



Roofing Alliance Faculty Workshop

Building codes and standards in roofing

presented by

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Definitions

Standard: something established for use as a rule or basis of comparison in measuring or judging capacity, quantity, content, extent, value or quality.

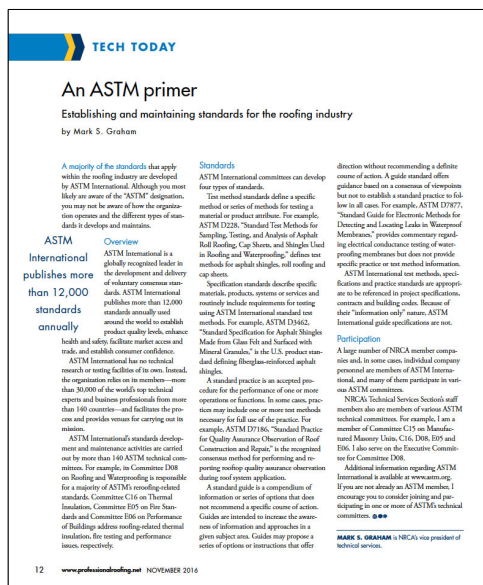
Code: 1) a body of laws, as a nation, city, etc., arranged systematically for easy reference; 2) any set of principles or rules of conduct (e.g., the moral code).

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Roofing-related standards

- Promulgators: AAMA, ASCE, ASTM, CSA, CSSB, FM, SPRI, UL and WDMA
- Types of standards:
 - Test method (e.g., ASTM E108)
 - Specification/product standard (ASTM D6878)
 - Practice (ASTM D7186)
 - Guide (ASTM D6630) – Not enforceable

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Professional Roofing, November 2016

[Link](#)

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Most roofing-related standards are developed/maintained by Committee D08. Most roofing-related standards are contained in Vol. 4.04

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Some background

Building codes and standards in roofing

- 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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The purpose of the code

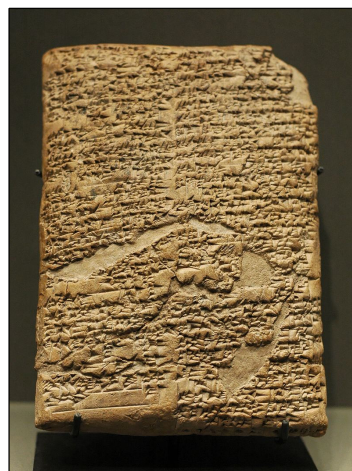
International Building Code, 2021 Edition

- **[A] 101.3 Purpose.** The purpose of this code is to establish the minimum requirements to provide a reasonable level of safety, health and general welfare through structural strength, *means of egress*, stability, sanitation, light and *ventilation*, energy conservation, and for providing a reasonable level of life safety and property protection from the hazards of fire, *explosion* or *dangerous* conditions, and to provide a reasonable level of safety to fire fighters and emergency responders during emergency operations.

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Code of Hammurabi

- Babylonian empire (1754 BC)
- 282 laws, scaled punishment
- "...an eye for an eye, a tooth for a tooth..."
- Specific provisions to construction and contracts



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Legal considerations

“In most states, a building code violation is considered to be evidence of negligence. In some situations, a building code violation may be considered *negligence per se*...”

--Stephen M. Phillips
Hendrick, Phillips, Salzman & Seigel, PC

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Code enforcement

- Code official
- Construction litigation



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Legacy codes

Early 1900s up to 1999

- Building Officials and Code Administrators International (BOCA)
 - *The BOCA National Building Code*
- Southern Building Code Congress International (SBCCI)
 - *The Standard Building Code (SBC)*
- International Conference of Building Officials
 - *Uniform Building Code (UBC)*

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2021 I-codes



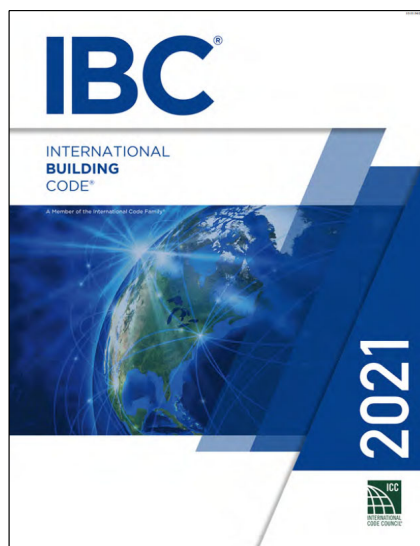
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I-codes commonly applicable to roofing

- IBC: International Building Code
- IRC: International Residential Code
- IECC: International Energy Conservation Code

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International Building Code, 2021 Edition



- Applicable to all buildings and structures, excepts those applicable to IRC 2021
- Roofing-related requirements:
 - Ch. 10-Means of egress
 - Ch. 12-Interior environment
 - Ch. 13-Energy efficiency
 - Ch. 15-Roof assemblies and rooftop structures
 - Ch. 16-Structural design
 - Ch. 20-Aluminum
 - Ch. 22-Steel
 - Ch. 24-Glass and glazing
 - Ch. 26-Plastic

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Significant roof requirements

International Building Code, 2021 Edition, Chapter 15-Roof Assemblies and Rooftop Structures

- Wind resistance
- Fire classification
- Installation requirements
- Prescriptive requirements
- Reroofing

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CHAPTER 15
ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

User notes:

About this chapter: Chapter 15 provides minimum requirements for the design and construction of roof assemblies and rooftop structures. The criteria address the weather-protective barrier at the roof and, in most circumstances, a fire-resistant barrier. The chapter is largely prescriptive in nature and is based on decades of experience with various traditional materials, but it also recognizes newer products. Section 1511 addresses rooftop structures, which include penthouses, tanks, towers and spires. Rooftop penthouses larger than prescribed in this chapter must be treated as a story under Chapter 5.

Code development reminder: Code change proposals to sections preceded by the designation [BF], [BG] or [P] will be considered by one of the code development committees meeting during the 2021 (Group A) Code Development Cycle. All other code change proposals will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

SECTION 1503 WEATHER PROTECTION

1503.1 General. Roof decks shall be covered with approved roof coverings secured to the building or structure in accordance with the provisions of this chapter. Roof coverings shall have a minimum slope of 1/4 inch (6.35 mm) per foot (30.48 mm) and shall be installed in accordance with the manufacturer's instructions.

1503.2 Parapet walls. Parapet walls shall be coped or covered in accordance with Sections 1503.3.1 and 1503.3.2. The top surface of the parapet wall shall provide positive drainage.

1503.3.1 Fire-resistance-rated parapet wall. Parapet walls required by Section 705.11 shall be coped or covered with weatherproof materials of a width not less than the thickness of the parapet wall such that the fire-resistance rating of the wall is not decreased.

1503.3.2 Other parapet wall. Parapet walls meeting one of the exceptions in Section 705.11 shall be coped or covered with weatherproof materials of a width not less than the thickness of the parapet wall.

1503.4 Attic and rafter ventilation. Intake and exhaust vents shall be provided in accordance with Section 1202.2 and the vent product manufacturer's installation instructions.

