIRED PARAPET HEIGHT (INCHES) FOR AGGREGATE SURFACED ROOFS<sup>a, b, c</sup>**

AGGREGATE SIZE	MEAN ROOF HEIGHT (ft)	WIND EXPOSURE AND BASIC DESIGN WIND SPEED (MPH)																	
		Exposure B								Exposure C <sup>d</sup>									
		≤ 95	100	105	110	115	120	130	140	150	≤ 95	100	105	110	115	120	130	140	150
ASTM D1863 (No. 7 or No. 67)	15	2	2	2	2	12	12	16	20	24	2	13	15	18	20	23	27	32	37
	20	2	2	2	2	12	14	18	22	26	12	15	17	19	22	24	29	34	39
	30	2	2	2	13	15	17	21	25	30	14	17	19	22	24	27	32	37	42
	50	12	12	14	16	18	21	25	30	35	17	19	22	25	28	30	36	41	47
	100	14	16	19	21	24	27	32	37	42	21	24	26	29	32	35	41	47	53
ASTM D1863 (No. 6)	15	2	2	2	2	12	12	12	15	18	2	2	2	13	15	17	22	26	30
	20	2	2	2	2	12	12	13	17	21	2	2	12	15	17	19	23	28	32
	30	2	2	2	2	12	12	16	20	24	2	12	14	17	19	21	26	31	35
	50	12	12	12	12	14	16	20	24	28	12	15	17	19	22	24	29	34	39
	100	12	12	14	16	19	21	26	30	35	16	18	21	24	26	29	34	39	45
	150	12	14	17	19	22	24	29	34	39	18	21	23	26	29	32	37	43	48

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 mile per hour = 0.447 m/s.  
 a. Interpolation shall be permitted for mean roof height and parapet height.  
 b. Basic design wind speed, *V*, and wind exposure shall be determined in accordance with Section 1609.  
 c. Where the minimum required parapet height is indicated to be 2 inches (51 mm), a gravel stop shall be permitted and shall extend not less than 2 inches (51 mm) from the roof surface and not less than the height of the aggregate.  
 d. For Exposure D, add 8 inches (203 mm) to the parapet height required for Exposure C and the parapet height shall not be less than 12 inches (305 mm).

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## Rooftop PV – Fire resistance

Changes in IBC 2021, Section 1505-Fire Classification

**[BF] 1505.8 Building-integrated photovoltaic (BIPV) products.** *BIPV products* installed as the roof covering shall be tested, *listed* and *labeled* for fire classification in accordance with Section 1505.1.

**[BF] 1505.9 Rooftop mounted photovoltaic (PV) panel systems.** Rooftop mounted *photovoltaic (PV) panel systems* shall be tested, *listed* and identified with a fire classification in accordance with UL 2703. Listed systems shall be installed in accordance with the manufacturer's installation instructions and their listing. The fire classification shall comply with Table 1505.1 based on the type of construction of the building.

**1507.16.6 Material standards.** *Photovoltaic shingles* shall be *listed* and labeled in accordance with UL 7103 or with both UL 61730-1 and UL 61730-2.

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## Single-ply membrane roof systems

**1507.12 Single-ply roofing.** The installation of single-ply roofing shall comply with the provisions of this section.

**1507.12.1 Slope.** Single-ply membrane roofs shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope) for drainage.

**1507.12.2 Material standards.** Single-ply roof coverings shall comply with the material standards in Table 1507.12.2.

**TABLE 1507.12.2  
SINGLE-PLY ROOFING MATERIAL STANDARDS**

MATERIAL	MATERIAL STANDARD
Chlorosulfonated polyethylene (CSPE) or polyisobutylene (PIB)	ASTM D5019
Ethylene propylene diene monomer (EPDM)	ASTM D4637
Ketone Ethylene Ester (KEE)	ASTM D6754
Polyvinyl Chloride (PVC) or (PVC/KEE)	ASTM D4434
Thermoplastic polyolefin (TPO)	ASTM D6878

**1507.12.3 Ballasted low-slope roofs.** Ballasted low-slope roofs (roof slope < 2:12) shall be installed in accordance with this section and Section 1504.5. Stone used as *ballast* shall comply with ASTM D448 or ASTM D7655.

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## SPF roof systems

**1507.13 Sprayed polyurethane foam roofing.** The installation of sprayed polyurethane foam roofing shall comply with the provisions of this section.

**1507.13.1 Slope.** Sprayed polyurethane foam roofs shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope) for drainage.

**1507.13.2 Material standards.** Spray-applied polyurethane foam insulation shall comply with ASTM C1029 Type III or IV or ASTM D7425.

**1507.13.3 Application.** Foamed-in-place roof insulation shall be installed in accordance with the manufacturer's instructions. A liquid-applied protective coating that complies with Table 1507.13.3 shall be applied not less than 2 hours nor more than 72 hours following the application of the foam.

**TABLE 1507.13.3  
PROTECTIVE COATING MATERIAL STANDARDS**

MATERIAL	STANDARD
Acrylic coating	ASTM D6083
Silicone coating	ASTM D6694
Moisture-cured polyurethane coating	ASTM D6947

**1507.13.4 Foam plastics.** Foam plastic materials and installation shall comply with Chapter 26.

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## Liquid-applied membrane roof systems

Changes in IBC 2021, Section 1507.14-Liquid-applied Roofing

**1507.14 Liquid-applied roofing.** The installation of liquid-applied roofing shall comply with the provisions of this section.

**1507.14.1 Slope.** Liquid-applied roofing shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope).

**1507.14.2 Material standards.** Liquid-applied roofing shall comply with ASTM C836, ASTM C957 or ASTM D3468. ■

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## Roof coatings

Changes in IBC 2021, Section 1509-Roof Coatings (new)

### SECTION 1509 ROOF COATINGS

**1509.1 General.** The installation of a *roof coating* on a *roof covering* shall comply with the requirements of Section 1505 and this section.

**1509.2 Material standards.** Roof coating materials shall comply with the standards in Table 1509.2.

**TABLE 1509.2  
ROOF COATING MATERIAL STANDARDS**

MATERIAL	STANDARD
Acrylic coating	ASTM D6083
Asphaltic emulsion coating	ASTM D1227
Asphalt coating	ASTM D2823
Asphalt roof coating	ASTM D4479
Aluminum-pigmented asphalt coating	ASTM D2824
Silicone coating	ASTM D6694
Moisture-cured polyurethane coating	ASTM D6947

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## Reroofing

Changes in IBC 2021, Section 1512-Reroofing

**1512.2 Roof replacement.** *Roof replacement* shall include the removal of all existing layers of *roof assembly* materials down to the *roof deck*.

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## Reroofing

Changes to IBC 2021, Section 1512-Reroofing

**1512.4 Reinstallation of materials.** Existing slate, clay or cement tile shall be permitted for reinstallation, except that damaged, cracked or broken slate or tile shall not be reinstalled. Existing vent flashing, metal edgings, drain outlets, collars and metal counterflashings shall not be reinstalled where rusted, damaged or deteriorated. Existing *ballast* that is damaged, cracked or broken shall not be reinstalled. Existing aggregate surfacing materials from built-up roofs shall not be reinstalled.

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## Roof zones

Changes in IBC 2021, Section 1603-Construction Documents

CHAPTER 16  
STRUCTURAL DESIGN

**1603.1.4 Wind design data.** The following information related to wind *loads* shall be shown, regardless of whether wind *loads* govern the design of the lateral force-resisting system of the structure:

1. Basic design *wind speed*,  $V$ , miles per hour and *allowable stress design wind speed*,  $V_{asd}$ , as determined in accordance with Section 1609.3.1.
2. *Risk category*.
3. Wind exposure. Applicable wind direction if more than one wind exposure is utilized.
4. Applicable internal pressure coefficient.
5. Design wind pressures and their applicable zones with dimensions to be used for exterior component and cladding materials not specifically designed by the *registered design professional* responsible for the design of the structure, pounds per square foot ( $\text{kN/m}^2$ ).

