Denver, CO – Wednesday, December 17, 2014

Technical update

presented by

Mark S. Graham
Associate Executive Director, Technical Services
National Roofing Contractors Association

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Topics

- Building code issues
- Energy code update
- Technical issue update
- Questions

2

Building code requirements applicable to roof assemblies

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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)
- The code can also provide a basis for construction claims-related litigation

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Code enforcement

- AHJ's code official
- Construction litigation

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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 & Flatt

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Who is responsible for compliance?

- The building owner
- And, everyone else involved

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AIA General Conditions

AIA A201 – General Conditions of The Contract for Construction

Article 3 Contractor

3.2.3 The Contractor is not required to ascertain that the Contract Documents are in accordance with applicable laws, statues, ordinances, codes, rules and regulations, or lawful orders of public authorities, but the Contractor shall promptly report to the Architect any nonconformity discovered by and made known to the Contractor as a request for information in such a form as the Architect may require.

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AIA General Conditions

AIA A201 – General Conditions of The Contract for Construction

3.2.4 …If the Contractor fails to perform the obligations of Sections 3.2.2 or 3.2.3, the Contractor shall pay the costs and damages to the Owner as would have been avoided if the Contractor had performed such obligations. If the Contractor performs those obligations, the Contractor shall not be liable to the Owner or Architect for damages …for nonconformities of the Contract Documents to… codes…

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International Building Code, 2012 Edition (IBC 2012)

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International Building Code, 2012 Edition

101.2 Scope. The provisions of this code shall apply to the construction, *alteration,* relocation, enlargement, replacement*, repair,* equipment, use and occupancy, location, maintenance, removal and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures.

Exception: Detached one- and two-family *dwellings* and multiple single-family *dwellings* (townhouses) not more than three *stories* above *grade plane* in height with a separate *means of egress* and their accessory structures shall comply with the *International Residential Code.*

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International Building Code, 2012 Edition

Specific roofing-related requirements

- Ch. 12-Interior Environment (attic ventilation)
- Ch. 13-Energy Efficiency (thermal insulation)
- Ch. 15-Roof Assemblies and Rooftop Structures
- Ch. 16-Structural Design (design loads)
- Ch. 22-Steel (structural metal panel roofing)
- Ch. 24-Glass and Glazing (skylights)
- Ch. 26-Plastic (foam plastic insulation)
- Ch. 35-Referenced Standards

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Ch. 15-Roof Assemblies and Rooftop Structures

International Building Code, 2012 Edition

SECTION 1501

GENERAL

1501.1 Scope. The provisions of this chapter shall govern the design, materials, construction and quality of roof assemblies and rooftop structures.

Building code requirements for vegetative roof systems and rooftop PV are in Ch. 15

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Ch. 15-Roof Assemblies and Rooftop Structures

International Building Code, 2012 Edition

- Sec. 1501-Scope
- Sec. 1502-Defintions
- Sec. 1503-Weather Protection
- Sec. 1504-Performance Requirements (wind)
- Sec. 1505-Fire Classification
- Sec. 1506-Materials
- Sec. 1507-Requirements for Roof Coverings
- Sec. 1508-Roof Insulation
- Sec. 1509-Rooftop Structures
- Sec. 1510-Reroofing

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Roofing-related building code provisions addressed in this presentation

- Reroofing
- Prescriptive requirements
- Fire resistance
- Wind-uplift resistance
- Alternate approval

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Sec. 1510-Reroofing

International Building Code, 2012 Edition

1510.1 General. Materials and methods of application used for recovering or replacing an existing roof covering shall comply with the requirements of Chapter 15.

Exception: Reroofing shall not be required to meet the minimum design slope requirement of one-quarter unit vertical in 12 units horizontal (2-percent slope) in Section 1507 for roofs that provide positive roof drainage.

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Sec. 1510-Reroofing

International Building Code, 2012 Edition

1510.3 Recovering versus replacement. New roof coverings shall not be installed without first removing all existing layers of roof coverings down to the roof deck where any of the following conditions occur:

1. Where the existing roof or roof covering is water soaked or has deteriorated to the point that the existing roof or roof covering is not adequate as a base for additional roofing.
2. Where the existing roof covering is wood shake, slate, clay, cement or asbestos-cement tile.
3. Where the existing roof has two or more applications of any type of roof covering.