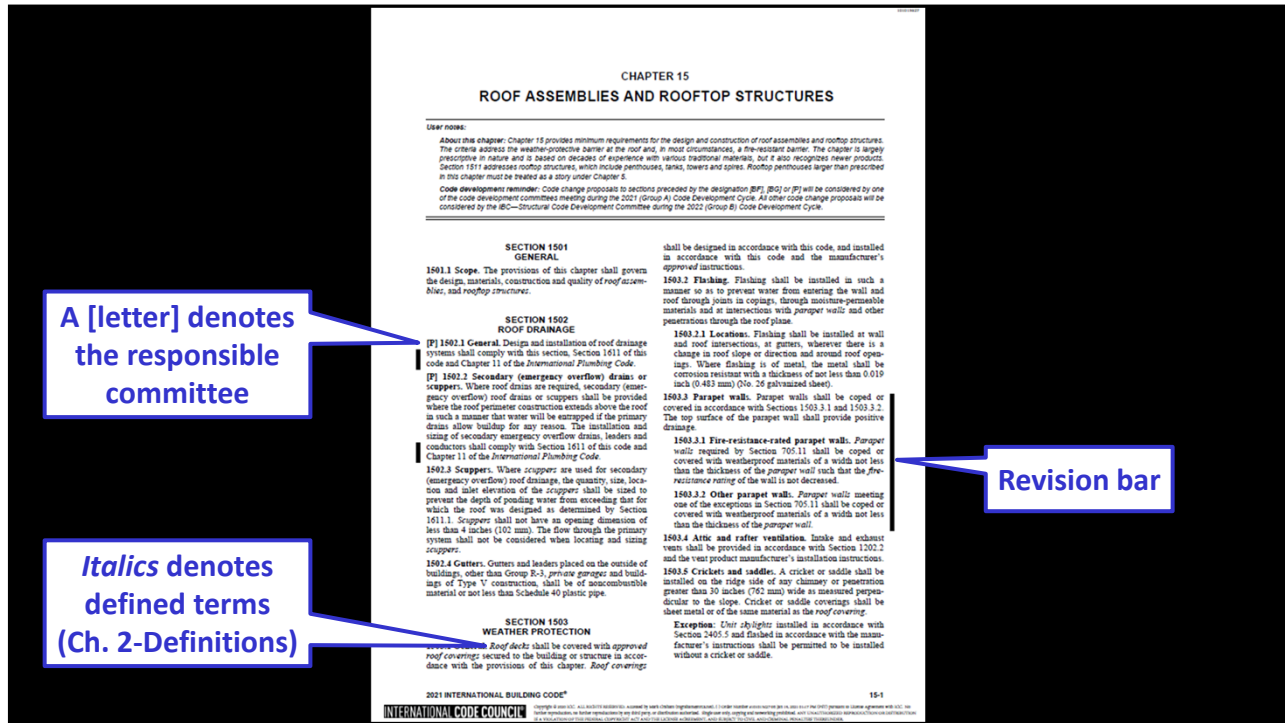
1503.5 Crickets and saddles. A cricket or saddle shall be installed on the ridge side of any chimney or penetration greater than 30 inches (762 mm) wide as measured perpendicular to the slope. Cricket or saddle coverings shall be sheet metal or of the same material as the roof covering.

Exception: One shingle installed in accordance with Section 1405.5 and finished in accordance with the manufacturer's instructions shall be permitted to be installed without a cricket or saddle.

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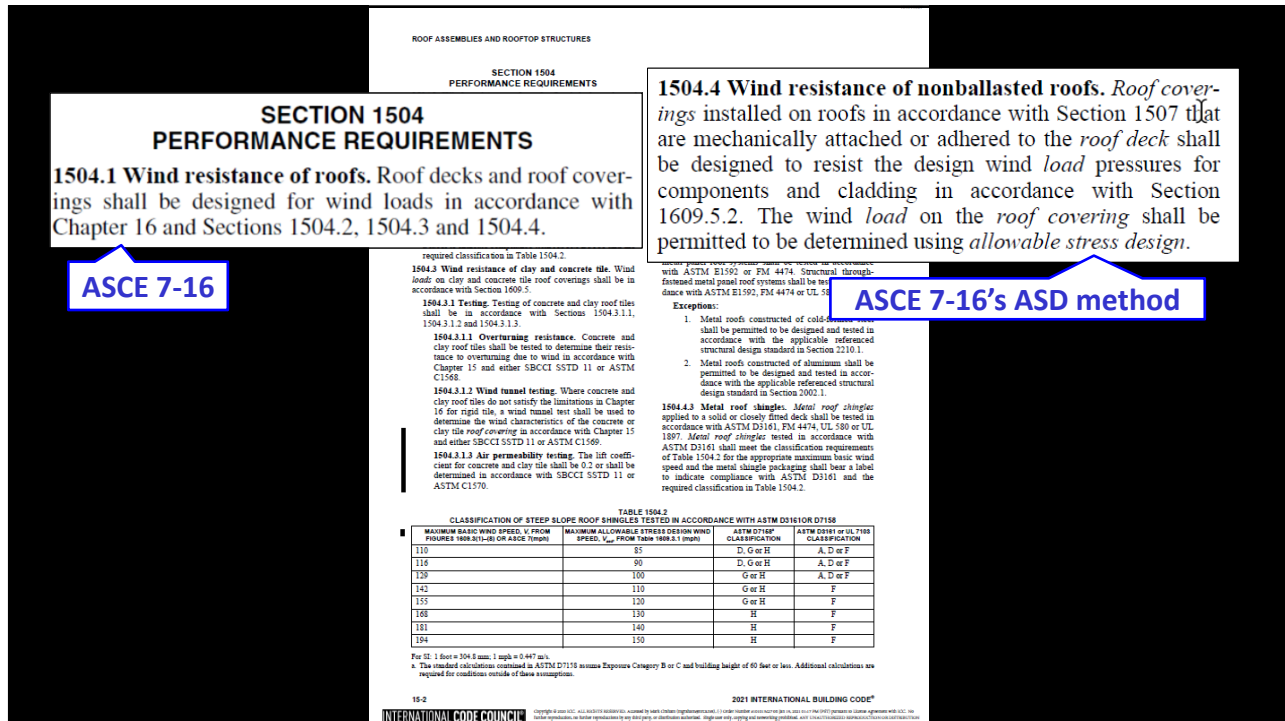


A [letter] denotes the responsible committee

Italics denotes defined terms (Ch. 2-Definitions)

Revision bar

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ASCE 7-16

ASCE 7-16's ASD method

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1504.1.1 Wind resistance of asphalt shingles. Asphalt shingles shall be tested in accordance with ASTM D7158. Asphalt shingles shall meet the classification requirements of Table 1504.1.1 for the appropriate maximum basic wind speed. Asphalt shingle packaging shall bear a label to indicate compliance with ASTM D7158 and the required classification in Table 1504.1.1.

Exception: Asphalt shingles not included in the scope of ASTM D7158 shall be tested and labeled in accordance with ASTM D3161. Asphalt shingle packaging shall bear a label to indicate compliance with ASTM D3161 and the required classification in Table 1504.1.1.

TABLE 1504.1.1 CLASSIFICATION OF STEEP SLOPE ROOF SHINGLES TESTED IN ACCORDANCE WITH ASTM D316 OR D71581

MAXIMUM BASIC WIND SPEED, V, FROM FIGURES 1609.3(1)-(8) OR ASCE 7 (mph)	MAXIMUM ALLOWABLE STRESS DESIGN WIND SPEED, V _{all} , FROM TABLE 1609.3.1 (mph)	ASTM D7158 ^a CLASSIFICATION	ASTM D3161 CLASSIFICATION
110	85	D, G or H	A, D or F
116	90	D, G or H	A, D or F
129	100	G or H	A, D or F
142	110	G or H	F
155	120	G or H	F
168	130	H	F
181	140	H	F
194	150	H	F

For SI: 1 foot = 304.8 mm; 1 mph = 0.447 m/s.

a. The standard calculations contained in ASTM D7158 assume Exposure Category B or C and building height of 60 feet or less. Additional calculations are required for conditions outside of these assumptions.

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ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

1504.5 Ballasted low-slope single-ply roof systems. Ballasted low-slope (roof slope \leq 2:12) single-ply roof system coverings installed in accordance with Section 1507.12 shall be designed in accordance with AISI SPS12-12 coverings that are subject to cyclical flexural response due to wind loads shall not demonstrate any significant loss of tensile strength for unreinforced membranes or breaking strength for reinforced membranes when tested as herein required.

SECTION 1505 FIRE CLASSIFICATION

[BF] 1505.1 General. Roof assemblies shall be divided into the classes defined in this section. Class A, B and C roof assemblies and roof coverings required to be listed by this section shall be tested in accordance with ASTM E108 or UL 790. In addition, *fire-retardant-treated wood* roof coverings shall be tested in accordance with ASTM D2898. The minimum roof coverings installed on buildings shall comply with Table 1505.1 based on the type of construction of the building.

Exception: Skylights and sloped glazing that comply with Chapter 24 or Section 2610.

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 mile per hour = 0.447 m/s.
 a. Inspections shall be permitted for mean roof height and parapet height.
 b. Basic design wind speed of roof and aggregate shall be determined in accordance with Section 1609.
 c. To save the maximum aggregate proper design of aggregate for a given (1) mm, a gravel ring 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 9 inches (229 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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[BF] 1505.2 Class A roof assemblies. Class A roof assemblies are those that are effective against severe fire test exposure. Class A roof assemblies and roof coverings shall be *listed* and identified as Class A by an *approved* testing agency. Class A roof assemblies shall be permitted for use in buildings or structures of all types of construction.

Exceptions:

1. Class A roof assemblies include those with coverings of brick, masonry or an exposed concrete roof deck.
2. Class A roof assemblies also include ferrous or copper shingles or sheets, metal sheets and shingles, clay or concrete roof tile or slate installed on non-combustible decks or ferrous, copper or metal sheets installed without a roof deck on noncombustible framing.
3. Class A roof assemblies include minimum 16 ounce per square foot (0.0416 kg/m²) copper sheets installed over combustible decks.
4. Class A roof assemblies include slate installed over ASTM D226, Type II underlayment over combustible decks.