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## Attic ventilation

Changes in IBC 2021, Section 1203-Unvented Attics and Unvented Enclosed Rafter Spaces

5.2.7. The roof slope shall be greater than or equal to 3 units vertical in 12 units horizontal (3:12).

5.2.8. Where only air-permeable insulation is used, it shall be installed directly below the structural roof sheathing, on top the attic floor, or on top of the ceiling.

5.2.9. Where only air-permeable insulation is used and is installed directly below the structural roof sheathing, air shall be supplied at a flow rate greater than or equal to 50 cubic feet per minute (23.6 L/s) per 1,000 square feet (93 m<sup>2</sup>) of ceiling.

5.3. The air shall be supplied from ductwork providing supply air to the occupiable space when the conditioning system is operating. Alternatively, the air shall be supplied by a supply fan when the conditioning system is operating. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

**Exceptions:**

1. Section 1202.3 does not apply to special use structures or enclosures such as swimming pool enclosures, data processing centers, hospitals or art galleries.
2. Section 1202.3 does not apply to enclosures in Climate Zones 5 through 8 that are humidified beyond 35 percent during the three coldest months.

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## 2021 IRC

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## IRC's applicability

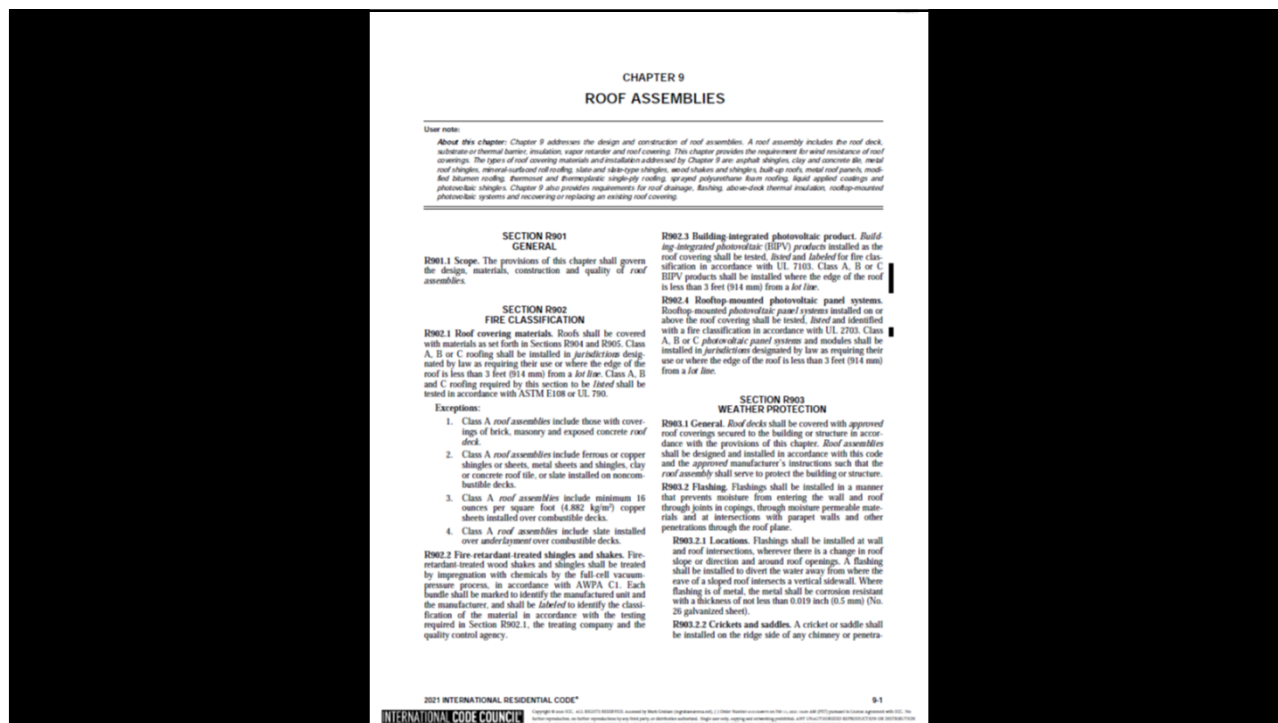
When does IRC apply vs. IBC?

**R101.2 Scope.** The provisions of this code shall apply to the construction, *alteration*, movement, enlargement, replacement, *repair*, equipment, use and occupancy, location, removal and demolition of detached one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height with a separate means of egress and their *accessory structures* not more than three stories above *grade plane* in height.

**Exception:** The following shall be permitted to be constructed in accordance with this code where provided with an automatic sprinkler system complying with Section P2904:

1. Live/work units located in townhouses and complying with the requirements of Section 508.5 of the *International Building Code*.
2. Owner-occupied *lodging houses* with five or fewer guestrooms.
3. A care facility with five or fewer persons receiving custodial care within a *dwelling unit*.
4. A care facility with five or fewer persons receiving medical care within a *dwelling unit*.
5. A care facility for five or fewer persons receiving care that are within a single-family dwelling.

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## Rooftop PV – Fire resistance

Changes in IRC 2021, Section R902-Fire Classification

**R902.3 Building-integrated photovoltaic product.** *Building-integrated photovoltaic (BIPV) products* installed as the roof covering shall be tested, *listed* and *labeled* for fire classification in accordance with UL 7103. Class A, B or C BIPV products shall be installed where the edge of the roof is less than 3 feet (914 mm) from a *lot line*.

**R902.4 Rooftop-mounted photovoltaic panel systems.** Rooftop-mounted *photovoltaic panel systems* installed on or above the roof covering shall be tested, *listed* and identified with a fire classification in accordance with UL 2703. Class A, B or C *photovoltaic panel systems* and modules shall be installed in *jurisdictions* designated by law as requiring their use or where the edge of the roof is less than 3 feet (914 mm) from a *lot line*.

**R905.16.4 Material standards.** *Photovoltaic shingles* shall be *listed* and *labeled* in accordance with UL 7103 or with both UL 61730-1 and UL 61730-2.

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## Steep-slope underlayment

Change in IRC 2021, Section R905-Requirements for Roof Coverings

**R905.1.1 Underlayment.** *Underlayment* for asphalt shingles, clay and concrete tile, *metal roof shingles*, mineral-surfaced roll roofing, slate and slate-type shingles, wood shingles, wood shakes, *metal roof panels* and *photovoltaic shingles* shall conform to the applicable standards listed in this chapter. *Underlayment* materials required to comply with ASTM D226, D1970, D4869 and D6757 shall bear a *label* indicating compliance to the standard designation and, if applicable, type classification indicated in Table R905.1.1(1). *Underlayment* shall be applied in accordance with Table R905.1.1(2). *Underlayment* shall be attached in accordance with Table R905.1.1(3).

### Exceptions:

1. As an alternative, self-adhering polymer-modified bitumen underlayment bearing a label indicating compliance with ASTM D1970
2. As an alternative, a minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane bearing a *label* indicating compliance with ASTM D1970, installed in accordance with the *manufacturer's installation instructions* for the deck material, shall be applied over all joints in the roof decking. An *approved underlayment* complying with Table R905.1.1(1) for the applicable roof covering for areas where wind design is not required in accordance with Figure R301.2.1.1 shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips. Underlayment shall be applied in accordance with Table R905.1.1(2) using the application requirements for areas where wind design is not required in accordance with Figure R301.2.1.1. Underlayment shall be attached in accordance with Table R905.1.1(3).