Exceptions:…

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Prescriptive requirements

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Sec. 1503-Weather Protection

International Building Code, 2012 Edition

1503.6 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: Unit skylights installed in accordance with Section 2405.5 and flashed in accordance with the manufacturer's instructions shall be permitted to be installed without a cricket or saddle.

Unit skylights need to comply with AAMA/WDMA/CSA 101/I.S./A440

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Sec. 1506-Materials

International Building Code, 2012 Edition

1506.1 Scope. The requirements set forth in this section shall apply to the application of roof-covering materials specified herein. Roof coverings shall be applied in accordance with this chapter and the manufacturer's installation instructions. Installation of roof coverings shall comply with the applicable provisions of Section 1507.

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Sec. 1507-Requirements for Roof Coverings

International Building Code, 2012 Edition

- Asphalt shingles
- Clay & concrete tile
- Metal roof panels
- Metal roof shingles
- Roll roofing
- Slate shingles
- Wood shingles
- Wood shakes
- Built-up roofs
- Modified bitumen roofs
- Thermoset single-ply roofs
- Thermosplastic single-ply roofs
- SPF roofs
- Liquid-applied roofing
- Roof gardens/landscaped roofs
- Photovoltaic modules/shingles

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Fire resistance

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Sec. 1505-Fire Classification

International Building Code, 2012 Edition

1505.1 General. Roof assemblies shall be divided into the classes defined below. Class A, B and C roof assemblies and roof coverings required to be listed by this section shall be tested in accordance with ASTM E 108 or UL 790. In addition, fire-retardant-treated wood roof coverings shall be tested in accordance with ASTM D 2898. 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.

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Sec. 1505-Fire Classification

International Building Code, 2012 Edition

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 m^2.

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 in height 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.

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Sec. 1505-Fire Classification

International Building Code, 2012 Edition

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 noncombustible decks or ferrous, copper or metal sheets installed without a roof deck on noncombustible framing.
3. Class A roof assemblies include 16 oz/sq. ft. (0.0416 kg/m^2) copper sheets installed over combustible decks.

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Wind-uplift resistance

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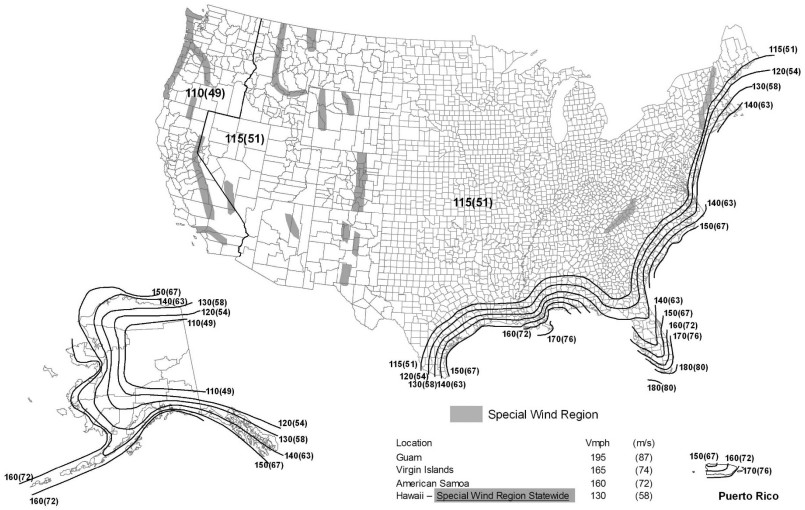
Design wind speed

IBC 2012, Fig. 1607A--V_{ult} for Risk Category II Buildings



Sec. 1504-Performance Requirements

International Building Code, 2012 Edition

1504.3 Wind resistance of nonballasted roofs. Roof coverings installed on roofs in accordance with Section 1507 that are mechanically attached or adhered to the roof deck shall be designed to resist the design wind load pressures for components and cladding in accordance with Section 1609.