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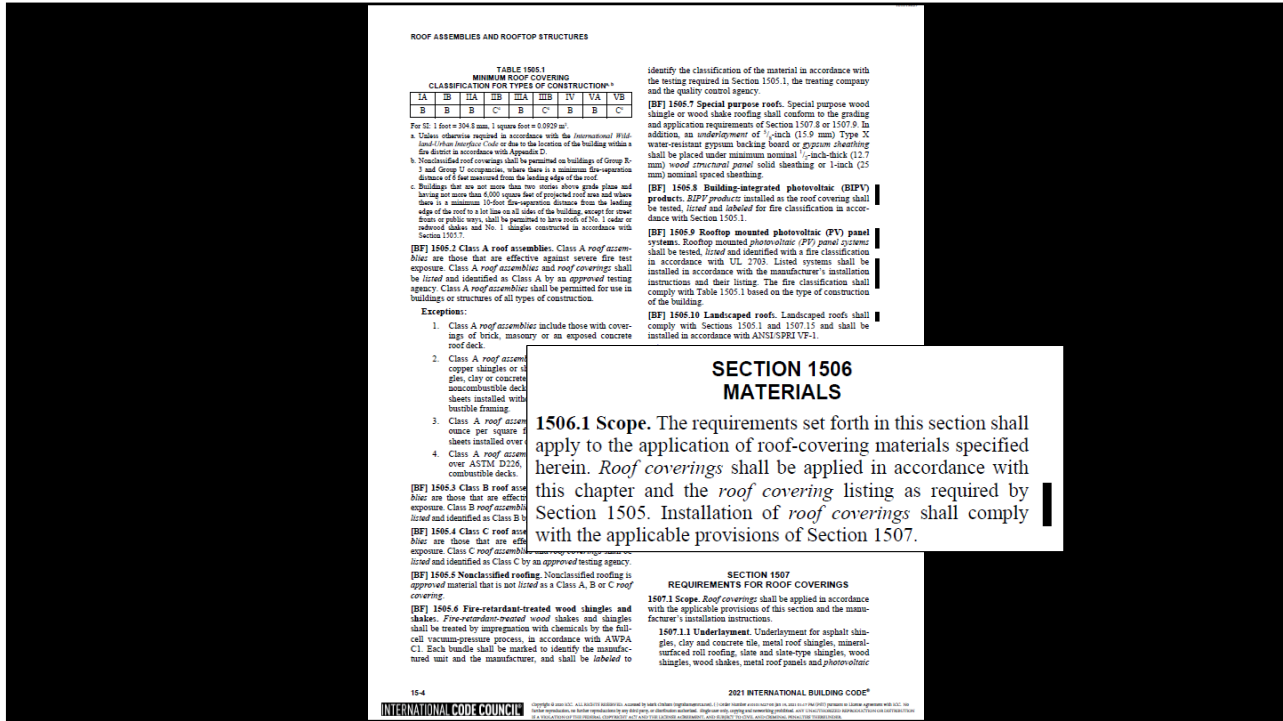
**TABLE 1505.1^{a, b}
MINIMUM ROOF COVERING CLASSIFICATION
FOR TYPES OF CONSTRUCTION**

IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
B	B	B	C ^c	B	C ^c	B	B	C ^c

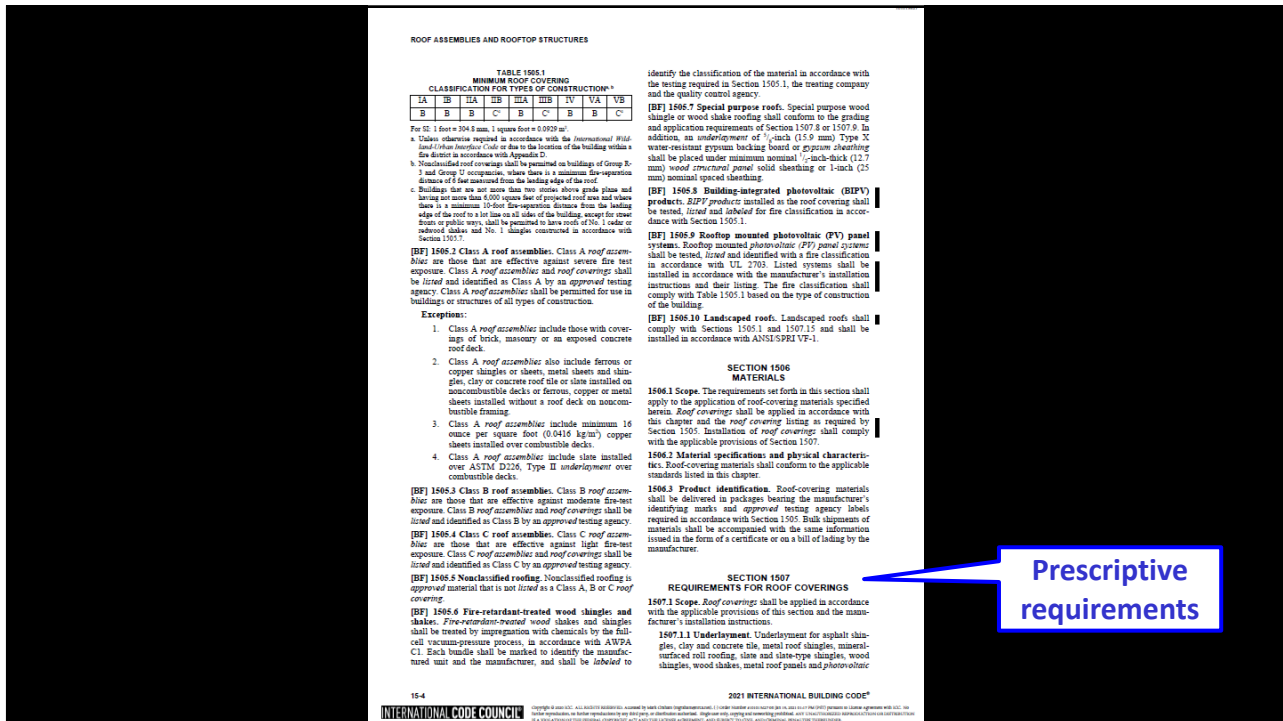
For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m².

- a. Unless otherwise required in accordance with the *International Wildland-Urban Interface Code* or due to the location of the building within a fire district in accordance with Appendix D.
- b. Nonclassified roof coverings shall be permitted on buildings of Group R-3 and Group U occupancies, where there is a minimum fire-separation distance of 6 feet measured from the leading edge of the roof.
- c. Buildings that are not more than two stories above grade plane and having not more than 6,000 square feet of projected roof area and where there is a minimum 10-foot fire-separation distance from the leading edge of the roof to a lot line on all sides of the building, except for street fronts or public ways, shall be permitted to have roofs of No. 1 cedar or redwood shakes and No. 1 shingles constructed in accordance with Section 1505.7.

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Roof system types

Prescriptive requirement in Section 1507

- Asphalt shingles
- Modified bitumen roofing
- Clay and concrete tile
- Single-ply roofing
- Metal panels
- Spray polyurethane foam
- Metal shingles
- Liquid-applied roofing
- Mineral-surfaced roll roofing
- Vegetative roofs, roof gardens and landscaped roofs
- Slate shingles
- Photovoltaic shingles
- Wood shingles
- Building-integrated photovoltaic roof panels
- Wood shakes
-
- Built-up roofs

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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 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.

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.

Silicone coating	ASTM D5694
Moisture-cured polyurethane coating	ASTM D6947

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

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 1/4 unit vertical in 12 units horizontal (2-percent slope).

ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

1507.14.2 Material standards. Liquid-applied roofing shall comply with ASTM C836, ASTM C957 or ASTM D3465.

1507.15 Vegetative roofs and landscaped roofs. Vegetative roofs and landscaped roofs shall comply with the requirements of this chapter, Section 1507.14.2.2 and the International Fire Code.

[RF] 1507.15.1 Structural fire resistance. The structural frame and roof construction supporting the load imposed on the roof by the vegetative roof or landscaped roofs shall comply with the requirements of Table 601.

1507.16 Photovoltaic shingles. The installation of photovoltaic shingles shall comply with the provisions of this section.

1507.16.1 Deck requirements. Photovoltaic shingles shall be applied to a solid or closely fitted deck, except where the shingles are specifically designed to be applied over spaced sheathing.