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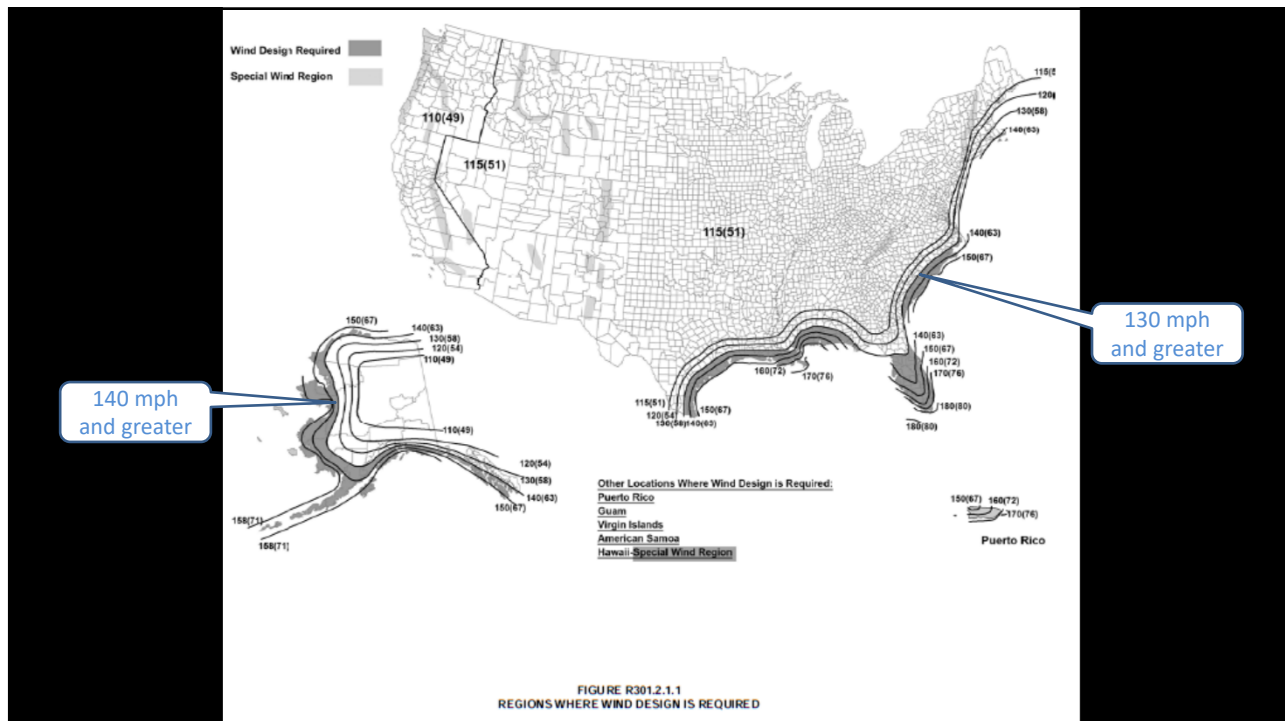
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**TABLE R905.1.1(1)  
UNDERLAYMENT TYPES**

ROOF COVERING	SECTION	AREAS WHERE WIND DESIGN IS NOT REQUIRED IN ACCORDANCE WITH FIGURE R301.2.1.1	AREAS WHERE WIND DESIGN IS REQUIRED IN ACCORDANCE WITH FIGURE R301.2.1.1
Asphalt shingles	R905.2	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV ASTM D6757	ASTM D226 Type II ASTM D4869 Type III or Type IV
Clay and concrete tile	R905.3	ASTM D226 Type II ASTM D2626 Type I ASTM D6380 Class M mineral-surfaced roll roofing	ASTM D226 Type II
Metal roof shingles	R905.4	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type III or Type IV
Mineral-surfaced roll roofing	R905.5	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type III or Type IV
Slate and slate-type shingles	R905.6	ASTM D226 Type I ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type III or Type IV
Wood shingles	R905.7	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type III or Type IV
Wood shakes	R905.8	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type III or Type IV
Metal panels	R905.10	Manufacturer's instructions	ASTM D226 Type II ASTM D4869 Type III or Type IV
Photovoltaic shingles	R905.16	ASTM D4869 Type I, II, III or IV ASTM D6757	ASTM D4869 Type III or Type IV

Continued...

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## **Clay and concrete tile**

Changes in IRC 2021, Section R905.3-Clay and Concrete Tile

**R905.3 Clay and concrete tile.** The installation of clay and concrete tile shall comply with the provisions of this section.

**R905.3.1 Deck requirements.** Concrete and clay tile shall be installed only over solid sheathing.

**Exception:** Spaced lumber sheathing in accordance with Section R803.1 shall be permitted in *Seismic Design Categories* A, B and C.

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## **Metal shingles**

Changes in IRC 2021, Section R905.4-Metal Roof Shingles

**R905.4.4.1 Wind resistance of metal roof shingles.** *Metal roof shingles* applied to a solid or closely fitted deck shall be tested in accordance with ASTM D3161, FM 4474, UL 580 or UL 1897. *Metal roof shingles* tested in accordance with ASTM D3161 shall meet the classification requirements of Table R905.4.4.1 for the appropriate maximum basic wind speed and the metal shingle packaging shall bear a *label* to indicate compliance with ASTM D3161 and the required classification in Table R905.2.4.1.

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**TABLE R905.4.4.1**  
**CLASSIFICATION OF STEEP SLOPE METAL ROOF SHINGLES TESTED IN ACCORDANCE WITH ASTM D3161**

MAXIMUM ULTIMATE DESIGN WIND SPEED, $V_{ult}$ FROM FIGURE R301.2(2) (mph)	MAXIMUM BASIC WIND SPEED, $V_{ASD}$ FROM TABLE R301.2.1.3 (mph)	ASTM D3161 SHINGLE CLASSIFICATION
110	85	A, D or F
116	90	A, D or F
129	100	A, D or F
142	110	F
155	120	F
168	130	F
181	140	F
194	150	F

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**Wood shingles and shakes**

Changes in IRC 2021, Section R905.7-Wood Shingles and Section R905.8-Wood Shakes

**TABLE R905.7.5(2)**  
**NAIL REQUIREMENTS FOR**  
**WOOD SHAKES AND WOOD SHINGLES**

PRODUCT TYPE	NAIL TYPE, MINIMUM LENGTH AND SHANK DIAMETER (inches)
<b>Shakes</b>	
18" straight-split	5d box $1\frac{3}{4}" \times 0.080$
18" and 24" handsplit and resawn	6d box $2" \times 0.099$
24" taper-split	5d box $1\frac{3}{4}" \times 0.080$
18" and 24" tapersawn	6d box $2" \times 0.099$
<b>Shingles</b>	
16" and 18"	3d box $1\frac{1}{4}" \times 0.076$
24"	4d box $1\frac{1}{2}" \times 0.076$

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## PV shingles – Wind resistance

Changes in IRC 2021, Section R905.16-Photovoltaic Shingles

**R905.16.6 Wind resistance.** *Photovoltaic shingles* shall comply with the classification requirements of Table R905.16.6 for the appropriate maximum basic wind speed.

**TABLE R905.16.6  
CLASSIFICATION OF PHOTOVOLTAIC SHINGLES**

MAXIMUM ULTIMATE DESIGN WIND SPEED, $V_{ult}$ , FROM FIGURE R301.2(2) (mph)	MAXIMUM BASIC WIND SPEED, $V_{ASD}$ , FROM TABLE R301.2.1.3 (mph)	UL 7103 SHINGLE CLASSIFICATION
110	85	A, D or F
116	90	A, D or F
129	100	A, D or F
142	110	F
155	120	F
168	130	F
181	140	F
194	150	F

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## Unvented attics

Changes in IRC 2021, Section R806.5-Unvented Attics and Enclosed Rafter Spaces

ROOF-CEILING CONSTRUCTION

**SECTION R806  
CEILING FINISHES**

**R806.1** Ceiling installation. Ceilings shall be installed in accordance with the requirements for interior wall finishes as provided in Sections R702.1 through R702.6.

**SECTION R806  
ROOF VENTILATION**

**R806.1** Ventilation required. Unvented attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters shall have cross ventilation for each separate space by ventilating openings protected against the entrance of rain or snow. Ventilating openings shall have a least dimension of  $\frac{1}{8}$  inch (3.2 mm) minimum and  $\frac{1}{4}$  inch (6.4 mm) maximum. Ventilating openings having a least dimension larger than  $\frac{1}{8}$  inch (3.2 mm) shall be provided with corrosion-resistant wire cloth screening, hardware cloth, perforated rigid or flexible material with openings having a least dimension of  $\frac{1}{8}$  inch (3.2 mm) minimum and  $\frac{1}{4}$  inch (6.4 mm) maximum. Openings in roof framing members shall conform to the requirements of Section R802.2. Required ventilating openings shall open directly to the outside air and shall be protected to prevent the entry of birds, rodents, snakes and other similar creatures.