1504.3.1 Other roof systems. Roof systems with built-up, modified bitumen, fully adhered or mechanically attached single-ply through fastened metal panel roof systems, and other types of membrane roof coverings shall also be tested in accordance with FM 4474, UL 580 or UL 1897.

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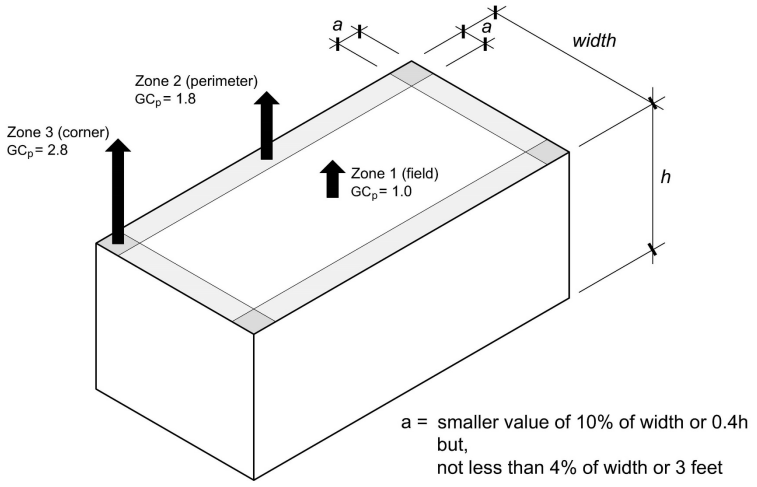
Design wind load pressures

ASCE 7-10 (Roof slope ≤ 1.5:12)



a = smaller value of 10% of width or 0.4h
but,
not less than 4% of width or 3 feet

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Design wind load pressures

International Building Code, 2012 Edition

SECTION 1603

CONSTRUCTION DOCUMENTS

1603.1 General. *Construction documents* shall show the size, section and relative locations of structural members with floor levels, column centers and offsets dimensioned. The design loads and other information pertinent to the structural design required by Sections 1603.1.1 through 1603.1.9 shall be indicated on the *construction documents.*

[continued…]

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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. Ultimate design wind speed, V_{ult}, *(3-second gust),* miles per hour (km/hr) and nominal design wind speed, V_{asd}, as determined in accordance with Section 1609.3.1.
2. *Risk category.*
3. Wind exposure. Where more than one wind exposure is utilized, the wind exposure and applicable wind direction shall be indicated.
4. The applicable internal pressure coefficient.
5. Components and cladding. The design wind pressures in terms of psf (kN/m^2) to be used for the design of exterior component and cladding materials not specifically designed by the *registered design professional.*

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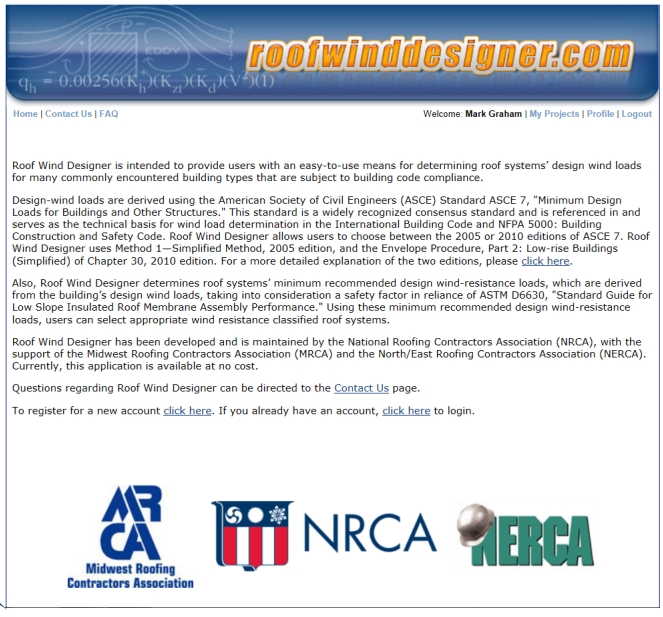
www.roofwinddesigner.com



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1504.3.1 Other roof systems. Roof systems with built-up, modified bitumen, fully adhered or mechanically attached single-ply through fastened metal panel roof systems, and other types of membrane roof coverings shall also be tested in accordance with FM 4474, UL 580 or UL 1897.