1507.16.2 Deck slope. Photovoltaic shingles shall be installed on roof slopes of not less than 2 units vertical in 12 units horizontal (2:12).

1507.16.3 Underlayment. Underlayment shall comply with Section 1507.1.1.

1507.16.4 Ice barrier. Where required, ice barriers shall comply with Section 1507.1.2.

1507.16.5 Fasteners. Fasteners for photovoltaic shingles shall be galvanized, stainless steel, aluminum or copper roofing nails, minimum 12-gage (0.105 inch (2.67 mm)) shank with a minimum 1/8-inch-diameter (9.5 mm) head, of a length to penetrate through the roofing materials and not less than 1/4 inch (19.1 mm) into the roof sheathing. Where the roof sheathing is less than 1/2 inch (12.7 mm) thick, the nails shall penetrate through the sheathing. Fasteners shall comply with ASTM F1667.

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.

1507.16.7 Attachment. Photovoltaic shingles shall be attached in accordance with the manufacturer's installation instructions.

1507.16.8 Wind resistance. Photovoltaic shingles shall comply with the classification requirements of Table 1504.2 for the appropriate maximum nominal design wind speed.

1507.17 Building-integrated photovoltaic roof panels. The installation of building-integrated photovoltaic (BIPV) roof panels shall comply with the provisions of this section.

1507.17.1 Deck requirements. BIPV roof panels shall be applied to a solid or closely fitted deck, except where the roof covering is specifically designed to be applied over spaced sheathing.

1507.17.2 Deck slope. BIPV roof panels shall be used only on roof slopes of 2 units vertical in 12 units horizontal (2:12) or greater.

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ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

1507.17.3 Underlayment. Underlayment shall comply with ASTM D226, ASTM D4869 or ASTM D6757.

1507.17.4 Underlayment application. Underlayment shall be applied *chingle fashion*, parallel to and starting from the eave, lapped 2 inches (51 mm) and fastened sufficiently to hold in place.

1507.17.4.1 High-wind attachment. Underlayment applied in areas subject to high winds (F_w greater than 110 mph (49 m/s) as determined in accordance with Section 1609.3.1) shall be applied in accordance with the manufacturer's instructions. Fasteners shall be applied along the overlap at not more than 36 inches (914 mm) on center. Underlayment installed where F_w is not less than 120 mph (54 m/s) shall comply with ASTM D226, Type III, ASTM D4869, Type IV or ASTM D6757. The underlayment shall be attached in a grid pattern of 12 inches (305 mm) between side laps with a 6-inch (152 mm) spacing at the side laps. The underlayment shall be applied in accordance with Section 1507.1.1 except all laps shall be not less than 4 inches (102 mm). Underlayment shall be attached using cap nails or cap staples. Caps shall be metal or plastic with a nominal head diameter of not less than 1 inch (25.4 mm). Metal caps shall have a thickness of not less than 0.010 inch (0.25 mm). Power-driven metal caps shall have a thickness of not less than 0.010 inch (0.25 mm). Thickness of the outside edge of plastic caps shall be not less than 0.031 inch (0.89 mm). The cap nail shank shall be not less than 0.083 inch (2.11 mm) for ring shank cap nails and 0.091 inch (2.31 mm) for smooth shank cap nails. Staple gage shall be not less than 21 gage (0.2 inch (0.81 mm)). Cap nail shank and cap staple legs shall have a length sufficient to penetrate through-the-roof sheathing or not less than $\frac{1}{8}$ inch (3.18 mm) into the roof sheathing.

Exception: As an alternative, adhered underlayment complying with ASTM D1970 shall be permitted.

1507.17.4.2 Ice barrier. In areas where there has been a history of ice forming along the eaves causing a back-up of water, an ice barrier consisting of not fewer than two layers of underlayment cemented together or of a self-adhering polymer modified bitumen sheet shall be used instead of normal underlayment and extend from the lowest edges of all roof surfaces to a point not less than 24 inches (610 mm) inside the exterior wall line of the building.

Exception: Detached accessory structures that do not contain conditioned floor area.

1507.17.5 Material standards. BIPV roof panels shall be listed and labeled in accordance with UL 7103 or with both UL 6170-1 and UL 6170-2.

1507.17.6 Attachment. BIPV roof panels shall be attached in accordance with the manufacturer's installation instructions.

SECTION 1508
ROOF INSULATION

[BF] 1508.1 General. The use of above-deck thermal insulation shall be permitted provided that such insulation is covered with an approved roof covering and passes the tests of NFPA 276 or UL 1256 when tested as an assembly.

Exceptions:

1. Foam plastic roof insulation shall conform to the material and installation requirements of Chapter 24.
2. Where a concrete or composite metal and concrete roof deck is used and the above-deck thermal insulation is covered with an approved roof covering.

[BF] 1508.2 Material standards. Above-deck thermal insulation board shall comply with the standards in Table 1508.2.

[BF] TABLE 1508.2
MATERIAL STANDARDS FOR ROOF INSULATION

Cellular glass board	ASTM C552
Composite boards	ASTM C1289, Type III, IV, V or VII
Expanded polystyrene	ASTM C578
Extruded polystyrene	ASTM C578
Fiber-reinforced gypsum board	ASTM C1278
Glass-faced gypsum board	ASTM C1177
High-density polyisocyanurate board	ASTM C1289, Type II, Class 4
Mineral fiber insulation board	ASTM C726
Pperlite board	ASTM C728
Polyisocyanurate board	ASTM C1289, Type I or II
Wood fiberboard	ASTM C208, Type II

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ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

1507.17.3 Underlayment. Underlayment shall comply with ASTM D226, ASTM D4869 or ASTM D6757.

1507.17.4 Underlayment application. Underlayment shall be applied *chingle fashion*, parallel to and starting from the eave, lapped 2 inches (51 mm) and fastened sufficiently to hold in place.

1507.17.4.1 High-wind attachment. Underlayment applied in areas subject to high winds (F_w greater than 110 mph (49 m/s) as determined in accordance with Section 1609.3.1) shall be applied in accordance with the manufacturer's instructions. Fasteners shall be applied along the overlap at not more than 36 inches (914 mm) on center. Underlayment installed where F_w is not less than 120 mph (54 m/s) shall comply with ASTM D226, Type III, ASTM D4869, Type IV or ASTM D6757. The underlayment shall be attached in a grid pattern of 12 inches (305 mm) between side laps with a 6-inch (152 mm) spacing at the side laps. The underlayment shall be applied in accordance with Section 1507.1.1 except all laps shall be not less than 4 inches (102 mm). Underlayment shall be attached using cap nails or cap staples. Caps shall be metal or plastic with a nominal head diameter of not less than 1 inch (25.4 mm). Metal caps shall have a thickness of not less than 0.010 inch (0.25 mm). Power-driven metal caps shall have a thickness of not less than 0.010 inch (0.25 mm). Thickness of the outside edge of plastic caps shall be not less than 0.031 inch (0.89 mm). The cap nail shank shall be not less than 0.083 inch (2.11 mm) for ring shank cap nails and 0.091 inch (2.31 mm) for smooth shank cap nails. Staple gage shall be not less than 21 gage (0.2 inch (0.81 mm)). Cap nail shank and cap staple legs shall have a length sufficient to penetrate through-the-roof sheathing or not less than $\frac{1}{8}$ inch (3.18 mm) into the roof sheathing.

Exception: As an alternative, adhered underlayment complying with ASTM D1970 shall be permitted.

1507.17.4.2 Ice barrier. In areas where there has been a history of ice forming along the eaves causing a back-up of water, an ice barrier consisting of not fewer than two layers of underlayment cemented together or of a self-adhering polymer modified bitumen sheet shall be used instead of normal underlayment and extend from the lowest edges of all roof surfaces to a point not less than 24 inches (610 mm) inside the exterior wall line of the building.

Exception: Detached accessory structures that do not contain conditioned floor area.

1507.17.5 Material standards. BIPV roof panels shall be listed and labeled in accordance with UL 7103 or with both UL 6170-1 and UL 6170-2.

1507.17.6 Attachment. BIPV roof panels shall be attached in accordance with the manufacturer's installation instructions.

SECTION 1509
ROOF COATINGS

[BF] 1509.1 General. The use of above-deck thermal insulation shall be permitted provided that such insulation is covered with an approved roof covering and passes the tests of NFPA 276 or UL 1256 when tested as an assembly.

Exceptions:

1. Foam plastic roof insulation shall conform to the material and installation requirements of Chapter 24.
2. Where a concrete or composite metal and concrete roof deck is used and the above-deck thermal insulation is covered with an approved roof covering and passes the tests of NFPA 276 or UL 1256 when tested as an assembly.