**R806.2** Minimum vent area. The minimum net free ventilating area shall be  $\frac{1}{150}$  of the area of the vented space.

**Exception:** The minimum net free ventilation area shall be  $\frac{1}{150}$  of the vented space provided both of the following conditions are met:

1. In Climate Zones 6, 7 and 8, a Class I or II vapor retarder is installed on the warm interior side of the ceiling.
2. Not less than 40 percent and not more than 50 percent of the required ventilating area is provided by ventilators located in the upper portion of the attic or rafter space. Upper ventilators shall be located not more than 3 feet (914 mm) below the ridge or highest point of the space, measured vertically. The balance of the required ventilation provided shall be located in the bottom one-third of the attic space. Where the location of wall or roof framing members conflicts with the installation of upper ventilators, ventilation more than 2 feet (610 mm) shall be provided between the insulation and the roof sheathing and at the location of the vent.

**R806.3** Vent and insulation clearance. Where eave or cornice vents are installed, blocking, bridging and insulation shall not block the free flow of air. Not less than a 3 inch (76 mm) space shall be provided between the insulation and the roof sheathing and at the location of the vent.

**R806.4** Installation and weather protection. Ventilators shall be installed in accordance with manufacturer's instructions. Installation of ventilators in roof systems shall be in accordance with the requirements of Section R905.16a.

size of ventilators in wall systems shall be in accordance with the requirements of Section R702.1.

**R806.5** Unvented attic and unvented enclosed rafter assemblies. Unvented attic and unvented enclosed rafter assemblies created by ceilings that are applied directly to the underside of the roof framing members and structural roof sheathing applied directly to the top of the roof framing members, shall be permitted where all the following conditions are met:

1. The unvented attic space is completely within the building thermal envelope.
2. Interior Class I vapor retarders are not installed on the ceiling side (top floor) or the unvented attic assembly or on the ceiling side of the unvented enclosed rafter assembly.
3. Where wood shingles or shakes are used, a minimum  $\frac{1}{8}$  inch (3.2 mm) vented airspace separates the shingles or shakes and the roofing underlayment above the structural sheathing.
4. In Climate Zones 6, 7 and 8, any air-impermeable insulation shall be a Class II vapor retarder or shall have a Class II vapor retarder coating or covering in direct contact with the underside of the insulation.
5. Insulation shall comply with Item 5.1.3 and other Item 5.1.3.1.2.

Item 5.1.1, 5.1.2, 5.1.3 or 5.1.4 shall be met, depending on the air permeability of the insulation directly above the structural roof sheathing.

5.1.1. Where only air-impermeable insulation is provided, it shall be applied in direct contact with the underside of the structural roof sheathing.

5.1.2. Where air-permeable insulation is installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing in accordance with the R-values in Table R806.5 for condensation control.

5.1.3. Where both air-impermeable and air-permeable insulation are provided, the air-impermeable insulation shall be applied in direct contact with the underside of the structural roof sheathing in accordance with Item 5.1.1 and shall be in accordance with the R-values in Table R806.5 for condensation control. The air-permeable insulation shall be installed directly under the air-impermeable insulation.

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5.1.4. Alternatively, sufficient rigid board or sheet insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.

5.2. In Climate Zones 1, 2 and 3, air-permeable insulation installed in unvented attics shall meet the following requirements:

5.2.1. An approved vapor diffusion *part* shall be installed not more than 12 inches (305 mm) from the highest point of the roof, measured vertically from the highest point of the roof to the lower edge of the part.

5.2.2. The part area shall be greater than or equal to 1,600 of the ceiling area. Where there are multiple parts in the attic, the sum of the part areas shall be greater than or equal to the area requirement.

5.2.3. The vapor permeable membrane in the vapor diffusion *part* shall have a vapor permeance rating of greater than or equal to 20 perms when tested in accordance with Procedure A of ASTM E96.

5.2.4. The vapor diffusion *part* shall serve as an air barrier between the attic and the exterior of the building.

5.2.5. The vapor diffusion *part* shall protect the attic against the entrance of rain and snow.

5.2.6. Framing members and blocking shall not block the free flow of water vapor to the part. Not less than a 2-inch (51 mm) space shall be provided between any blocking and the roof sheathing. Air-permeable insulation shall be permitted within that space.

5.2.7. The roof slope shall be greater than or equal to 3:12 (vertical/horizontal).

5.2.8. Where only air-permeable insulation is used, it shall be installed directly below the structural roof sheathing, on top of the attic floor, or on top of the ceiling.

5.2.9. Air-impermeable insulation, when used in conjunction with air-permeable insulation, shall be directly above or below the structural roof sheathing and is not required to meet the R-value in Table R606.5. Where directly below the structural roof sheathing, there shall be no space between the air-impermeable insulation and air-permeable insulation.

5.2.10. Where air-permeable insulation is used and is installed directly below the roof structural sheathing, air shall be supplied at a flow rate greater than or equal to 50 CFM (23.1 L/s) per 1,000 square feet (93 m<sup>2</sup>) of ceiling. The air shall be supplied from ductwork providing supply air to the occupiable space when the conditioning system is operating. Alternatively, the air shall be supplied by a supply fan when the conditioning system is operating.

**Exceptions:**

1. Where both air-impermeable and air-permeable insulation are used, and the R-value in Table R606.5 is met, air supply to the attic is not required.
2. Where only air-permeable insulation is used and is installed on top of the attic floor, or on top of the ceiling, air supply to the attic is not required.

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ROOF CEILING CONSTRUCTION

5.3. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

**TABLE R606.5  
INSULATION FOR CONDENSATION CONTROL**

CLIMATE ZONE	MINIMUM R-VALUE REQUIRED ON AIR-IMPERMEABLE INSULATION IN ATTIC <sup>a</sup>
2B and 3B air roof only	R-5
1, 2A, 2B, 3A, 3B, 3C	R-10
4A, 4B	R-15
5	R-20
6	R-25
7	R-30
8	R-35

a. Contributions to heat flux not applicable to the requirements in Section N1102.

b. Alternatively, sufficient continuous insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 47°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.

**SECTION R907  
ATTIC ACCESS**

**R907.1 Attic access.** Buildings with combustible ceiling or roof construction shall have an attic access opening to attic areas that have a vertical height of 30 inches (762 mm) or greater over an area of not less than 30 square feet (2.8 m<sup>2</sup>). The vertical height shall be measured from the top of the ceiling framing members to the underside of the roof framing members.

The rough-framed opening shall be not less than 22 inches by 30 inches (559 mm by 762 mm) and shall be located in a hallway or other location with ready access. Where located in a wall, the opening shall be not less than 22 inches wide by 30 inches high (559 mm wide by 762 mm high). Where the access is located in a ceiling, minimum manufactured headroom in the attic space shall be 30 inches (762 mm) at some point above the access measured vertically from the bottom of ceiling framing members. See Section M1305.1.2 for access requirements where mechanical equipment is located in attics.