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Wind uplift test methods

FM Approvals (FM)

FM 4474:

- Class 60 (30 psf field)
- Class 90 (45 psf field)
- Class 120 (60 psf field)
- Class 150 (75 psf field)
- Class 180 (90 psf field)
- and on, and on….

Underwriters Laboratories (UL)

UL 580 and UL 1897:

- Class 30 (30 psf)
- Class 60 (60 psf)
- Class 90 (90 psf)

Wind uplift testing at and certification by FM or UL is not required by the Code

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Sec. 1504-Performance Requirements

International Building Code, 2012 Edition

1504.3.2 Metal panel roof systems. Metal panel roof systems through fastened or standing seam shall be tested in accordance with UL 580 or ASTM E 1592.

Exception: Metal roofs constructed of cold-formed steel, where the roof deck acts as the roof covering and provides both weather protection and support for structural loads, shall be permitted to be designed and tested in accordance with the applicable referenced structural design standard in Section 2210.1.

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Sec. 1504-Performance Requirements

International Building Code, 2012 Edition

1504.4 Ballasted low-slope roof systems. Ballasted lowslope (roof slope < 2:12) single-ply roof system coverings installed in accordance with Sections 1507.12 and 1507.13 shall be designed in accordance with Section 1504.8 and ANSI/SPRI RP-4.

ANSI/SPRI RP-4 is available on SPRI's website: www.spri.org

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Sec. 1504-Performance Requirements

International Building Code, 2012 Edition

1504.8 Aggregate. Aggregate used as surfacing for roof coverings and aggregate, gravel or stone used as ballast shall not be used on the roof of a building located in a hurricane-prone region as defined in Section 202, or on any other building with a mean roof height exceeding that permitted by Table 1504.8 based on the exposure category and basic wind speed at the site.

[Continued…]

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TABLE 1504.8
MAXIMUM ALLOWABLE MEAN ROOF HEIGHT PERMITTED FOR BUILDINGS WITH AGGREGATE ON THE ROOF IN AREAS OUTSIDE A HURRICANE-PRONE REGION

NOMINAL DESIGN WIND SPEED, V_{asd} (mph)[b, d]	MAXIMUM MEAN ROOF HEIGHT (ft)[a, c]		
	Exposure category		
	B	C	D
85	170	60	30
90	110	35	15
95	75	20	NP
100	55	15	NP
105	40	NP	NP
110	30	NP	NP
115	20	NP	NP
120	15	NP	NP
Greater than 120	NP	NP	NP

For SI: 1 foot = 304.8 mm; 1 mile per hour = 0.447 m/s.

a. Mean roof height as defined in ASCE 7.

b. For intermediate values of V_{asd}, the height associated with the next higher value of V_{asd} shall be used, or direct interpolation is permitted.

c. NP = gravel and stone not permitted for any roof height.

d. V_{asd} shall be determined in accordance with Section 1609.3.1.

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Alternate approval

IBC 2012, Sec. 104.11

104.11 Alternative materials, design and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

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104.11.1 Research reports. Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from approved sources.

104.11.2 Tests. Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the building official shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the building official shall approve the testing procedures. Tests shall be performed by an approved agency. Reports of such tests shall be retained by the building official for the period required for retention of public records.