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.

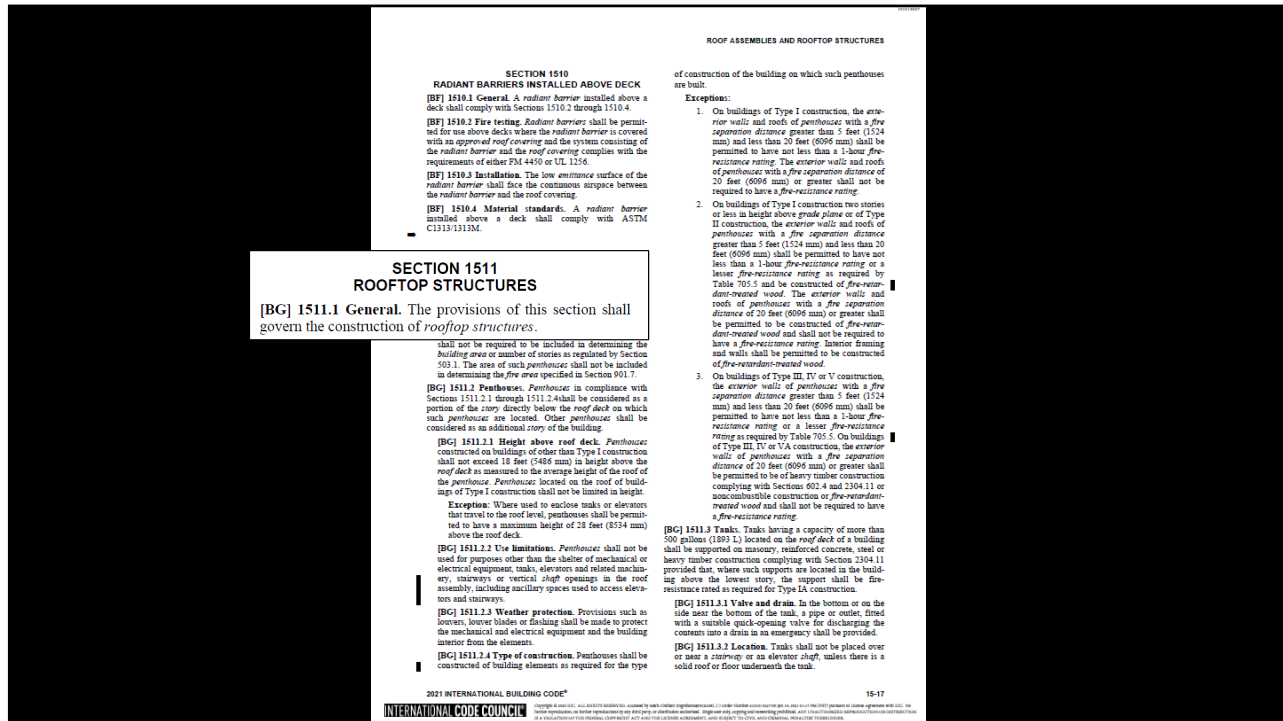
TABLE 1509.2
ROOF COATING MATERIAL STANDARDS

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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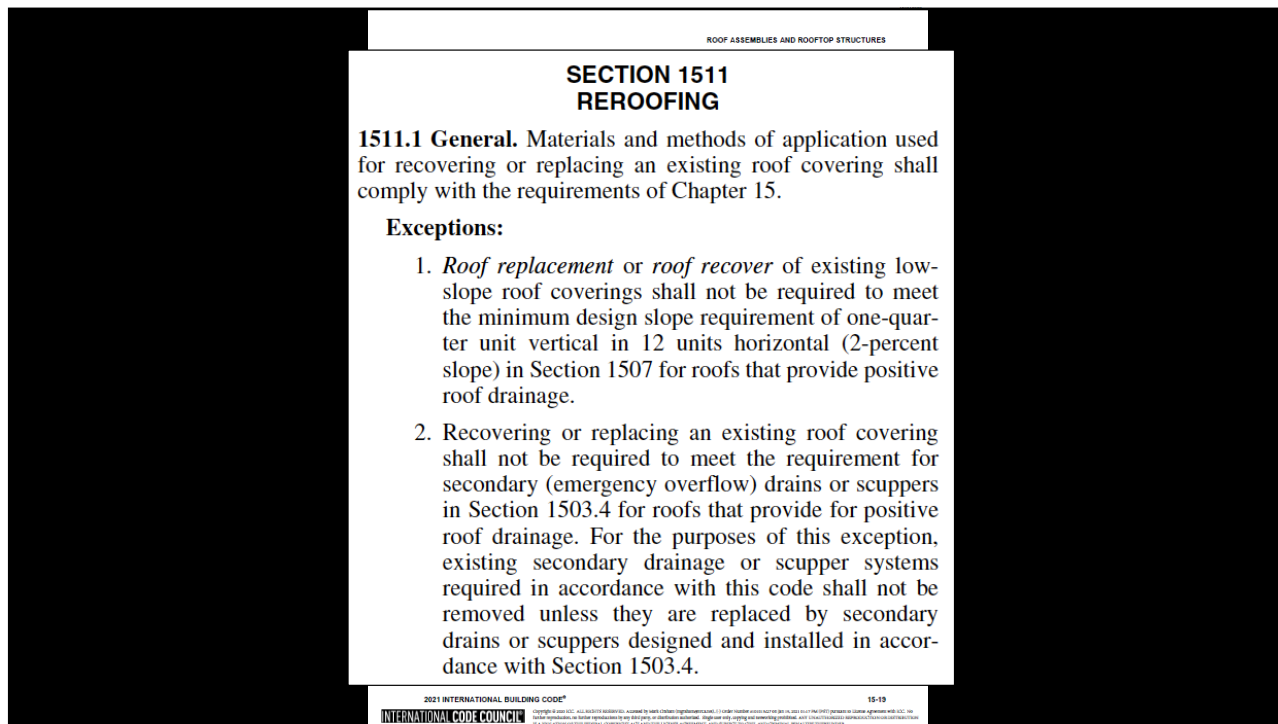
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Types of roof structures

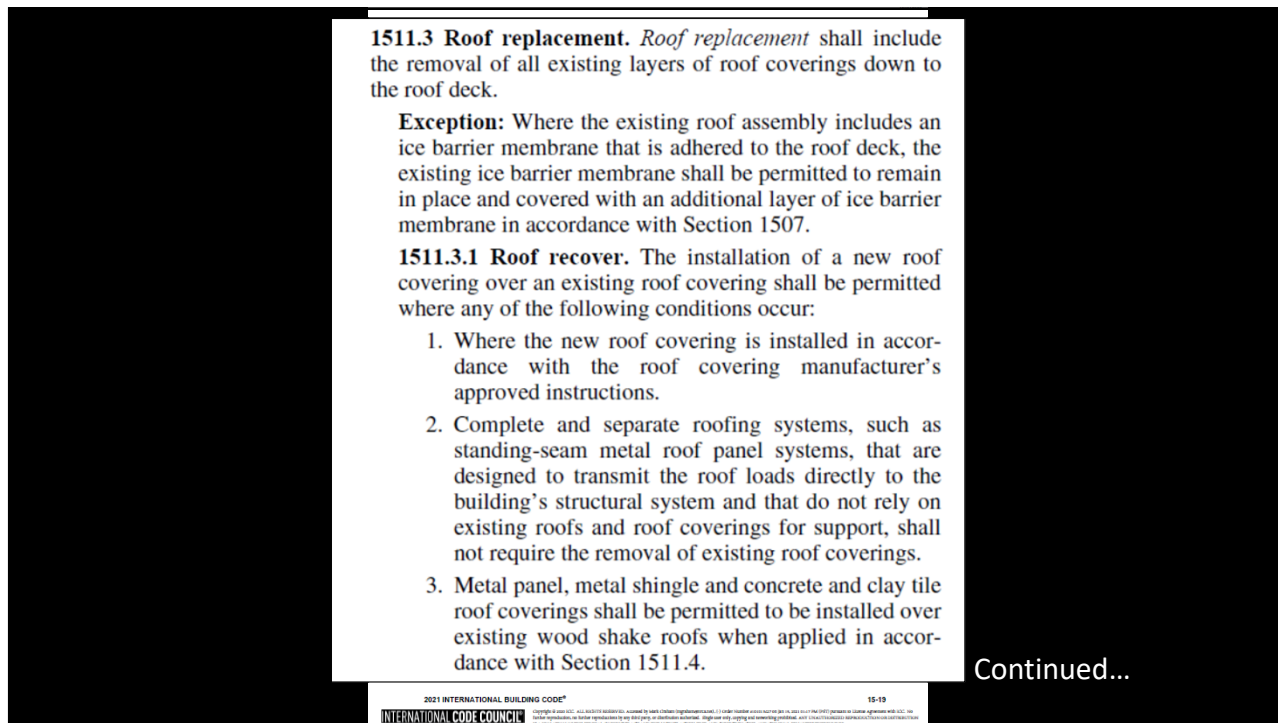
IBC 2021, Section 1511-Roof Structures

- Penthouses
- Tanks
- Cooling towers
- Towers, spires, domes and cupolas
- Mechanical equipment screens
- Photovoltaic panels and modules
- Other rooftop structures:
 - Aerial supports
 - Dormers
 - Fences
 - Flagpoles