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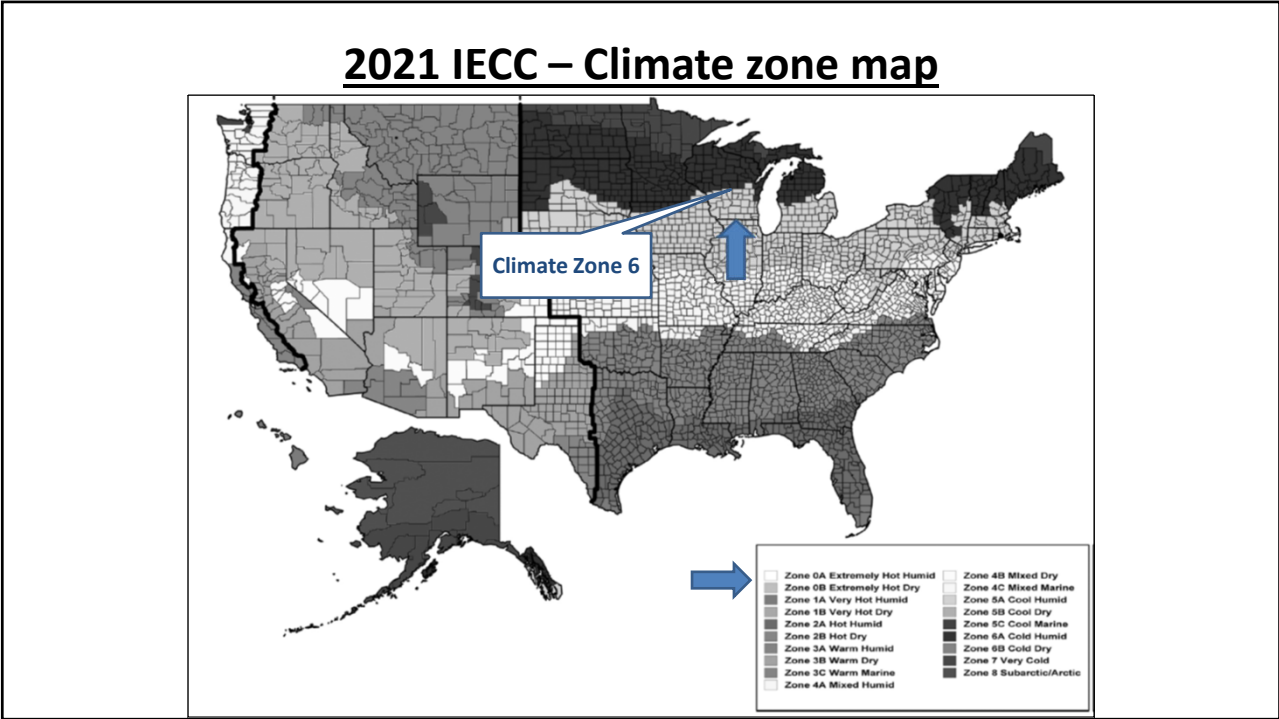
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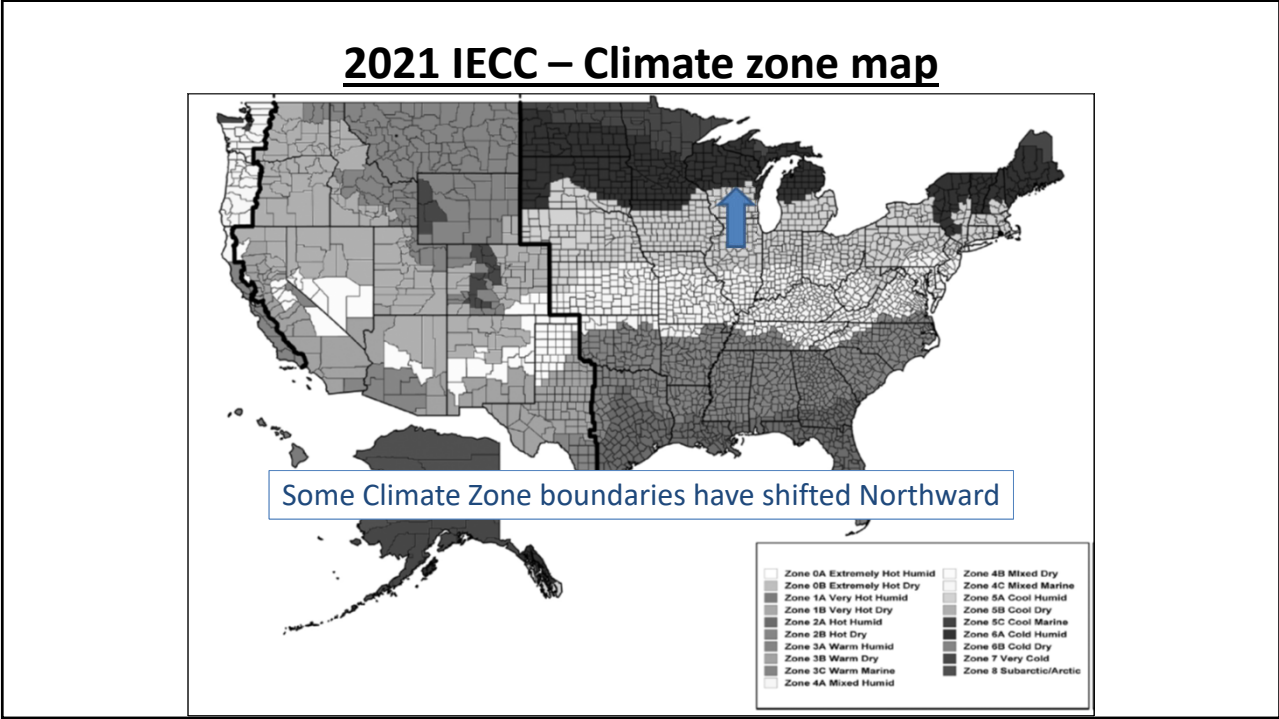
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GENERAL REQUIREMENTS

TABLE C301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY\*

WEST VIRGINIA (continued)		GENERAL REQUIREMENTS	
4A Jefferson	6A Boone	6A Boone	
4A Kanawha	6A Cabnet	6A Cabnet	
4A Lewis	6A Chippewa	6A Chippewa	
4A Lincoln	6A Clark	6A Clark	
4A Logan	6A Columbia	6A Columbia	
4A Mingo	6A Crawford	6A Crawford	
4A Boone	6A Dine	6A Dine	
4A Hancock	6A Dodge	6A Dodge	
4A Mason	6A Door	6A Door	
4A McDowell	6A Douglas	6A Douglas	
4A Mercer	6A Drum	6A Drum	
4A Mineral	6A Elm City	6A Elm City	
4A Mingo	6A Florence	6A Florence	
4A Monongalia	6A Fond du Lac	6A Fond du Lac	
4A Monroe	6A Forest	6A Forest	
4A Morgan	6A Grant	6A Grant	
4A Nicholas	6A Green	6A Green	
4A Ohio	6A Green Lake	6A Green Lake	
4A Pendleton	6A Inez	6A Inez	
4A Pleasants	6A Iowa	6A Iowa	
4A Putnam	6A Jackson	6A Jackson	
4A Raleigh	6A Jefferson	6A Jefferson	
4A Randolph	6A Jones	6A Jones	
4A Richwood	6A Kanawha	6A Kanawha	
4A Putnam	6A Kenesaw	6A Kenesaw	
4A Summers	6A La Crosse	6A La Crosse	
4A Taylor	6A Lincoln	6A Lincoln	
4A Tucker	6A Longdale	6A Longdale	
4A Tyler	6A Lincoln	6A Lincoln	
4A Upshur	6A Mantua	6A Mantua	
4A Wayne	6A Marlinton	6A Marlinton	
4A Weber	6A Martinsburg	6A Martinsburg	
4A West	6A Marquette	6A Marquette	
4A Wood	6A Meigs	6A Meigs	
4A Wyoming	6A Mineral	6A Mineral	
6A Adams	6A Monroeville	6A Monroeville	
6A Ashland	6A Monroe	6A Monroe	
6A Barren	6A Oconee	6A Oconee	
6A Bayfield	6A Owsa	6A Owsa	
6A Boone	6A Otagonia	6A Otagonia	
	6A Putnam	6A Putnam	
	6A Putnam	6A Putnam	

(continued)

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GENERAL REQUIREMENTS

TABLE C301.1—continued  
CLIMATE ZONES, MOISTURE REGIMES, AND WARM HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY