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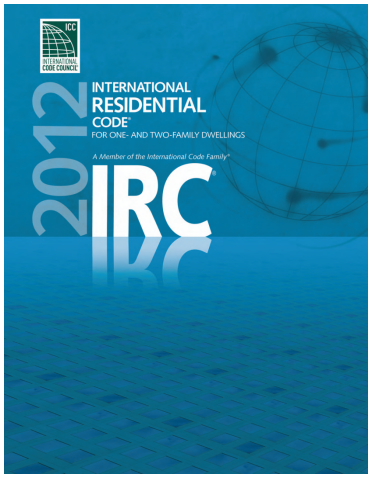
International Residential Code, 2012 Edition (IRC 2012)



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International Residential Code, 2012 Edition

- Chapter 9-Roof Assemblies
- Similar to IBC 2012, Chapter 15
- Required fire classification by local ordinance
- More prescriptive-based language

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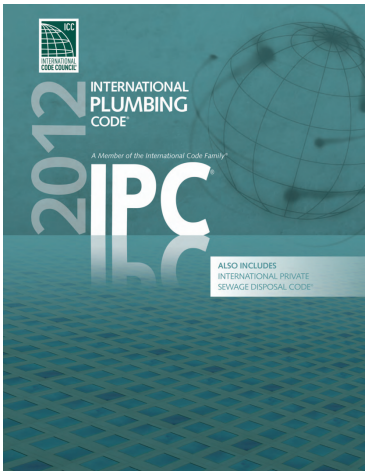
International Plumbing Code, 2012 Edition (IPC 2012)



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International Plumbing Code, 2012 Edition

Roof drain, drain piping, scupper, gutter and downspout sizing is dictated by the *International Plumbing Code.*

IPC Chapter 11-Storm Drainage

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International Fire Code, 2012 Edition (IFC 2012)

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International Fire Code, 2012 Edition

Fire safety during roofing operations, and rooftop PV and vegetative roof systems are dictated by the *International Fire Code.*

IFC Sec. 303-Kettles (e.g., ≥ 20 ft.)
IFC Sec. 3317-Safegauarding Roofing Operations
IFC Sec. 605.11-Solar Photovoltaic Power Systems
IFC Sec. 317-Rooftop Gardens and Landscaped Roofs

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In summary

- Be knowledgeable of applicable codes
- Watch for state/local modifications
- Comply with the applicable codes
- Building/Residential Code
- Plumbing Code
- Fire Code

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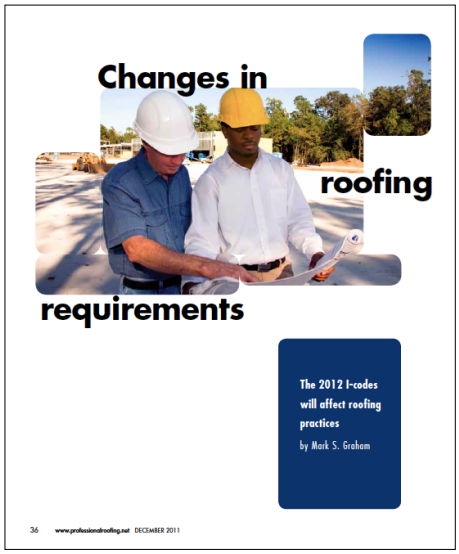
Professional Roofing, December 2011



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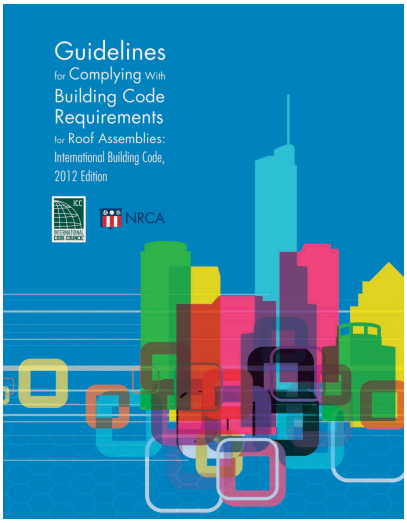
Building Codes Manual (2012 Codes)



- Based on 2012 I-codes:
  - IBC 2012
  - IRC 2012
  - IECC 2012
  - IPC 2012
  - IFC 2012
- Includes roofing-related code text and NRCA commentary on each section
- Co-branded with ICC; NRCA promotes to industry and ICC promotes to code officials

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Energy code requirements applicable to roof assemblies