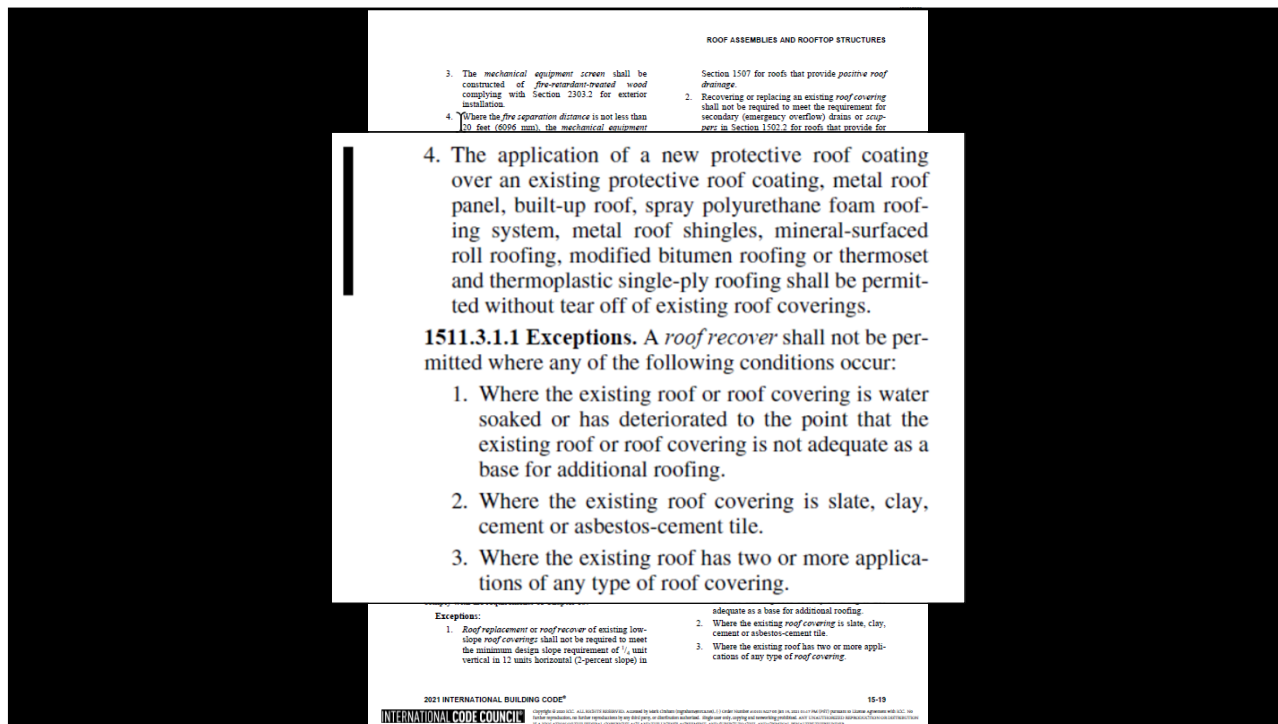
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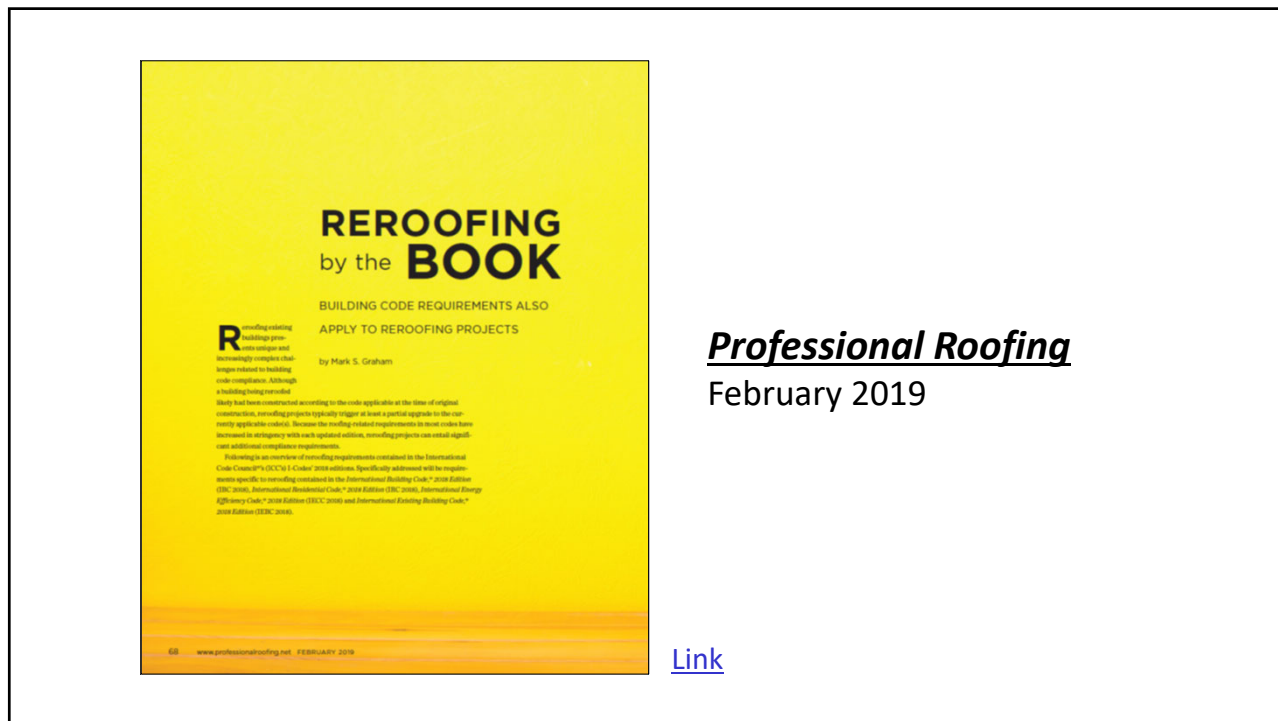
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International Residential Code, 2021 Edition



- Applicable to one- and two-family dwellings and townhouses no more than three stories in height
- Roofing-related requirements:
 - Ch. 8-Roof/ceiling construction
 - Ch. 9-Roof assemblies

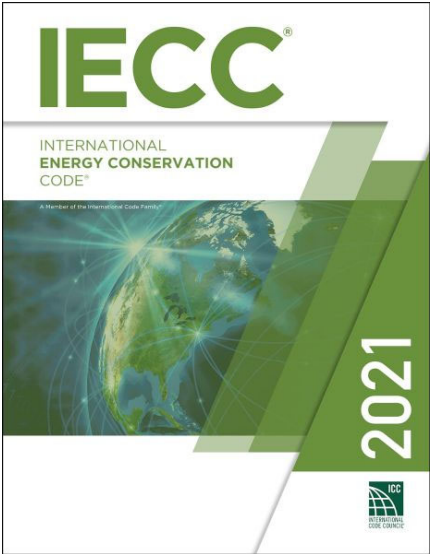
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Ch. 9-Roof assemblies

International Residential Code, 2021 Edition

- Ch. 9 closely mirrors IBC Ch. 15's requirements
- Except IRC only requires fire classified roof assemblies where:
 - Required by local ordinance
 - Roof edge is less than 3 ft. from the lot line

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Roof requirements:

- R-value
- Roof reflectivity
- Air retarder

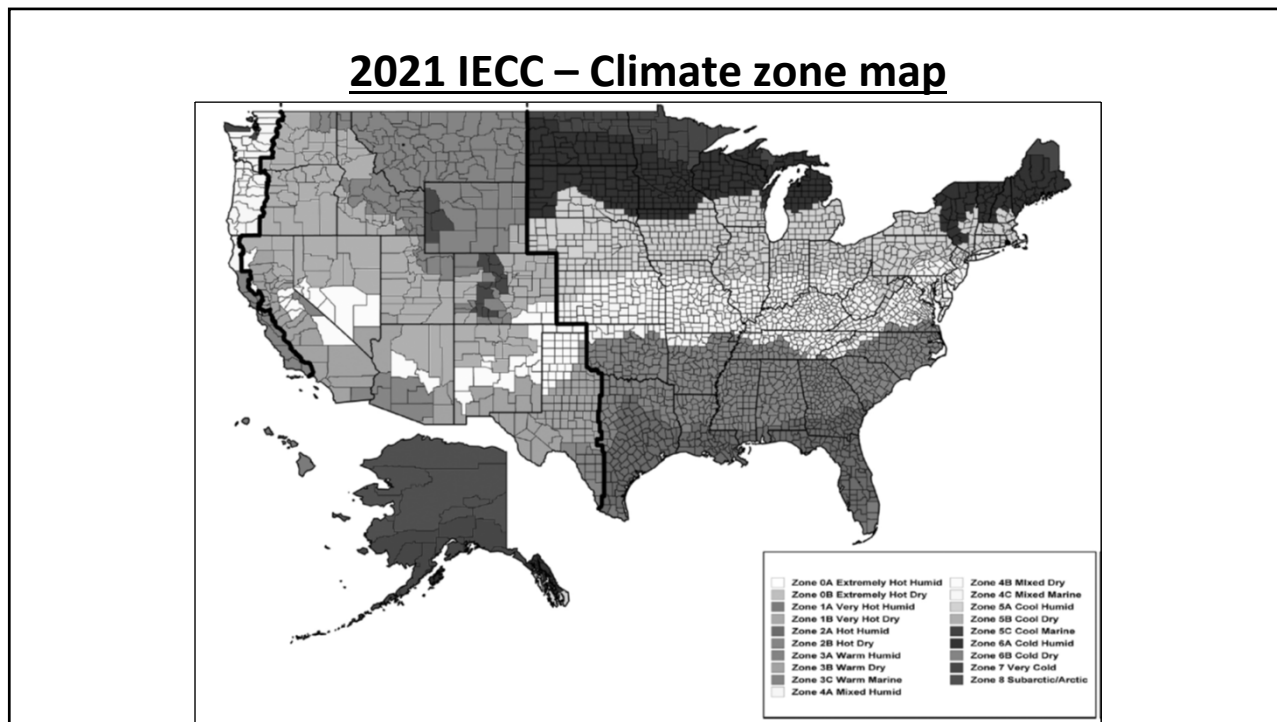
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**TABLE C402.1.3
OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD^a**

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-20ci	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 ^b	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 + 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, below grade																
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	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-15ci	R-13 + R-15ci	R-13 + R-18ci	R-13 + R-18ci
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 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-7.5ci or R-20 + R-3.8ci	R-13 + R-18ci	R-13 + R-18ci
Floors																
Below-grade wall ^c	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
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 24" below	R-20 for 48" below	R-20 for 48" below	R-20 for 48" below	R-25 for 48" below
Heated slabs ^d	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 36" below + R-5 fall slab	R-15 for 36" below + R-5 fall slab	R-15 for 36" below + R-5 fall slab	R-20 for 48" below + R-5 fall slab	R-20 for 48" below + R-5 fall slab	R-20 for 48" below + R-5 fall slab	R-20 for 48" below + R-5 fall slab	R-20 for 48" below + R-5 fall slab

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m², 1 pound per cubic foot = 16 kg/m³.
 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-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, augmented or partially augmented at 32 inches or less on center vertically and 48 inches or less on center horizontally, with augmented cores filled with material having a maximum thermal conductivity of 0.44 Btu-in-hk/ft²-°F.
 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 C402.2.3.
 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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Comparison of IECC's various editions

Commercial Buildings (Insulation component R-value-based method)

Climate Zone	IECC 2003	IECC 2006	IECC 2009	IECC 2012*	IECC 2015*	IECC 2018*
1	R-12 ci	R-15 ci	R-15 ci	R-20 ci	R-20 ci	R-20 ci
2	R-14 ci		R-20ci		R-25 ci	R-25 ci
3	R-10 ci				R-30 ci	R-30 ci
4	R-12 ci	R-20 ci	R-25 ci	R-30 ci	R-35 ci	R-35 ci
5	R-15 ci					
6	R-11 ci					
7	R-15 ci	R-25 ci	R-25 ci	R-30 ci	R-35 ci	R-35 ci
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* Applies to roof replacement projects
ci = continuous insulation

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COMMERCIAL ENERGY EFFICIENCY

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

Exception: Where the slab-on-grade floor is greater than 24 inches (61 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 Table 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 finished ground level, or to the area of the lowest floor of the conditioned space enclosed 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 concrete or exterior insulation, shall be insulated to an E-value of not less than 0.5 U or 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 the E-value of insulation installed in the exterior assembly in which they are installed or the assembly shall comply with Section C402.1.4.

Exception: 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 on its unheated cavity constructed in unheated surface 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.

Exception: 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 at an air movement rate of not less than 75 mm/second.

C402.3 Roof solar reflectance and thermal emittance. Low-sloped roofs shall have unadorned conditioned spaces in Climate Zones 0 through 3 shall comply with one or more of the options in Table C402.3.

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

1. Portions of the roof that are or are covered by the following:
 - 1.1. Photovoltaic system or component.
 - 1.2. Solar air or water-heating system or component.
 - 1.3. Vegetative roof or landscaped roof.
 - 1.4. Above-roof decks or walkways.
 - 1.5. Skylight.
 - 1.6. HVAC system and component, 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 roofs that are ballasted with a maximum mass ballast of 17 pounds per square foot (74 kg/m²) or 23 psf (117 kg/m²) pavers.
4. Roofs where not less than 75 percent of the roof area complies with one or more of the exceptions in this section.

TABLE C402.3
MINIMUM ROOF REFLECTANCE AND EMITTANCE OPTIONS*

Three-year aged solar reflectance index¹ of 17 and 3-year aged thermal emittance² of 0.75

Three-year aged solar reflectance index¹ of 64

* The use of area-weighted averages to comply with these requirements shall be permitted. Minimum lighting transmittance from the solar solar reflectance or thermal emittance shall be subject to a 3-year aged solar reflectance in accordance with Section C402.1.1 and 3-year aged solar emittance of 0.65.

1. Aged solar reflectance index is in accordance with ASTM C1363, ASTM D5033 or ASTM E1918 or CIE S010.

2. Aged thermal emittance index is in accordance with ASTM C1371 or ASTM E1918 or CIE S010.

3. Solar reference index (SRI) shall be determined in accordance with ASTM E1918 with a conversion coefficient of 1.1. $SRI = (11 W/m^2 \cdot K) \cdot (E_{solar} - E_{sky})$. Calculations of aged SRI shall be based on aged test data of solar reflectance and thermal emittance.

C402.3.1 Aged roof solar reflectance. Where an aged solar reflectance is required by Section C402.3, if not available, it shall be determined in accordance with Equation 4-2:

$$R_{solar} = [0.2 + 0.7(R_{solar,aged}) + 0.2] \quad \text{(Equation 4-2)}$$

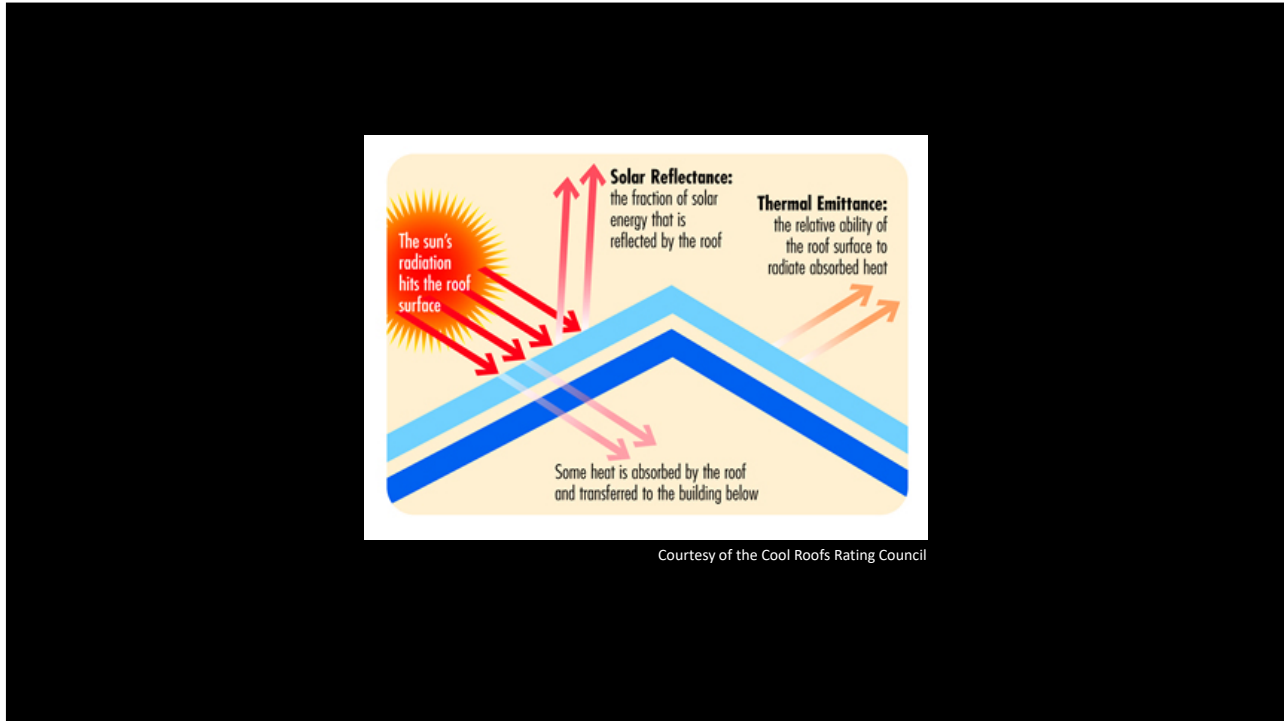
where:
 R_{solar} = The aged solar reflectance
 $R_{solar,aged}$ = The annual solar reflectance determined in accordance with Section C402.3.10.

C402.4 Fenestration. Fenestration shall comply with Sections C402.1.1 through C402.4.2 and Table C402.4. Daylight responsive controls shall comply with this section and Section C402.4.4.

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Daylight energy lighting systems shall comply with Section C402.4.5.1. Other than as specified in Section C402.4.5.1, the requirements of Section C402.4.5.1 shall apply to all other lighting systems.

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C402.4.5.1 Daylight energy lighting systems shall comply with Section C402.4.5.1. Other than as specified in Section C402.4.5.1, the requirements of Section C402.4.5.1 shall apply to all other lighting systems.

Exception: In Climate Zones 3 through 8, where construction is required through openings in an exterior wall to a room or space containing a space-conditioning load-bearing 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:
 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. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be sealed in accordance with Section C402.1.1.

COMMERCIAL ENERGY EFFICIENCY

The measured air leakage rate shall not exceed 0.40 cfm/ft² (0.2 L/s · m²) 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 leakage rate shall be weighted by the surface area 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 space directly under a roof.
2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or an below grade.
3. Representative above-grade sections of the building envelope at least 25 percent of the wall area enclosing the remaining conditioned space.

Exception: When the measured air leakage rate exceeds 0.40 cfm/ft² (0.2 L/s · m²), 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. Air 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.

C402.5.4 Air leakage of fenestration. The air leakage of fenestration assemblies shall meet the provisions of Table C402.1.4. Testing shall be in accordance with the applicable reference test standard in Table C402.1.4 by an accredited, independent testing laboratory and labeled by the manufacturer.

Exceptions:

1. Field-fabricated fenestration assemblies that are sealed in accordance with Section C402.1.1.
2. Fenestration in buildings that comply with the testing alternative of Section C402.5.4 are not required to meet the air leakage requirements in Table C402.1.4.

C402.5.5 Rooms containing fuel-burning appliances. In Climate Zones 3 through 8, where construction is required through openings in an exterior wall to a room or space containing a space-conditioning load-bearing 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:
 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. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be sealed in accordance with Section C402.1.1.

TABLE C402.1.4 MAXIMUM AIR LEAKAGE RATE FOR FENESTRATION ASSEMBLIES		
FENESTRATION ASSEMBLY	MINIMUM RATING (CFM/FT ²)	TEST PROCEDURE
Windows	0.30*	
Sliding doors	0.30*	
Swinging doors	0.30*	AAMA/WDMA/CSA101/ES1.3/A440 or NFRC 405
Tighten-weld construction wedge openings	0.30*	
Single-glaze glazing	0.30*	
Double-glaze glazing	0.30*	
Curved walls	0.68	
Transfer openings	0.68	
Construction-joint opening entrance doors	1.00	
Pressure-equalized sliding doors and pressure-equalized folding doors	1.00	NFRC 405 or ASTM E2138 at 1.77 psf (77 Pa)
Revolving doors	1.00	
Garage doors	0.40	
Folding doors	1.00	AAMA/WDMA/CSA101/ES1.3/A440 or NFRC 405 or ASTM E2138 at 1.77 psf (77 Pa)
High-speed doors	1.00	

For 0.30 cfm per square foot = 0.2 L/s · m² per square foot = 0.091 m³/h · m² per square meter = 0.00091 m³/h · m² per square meter.

* The maximum rate for windows, sliding and folding doors, and double-glazing is permitted to be 0.3 cfm per square foot of fenestration or three times what would be calculated with AAMA/WDMA/CSA101/ES1.3/A440 at 1.77 psf (77 Pa).

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How should we deal with alternatives other than what is specifically permitted by the Code?


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Alternative materials, design and methods of construction and equipment

- IBC 2021, Sec. 104.11
- IRC 2021, Sec. R104.11
- IECC 2021, Sec. C102 and Sec. R102
- IEBC 2021, Sec. 104.11
- IFC 2021, Sec. 104.9
- IPC 2021, Sec. 105.2

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RESEARCH+TECH



Consider alternatives

Code interpretations, modifications and alternatives provide some code compliance flexibility

by Mark S. Graham

Building codes by their nature tend to be relatively restrictive; they limit designs, materials and construction methods to those specifically prescribed in codes and meeting the code's performance requirements. However, most codes also contain provisions that allow code officials to accept limited, project-specific modifications and alternatives to code requirements.

You should be aware of a code's interpretation, modification and alternative acceptance provisions because these may provide a basis for acceptance of novel system designs and modifications that do not specifically comply with a code's requirements.

Alternative acceptance

In Chapter 5, Scope and Administration of the International Building Code®, 2018 Edition, Section 104.04(a) and Powers of Building Official grants a code official the authority to enforce the code, render interpretations and adopt procedures to carry the code's provisions. Such interpretations and procedures are not intended to waive code requirements.

Section 104.10, Modifications gives a code official authority to

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Link

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ICC codes accessible online

codes.iccsafe.org



The screenshot shows the ICC Codes website interface. At the top, there's a navigation bar with 'Find Codes', 'Premium Features', and 'Premium for Teams'. Below that, a search bar and a 'Sign In' button are visible. The main content area is titled 'I-Codes Building Codes' and features a grid of eight code book covers for the year 2021: IBC (International Building Code), IRC (International Residential Code), IFC (International Fire Code), IFGC (International Fuel Gas Code), IMC (International Mechanical Code), IPC (International Plumbing Code), IEBC (International Existing Building Code), and IECC (International Energy Conservation Code). A 'Premium exclusive title requires subscription to access content' message is displayed above the grid. On the right side, there's a 'Bundle and Save' section for the '2012 International Codes, Designer Collection' with a 'Subscribe today!' button. A sidebar on the left lists various categories like 'Collections', 'Commentaries', 'I-Codes', 'Legacy', 'ICBO', 'Publications', 'Resources', 'Revision History', 'Significant Changes', and 'Standards'. At the bottom right, there's a 'LIVE CHAT' and 'FEEDBACK' button.

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The screenshot shows the homepage of www.iccsafe.org. The header includes the ICC International Code Council logo, navigation links for 'Help', 'Become a Member', 'Sign In', and 'My Cart'. The main content area is titled 'FEATURED PRODUCTS' and displays a grid of code books for sale. The products listed are:

- International Codes: Wind Design Overview (ASCE 7-16 And 2018/2021 IBC) - As low as \$13.60
- International Codes: 2021 International Fuel Gas Code® - As low as \$4.90
- International Codes: 2021 International Building Code® - As low as \$7.95
- International Codes: 2021 Complete 14 Collection
- International Codes: 2021 International Residential Code®
- International Codes: 2021 International Mechanical Code®

Each product card includes an 'Add to Cart' button. A vertical sidebar on the right contains links for 'FEEDBACK', 'LIVE CHAT', and social media icons for Twitter, Facebook, and LinkedIn.

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