3A San Saba*	3A Young	4C Clark	4A Gilmer	6A Adams
3B Schuylker	3B Zavalza	3B Columbia	5A Grant	7 Ashland
3B Sevier	UTAH	4C Cowley	5A Goswell	6A Barren
3A Shelby*	5B Beaver	6B Ferry	5A Hampshire	7 Bayfield
4B Sherman	6B Bon Elder	5B Franklin	5A Hancock	6A Barren
3A Smith*	6B Boone	5B Garfield	5A Harrison	6A Boone
3A Somervell*	6B Carib	5B Grant	4A Jackson	7 Burnett
2A Stan*	6B Duggett	4C Gray's Harbor	4A Jefferson	6A Cabnet
3A Stephens	5B Davis	4C Island	4A Kanawha	6A Chippewa
3B Steubing	6B Duchesne	4C Jefferson	5A Lewis	6A Clark
3B Stone	5B Emery	4C King	4A Lincoln	6A Columbia
3B Sutton	5B Garfield	4C Knap	4A Logan	6A Crawford
4B Swisher	5B Grand	5B Knott	5A Marion	6A Dine
3A Tarrant*	5B Inez	5B Klickitat	5A Marshall	6A Dodge
3B Taylor	5B Inez	4C Lewis	4A Mason	6A Door
3B Terry	5B Kane	5B Lincoln	4A McDowell	7 Douglas
3B Throckmorton	5B Millard	4C Mason	4A Mercer	6A Drum
3A Tins*	6B Morgan	6B Okanogan	5A Mineral	6A Eau Claire
3B Tom Green	5B Paine	4C Pacific	4A Mingo	7 Florence
2A Travis*	6B Rich	6B Pend Oreille	5A Monongalia	6A Fond du Lac
2A Trinity*	5B Salt Lake	4C Pierce	4A Monroe	6A Grant
2A Tyler*	5B San Juan	4C San Juan	4A Morgan	6A Green
3A Uchida*	5B Saupeta	4C Skagit	5A Nicholas	6A Green Lake
3B Upton	5B Sevier	5B Skamania	5A Ohio	6A Inez
2B Uvalde	6B Summit	5B Spokane	5A Pendleton	7 Inez
2B Val Verde	5B Toole	6B Stevens	4A Pleasant	6A Jackson
3A Van Zandt*	6B Umatilla	4C Thurston	5A Pocahontas	6A Jones
2A Victoria*	5B Utah	4C Waiilatpu	4A Putnam	6A Kanawha
2A Walker*	6B Wainath	5B Walla Walla	5A Raleigh	6A Kenesaw
3A Williams*	5B Washington	4C Wharton	5A Randolph	6A Keweenaw
3B Winkler	5B Wayne	5B Whitman	4A Rich	6A La Crosse
3A Wise	5B Weber	5B Yakima	4A Rouse	6A Lafayette
2B Washington*	VERMONT	5A Summers	5A Summers	7 Langdale
2B Webb	6A (all)	5A Taylor	5A Taylor	7 Lincoln
2B Wharton*	VERMONT	5A Tucker	5A Tucker	6A Marlinton
3B Wheeler	VIRGINIA	4A Berkeley	4A Tyler	6A Marlinton
3A Wichita	4A (all)	4A Boone	5A Upshur	6A Marquette
3B Wilberger	WASHINGTON	4A Braxton	4A Wayne	6A Marietta
2A Willey*	5B Adams	5A Brooke	4A Wayne	6A Marquette
3A Williams*	5B Adams	4A Cabell	4A White	6A Meigs
2A Wilson*	5B Adams	4A Callahan	5A Wetzel	6A Mineral
3B Winkler	5B Adams	4A Clay	4A West	6A Monroe
3A Wise	5B Chelan	5A Doddridge	4A Wood	6A Oconee
3A Wood*	4C Clallam	5A Fayette	4A Wyoming	7 Owsa
4B Yorkum				6A Otagonia

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Climate Zone 6A

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# 2021 IECC Commercial – Tapered insulation

**C402.2 Specific building thermal envelope insulation requirements.** Insulation in *building thermal envelope* opaque assemblies shall comply with Sections C402.2.1 through C402.2.7 and Table C402.1.3.

**C402.2.1 Roof assembly.** The minimum thermal resistance (*R*-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table C402.1.3, based on construction materials used in the roof assembly.

COMMERCIAL ENERGY EFFICIENCY

**C402.1.3 Thermal resistance of cold-formed steel walls.** *C*-factor of walls with cold-formed steel shall be determined in accordance with Equation 4.1.

$$U = 1/R_s + (ZR) \quad \text{(Equation 4.1)}$$

where:

- $R_s$  = The cumulative *R*-value of the wall components along the path of heat transfer, excluding the cavity insulation and steel studs.
- $ZR$  = The effective *R*-value of the cavity insulation with steel studs as specified in Table C402.1.4.2.

NOMINAL STUD SPACING (inches)	SPACING OF STUDS (inches)	CAVITY ASSEMBLY (prescription)	CORRECTION FACTOR (Z)	EFFECTIVE R-VALUE (R <sub>s</sub> + ZR)
P <sub>1</sub>	16	11	0.48	3.98
	12	11	0.42	4.42
P <sub>2</sub>	24	11	0.52	3.80
	12	11	0.46	4.24
6	18	11	0.53	3.73
	12	11	0.47	4.17
6	24	11	0.49	3.91
	12	11	0.43	4.35

**C402.2 Specific building thermal envelope insulation requirements.** Insulation in *building thermal envelope* opaque assemblies shall comply with Sections C402.2.1 through C402.2.7 and Table C402.1.3.

**C402.2.1 Roof assembly.** The minimum thermal resistance (*R*-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table C402.1.3, based on construction materials used in the roof assembly.

**Prescriptive approach**

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TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD <sup>a</sup>																	
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	
<b>Roofs</b>																	
Insulation entirely above roof deck	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings <sup>b</sup>	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-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 LS	R-25 + 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-49	R-60	R-60	R-60	R-60
<b>Walls, below grade</b>																	
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci
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-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-3.8ci or R-20
<b>Floors</b>																	
Mast <sup>c</sup>	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	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-30	R-30	R-30	R-30	R-30	R-30	R-30
<b>Slab-on-grade floors</b>																	
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-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 24" below	R-20 for 24" below	R-25 for 48" below
Heated slabs <sup>d</sup>	R-7.5 for 12" below+ R-5 fall slab	R-7.5 for 12" below+ R-5 fall slab	R-7.5 for 12" below+ R-5 fall slab	R-7.5 for 12" below+ R-5 fall slab	R-10 for 24" below+ R-5 fall slab	R-10 for 24" below+ R-5 fall slab	R-15 for 24" below+ R-5 fall slab	R-15 for 24" below+ R-5 fall slab	R-15 for 24" below+ R-5 fall slab	R-15 for 24" below+ R-5 fall slab	R-15 for 24" below+ R-5 fall slab	R-15 for 24" below+ R-5 fall slab	R-20 for 24" below+ R-5 fall slab	R-20 for 24" below+ R-5 fall slab	R-20 for 24" below+ R-5 fall slab	R-20 for 24" below+ R-5 fall slab	R-25 for 48" below+ R-5 fall slab

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m<sup>2</sup>, 1 pound per cubic foot = 16 kg/m<sup>3</sup>.  
 ci = Continuous Insulation, NR = No Requirement, LS = Linear System.  
 a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.  
 b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.  
 c. R-5.3ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with a material having a maximum thermal conductivity of 0.44 Btu-in/h-ft<sup>2</sup>.  
 d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.  
 e. "Mass floors" shall be in accordance with Section C402.2.2.  
 f. "Mass walls" shall be in accordance with Section C402.2.2.  
 g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

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# 2021 IECC Commercial – Tapered insulation

**C402.2.1.1 Tapered, above-deck insulation based on thickness.** Where used as a component of a roof/ceiling assembly R-value calculation, the sloped roof insulation R-value contribution to that calculation shall use the average thickness in inches (mm) along with the material R-value-per-inch (per-mm) solely for R-value compliance as prescribed in Section 402.1.3.

**C402.2.1.2 Minimum thickness, lowest point.** The minimum thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch (25 mm).

**C402.2.1.3 Suspended ceilings.** Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the minimum thermal resistance (R-value) of roof insulation in roof/ceiling construction.