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Some history…

Energy efficiency of buildings

- 1973: Arab oil embargo
- 1974: NBS Interim Report 74-452 (prelim. criteria)
- 1975: ASHRAE 90-75 (energy-efficiency std.)
- 1977: BOCA/ICBO/SBCCI code (CABO *MEC*)
- 1980: ASHRAE 90-80
- 1989: ASHRAE 90.1-89
- 1992: Energy Policy Act (EPAct)
- 1998: *International Energy Conservation Code*
- 1999: ASHRAE 90.1-99

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More recent history…

Energy efficiency in buildings

- 2004: ASHRAE 90.1-04
- 2006: *International Energy Conservation Code, 2006 Edition*
- 2007: ASHRAE 90.1-07
- 2009: *International Energy Conservation Code, 2009 Edition*
- 2009: ASHRAE 189.1-09
- 2010: ASHRAE 90.1-10
- 2011: *International Energy Conservation Code, 2012 Edition*
- 2013: ASHRAE 90.1-13
- 2014: *International Energy Conservation Code, 2015 Edition*

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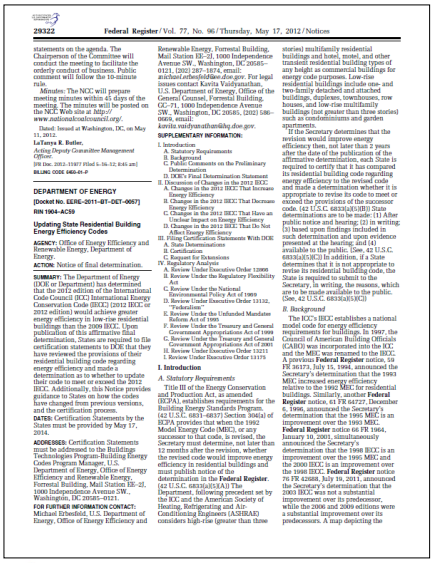
Federal Register, May 17, 2012



29322 Federal Register / Vol. 77, No. 96 / Thursday, May 17, 2012 / Notices

statements on the agenda. The Chairperson of the Committee will conduct the meeting to facilitate the orderly conduct of business. Public comment will follow the 10-minute rule.

Minutes: The NCC will prepare meeting minutes within 45 days of the meeting. The minutes will be posted on the NCC Web site at *http://www.nationalcoalcouncil.org/*.

Dated: Issued at Washington, DC, on May 11, 2012.

LaTanya R. Butler,

Acting Deputy Committee Management Officer.

[FR Doc. 2012-11977 Filed 5-16-12; 8:45 am]

BILLING CODE 0450-01-P

DEPARTMENT OF ENERGY

[Docket No. EERE-2011-BT-DET-0057]

RIN 1904-AC59

Updating State Residential Building Energy Efficiency Codes

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Notice of final determination.

SUMMARY: The Department of Energy (DOE or Department) has determined that the 2012 edition of the International Code Council (ICC) International Energy Conservation Code (IECC) (2012 IECC or 2012 edition) would achieve greater energy efficiency in low-rise residential buildings than the 2009 IECC. Upon publication of this affirmative final determination, States are required to file certification statements to DOE that they have reviewed the provisions of their residential building code regarding energy efficiency and made a determination as to whether to update their code to meet or exceed the 2012 IECC. Additionally, this Notice provides guidance to States on how the codes have changed from previous versions, and the certification process.

DATES: Certification Statements by the States must be provided by May 17, 2014.

ADDRESSES: Certification Statements must be addressed to the Buildings Technologies Program-Building Energy Codes Program Manager, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Forrestal Building, Mail Station EE–2J, 1000 Independence Avenue SW., Washington, DC 20585–0121. (202) 287–1874, email: *michael.rosenberg@ee.doe.gov*. For legal issues contact Kavita Vaidyanathan, U.S. Department of Energy, Office of the General Counsel, Forrestal Building, GC–71, 1000 Independence Avenue SW., Washington, DC 20585, (202) 586-0669, email: *kavita.vaidyanathan@hq.doe.gov*.