**C402.2.1.4 Joints staggered.** Continuous insulation board shall be installed in not less than two layers and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

**C402.2.3 Floors.** E-value as shown elsewhere over or under floor assemblies shall be as follows:

“Main floor” where used as a component of the thermal envelope of a building shall provide one of the following weights:

1. 35 pounds per square foot (171 kg/m<sup>2</sup>) of floor surface area.
2. 27 pounds per square foot (122 kg/m<sup>2</sup>) of floor surface area where the nominal weight is not more than 120 pounds per square foot (544 kg/m<sup>2</sup>).

Exemptions:

1. The floor finish shall be:

“...average thickness...”

“...not less than 1 inch...”

**C402.2.4 Slabs on grade.** The minimum thermal resistance (R-value) of the insulation for unheated or heated slab-on-grade floors designed in accordance with the R-value method of Section C402.1.3 shall be as specified in Table C402.1.3.

**C402.2.4.1 Insulation installation.** Where installed, the perimeter insulation shall be placed on the outside of the foundation or on the inside of the foundation wall. The perimeter insulation shall extend downwards from the top of the slab for the minimum distance shown in the table to the top of the footing, which ever is less, or downwards to not less than the bottom of the slab and horizontally to the exterior or interior for the total distance shown in the table. Insulation extending over from the building shall be protected by pavement or by not less than 10 inches (254 mm) of soil. Where installed, full thickness insulation shall be continuous under the entire area of the slab-on-grade floor, except for certain, limited locations and service penetrations. Insulation required at the heated slab

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# ICC 2021 Commercial – Roof Reflectivity

**COMMERCIAL ENERGY EFFICIENCY**

1.2. Solar air or water-heating systems or components.

1.3. Vegetation such as landscaped roofs.

1.4. Above-roof decks or walkways.

1.5. Skylights.

1.6. HVAC systems and components, and other opaque objects mounted above the roof.

2. Portions of the roof shaded during the peak sun angle on the summer solstice by permanent features of the building or by permanent features of adjacent buildings.

3. Portions of roof that are ballasted with a maximum mass ballast of 17 pounds per square foot (74 kg/m<sup>2</sup>) or 23 pcf (117 kg/m<sup>3</sup>) pavers.

4. Roofs where not less than 75 percent of the roof area complies with one or more of the exceptions to this section.

**TABLE C402.3**  
**MINIMUM ROOF REFLECTANCE AND EMISSIONS OPTIONS\***

Three-year aged solar reflectance index<sup>1</sup> of 77 and 3-year aged thermal emittance<sup>2</sup> of 75.

Three-year aged solar reflectance index<sup>1</sup> of 64.

1. The use of area-weighted averages to comply with these requirements shall be permitted. Minimum lighting equipment height shall be the same solar reflectance or thermal emittance shall be subject to a 3-foot (914 mm) minimum clearance with Section C402.1.1 and 3-foot (914 mm) minimum clearance.

2. Aged solar reflectance index is consistent with ASTM C1364, ASTM D5101 or ASTM E1918 or C826-10.

3. Aged thermal emittance index is consistent with ASTM C1371 or ASTM E1918 or C826-10.

4. Solar reflectance index (SRI) shall be determined in accordance with ASTM E1918 with a correction coefficient of 1.1.  $SRI = \frac{1}{0.09} [(11 W/m^2 \cdot K) \cdot \rho] + 2$ . Calculations of aged SRI that do not use aged thermal emittance are not permitted.

**C402.3.1 Aged roof solar reflectance.** Where an aged solar reflectance required by Section C402.3 is not available, it shall be determined in accordance with Equation 4-3:

$$R_{sri} = [0.2 + 0.7(R_{sri,unaged}) - 0.2] \quad \text{(Equation 4-3)}$$

where:

- $R_{sri}$  = The aged solar reflectance.
- $R_{sri,unaged}$  = The unaged solar reflectance determined in accordance with C826-10.

**C402.3.2 Emission index.** Fractions shall comply with Sections C402.1.1 through C402.4.2 and Table C402.3. Daylight responsive controls shall comply with this section and Section C402.4.2.

perimeter shall not be required to extend below the bottom of the heated slab and shall be continuous with the full slab insulation.

Exemption: Where the slab-on-grade floor is greater than 24 inches (610 mm) below the finished exterior grade, perimeter insulation is not required.

**C402.2.5 Below grade walls.** The C-factor for the below-grade exterior walls shall be in accordance with Table C402.1.4. The E-value of the unheated exterior wall shall be determined in accordance with Section C402.1.3. The C-factor or E-value required shall extend to a depth of not less than 10 feet (3048 mm) below the outside finished ground area, or to the level of the lowest floor of the conditioned space indicated by the below-grade wall, whichever is less.

**C402.2.6 Foundation of radiant heating systems.** Radiant heating system panels, and their associated components that are installed in interior or exterior assemblies, shall be insulated to an E-value of not less than 0.5 on all surfaces not facing the space being heated. Radiant heating system panels that are installed in the building thermal envelope shall be separated from the exterior of the building or unconditioned or exempt spaces by not less than 2 inches of insulation installed in the exterior assembly in which they are installed or the assembly shall comply with Section C402.1.4.

Exemption: Heated slabs on grade installed in accordance with Section C402.2.4.

**C402.2.7 Airspaces.** Where the E-value of an airspace is used for compliance in accordance with Section C402.1, the airspace shall be enclosed in an unventilated cavity constructed in unheated surface area and not of the enclosed airspace. Airflow shall be deemed minimized where the enclosed airspace is located on the exterior side of the continuous air barrier and is bounded on all sides by building components.

Exemption: The thermal resistance of airspaces located on the exterior side of the continuous air barrier and adjacent to, and behind the exterior wall-covering material shall be determined in accordance with ASTM C1363 modified with an airflow entering the bottom and exiting the top of the airspace or as an unventilated cavity of not less than 75 mm nominal.

**C402.3 Roof solar reflectance and thermal emittance.** Low-sloped roofs shall have unaged conditioned ground in Climate Zones 3 through 7 shall comply with one or more of the options in Table C402.3.

Exemption: The following roofs and portions of roofs are exempt from the requirements of Table C402.3:

1. Portions of the roof that are shaded or are covered by the following:
  - 1.1. Photovoltaic systems or components.

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# IECC 2021 Residential -- Application

## CHAPTER 4 [RE] RESIDENTIAL ENERGY EFFICIENCY

USER NOTE  
About this chapter: Chapter 4 presents the paths and options for compliance with the energy efficiency provisions. Chapter 4 contains energy efficiency provisions for the building envelope, mechanical and water heating systems, lighting and automation efficiency requirements. A performance alternative, energy saving alternative, and tropical region alternative are also provided to allow for energy code compliance other than by the prescriptive method.

**R401.2 Application.** Residential buildings shall comply with Section R401.2.5 and either Sections R401.2.1, R401.2.2, R401.2.3 or R401.2.4.

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

**R401.2.1 Prescriptive Compliance Option.** The Prescriptive Compliance Option requires compliance with Sections R401 through R404.

**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.

3. For buildings complying with the Energy Rating Index alternative in Section R401.2.3, the Energy Rating Index value shall be at least 1 percent less than the Energy Rating Index value specified in Table R404.1.

The option selected for compliance shall be identified in the conditions required by Section R401.3.

**R401.3 Certificate.** A permanent certificate shall be completed by the holder or other approved party and posted on a wall in the space where the fixture 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 correct directory label, service disconnect label or other required labels. The certificate shall indicate the following:

1. The predominant R-value of insulation installed in or on ceilings, walls, walls, foundation components such as walls, basement walls, crawl space walls and floors and doors outside conditioned spaces.
2. U-factors of fenestration and the solar heat gain coefficient (SHGC) of fenestration. Where there is more than one value for any component of the building envelope, the certificate shall indicate both the value covering the largest area and the area weighted average value of fenestration.
3. The results from any required duct system and building envelope air leakage testing performed on the building.
4. The type, size and efficiencies of heating, cooling and service water-heating equipment. Where a gas-fired furnace, boiler, water heater, electric furnace or heat-pump electric heater is installed in the residence, the certificate shall indicate "gas-fired furnace/boiler", "electric furnace" or "heat-pump electric heater," as appropriate. An efficiency shall not be indicated for gas-fired furnace/boiler, electric furnace and electric heat-pump boiler.
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, lock work and website.

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# IECC 2021 Residential -- Attics

## RESIDENTIAL ENERGY EFFICIENCY

**R402.2.1 Ceilings with attic spaces.** 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 whenever the full length of uncompressed R-38 insulation extends over the wall top plane at the eave. Where Section R402.1.3 requires R-60 insulation in the ceiling, installing R-49 over 100 percent of the ceiling area requiring insulation shall satisfy the requirement for R-60 insulation whenever the full length of uncompressed R-49 insulation extends over the wall top plane at the eave. 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.

**R402.2.2 Ceilings without attics.** Where Section R402.1.3 requires insulation R-value greater than R-30 in the unconditioned 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 plane to the outer edge of each plane and shall not be compressed. The reduction of insulation from the requirements of Section R402.1.3 shall be limited to 50 square feet (4.64 m<sup>2</sup>) 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.

**R402.2.3 Eave baffles.** For air-permeable insulation in unvented attics, a baffle shall be installed adjacent to rafters 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 plane in order to provide continuous space for attic insulation coverage over the top plane. Where eave venting is not continuous, baffles shall be installed continuously to prevent conditioned air in the eave vents from bypassing the baffles.

**R402.2.4 Access hatches and doors.** Access hatches and doors from conditioned to unconditioned spaces such as attics and crawl spaces shall be installed to the same R-value required by Table R402.1.3 for the wall or ceiling in which they are installed.

**Exception:**

1. Vertical doors providing access from conditioned spaces to unconditioned spaces that comply with the insulation requirements of Table R402.1.3 based on the applicable climate zone specified in Chapter 3.
2. Horizontal pull-down, rear-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:

1. The average U-factor of the hatch shall be less than or equal to U-0.30 or have an average insulation R-value of R-3.10 or greater.
2. The net free area of the hatch shall be less than or equal to 13.3 square feet (1.23 m<sup>2</sup>).
3. The net area of the closed opening shall be less than or equal to 13.3 square feet (1.23 m<sup>2</sup>).
4. The perimeter of the hatch edge shall be weatherstripped.

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

**R402.2.4.1 Access hatches and door insulation installation and retention.** Vertical or horizontal access hatches and doors from conditioned space to unconditioned spaces such as attics and crawl spaces shall be weatherstripped. Access that prevents damage to or compression of the insulation shall be provided for all equipment. Where loose-fill insulation is installed, a wind-driven or expanded baffle or restraint, or foam shall be installed to prevent the loose-fill insulation from spilling into the living space. Doors higher to lower sections of the attic and from attics covering conditioned spaces to unconditioned spaces. The baffle or restraint shall provide a permanent means of maintaining the installed R-value of the loose-fill insulation.

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

1. Above-ground walls of concrete block, concrete, insulated concrete form, masonry cavity, brick or masonry veneer, adobe, compressed earth block, rammed earth, solid masonry, mass timber or solid logs.
2. Any wall having a heat capacity greater than or equal to 8 Btu/ft<sup>2</sup> · °F (21 kJ/m<sup>2</sup> · °C).

**R402.2.6 Steel frame ceilings, walls and floors.** Steel-frame ceilings, walls, and floors shall comply with the insulation requirements of Table R402.1.3 and the U-factor requirements of Table R402.1.2. The calculation of the U-factor for a steel-frame envelope assembly shall use a series-parallel path calculation method.

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*Be aware whether and, if so, when your state and local jurisdictions will be adopting updated editions of the I-codes*

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## ICC codes accessible online

[codes.iccsafe.org](https://codes.iccsafe.org)

The screenshot shows the 'I-Codes Building Codes' section of the website. It features a search bar, a category list on the left, and a grid of code book covers for 2021. The codes include:
 

- IBC: 2021 International Building Code
- IRC: 2021 International Residential Code
- IFC: 2021 International Fire Code
- IFGC: 2021 International Fuel Gas Code
- IMC: 2021 International Mechanical Code
- IPC: 2021 International Plumbing Code
- IEBC: 2021 International Existing Building Code
- IECC: 2021 International Energy Conservation Code

 A 'Bundle and Save' section on the right offers a '2012 International Codes, Designer Collection' for purchase. A 'Premium exclusive title requires subscription to access content.' message is visible at the top of the code grid.

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## www.iccsafe.org

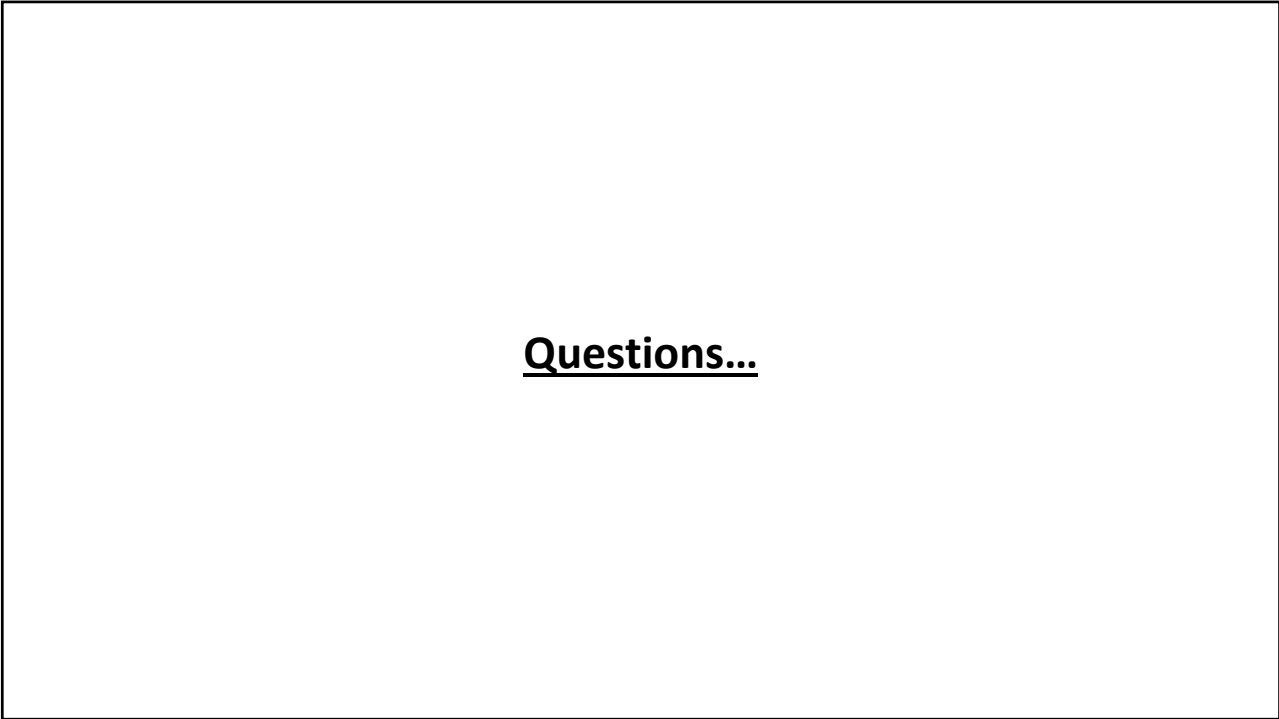
[shop.iccsafe.org](https://shop.iccsafe.org)

The screenshot shows the 'shop.iccsafe.org' website. The top navigation bar includes 'Help', 'Become a Member', 'Sign In', and 'My Cart'. The main content area is titled 'FEATURED PRODUCTS' and displays six product cards:
 

- Wind Design Overview (ASCE 7-16 And 2018/2021 IBC):** As low as \$13.60.
- 2021 International Fuel Gas Code:** As low as \$4.90.
- 2021 International Building Code:** As low as \$7.95.
- 2021 Complete 14 Collection:** A bundle of all 14 codes.
- 2021 International Residential Code:** As low as \$4.90.
- 2021 International Mechanical Code:** As low as \$7.95.

 Each card includes an 'Add to Cart' button. The right sidebar contains 'FEEDBACK', 'LIVE CHAT', and social media icons for Twitter, Facebook, and LinkedIn.

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