SUPPLEMENTARY INFORMATION:

I. Introduction
- A. Statutory Requirements
- B. Background
- C. Public Comments on the Preliminary Determination
- D. DOE's Final Determination Statement

II. Discussion of Changes in the 2012 IECC
- A. Changes in the 2012 IECC That Increase Energy Efficiency
- B. Changes in the 2012 IECC That Decrease Energy Efficiency
- C. Changes in the 2012 IECC That Have an Unclear Impact on Energy Efficiency
- D. Changes in the 2012 IECC That Do Not Affect Energy Efficiency

III. Filing Certification Statements With DOE
- A. Who Must Submit
- B. Certification
- C. Request for Extensions

IV. Regulatory Analysis
- A. Review Under Executive Order 12866
- B. Review Under the Regulatory Flexibility Act
- C. Review Under the National Environmental Policy Act of 1969
- D. Review Under Executive Order 13132, Federalism
- E. Review Under the Unfunded Mandates Reform Act of 1995
- F. Review Under the Treasury and General Government Appropriations Act of 1999
- G. Review Under the Treasury and General Government Appropriations Act of 2005
- H. Review Under Executive Order 13211
- I. Review Under Executive Order 13175

I. Introduction

A. Statutory Requirements

Title III of the Energy Conservation and Production Act, as amended (ECPA), establishes requirements for the Building Energy Standards Program. (42 U.S.C. 6831–6837) Section 304(a) of ECPA provides that when the 1992 Model Energy Code (MEC), or any successor to that code, is revised, the Secretary must determine, not later than 12 months after the revision, whether the revised code would improve energy efficiency in residential buildings and must publish notice of the determination in the **Federal Register**. (42 U.S.C. 6833(a)(5)(A)) The Department, following precedent set by the ICC and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) considers high-rise (greater than three stories) multifamily residential buildings and hotel, motel, and other transient residential building types of any height as commercial buildings for energy code purposes. Low-rise residential buildings include one- and two-family detached and attached buildings, duplexes, townhouses, row houses, and low-rise multifamily buildings (not greater than three stories) such as condominiums and garden apartments.

If the Secretary determines that the revision would improve energy efficiency then, not later than 2 years after the date of the publication of the affirmative determination, each State is required to certify that it has compared its residential building code regarding energy efficiency to the revised code and made a determination whether it is appropriate to revise its code to meet or exceed the provisions of the successor code. (42 U.S.C. 6833(a)(5)(B)) State determinations are to be made: (1) After public notice and hearing; (2) in writing; (3) based upon findings included in such determination and upon evidence presented at the hearing; and (4) available to the public. (See, 42 U.S.C. 6833(a)(5)(C)) In addition, if a State determines that it is not appropriate to revise its residential buildingcode, the State is required to submit to the Secretary, in writing, the reasons, which are to be made available to the public. (See, 42 U.S.C. 6833(a)(5)(C))

B. Background

The ICC's IECC establishes a national model code for energy efficiency requirements for buildings. In 1997, the Council of American Building Officials (CABO) was incorporated into the ICC and the MEC was renamed to the IECC. A previous **Federal Register** notice, 59 FR 36173, July 15, 1994, announced the Secretary's determination that the 1993 MEC increased energy efficiency relative to the 1992 MEC for residential buildings. Similarly, another **Federal Register** notice, 61 FR 64727, December 6, 1996, announced the Secretary's determination that the 1995 MEC is an improvement over the 1993 MEC. **Federal Register** notice 66 FR 1964, January 10, 2001, simultaneously announced the Secretary's determination that the 1998 IECC is an improvement over the 1995 MEC and the 2000 IECC is an improvement over the 1998 IECC. **Federal Register** notice 76 FR 42688, July 19, 2011, announced the Secretary's determination that the 2003 IECC was not a substantial improvement over its predecessor, while the 2006 and 2009 editions were a substantial improvement over its predecessors. A map depicting the

Key points:

- US DOE has determined IECC 2012 will achieve greater energy efficiency in low-rise residential buildings than IECC 2009
- States must certify by 5/17/14 their energy code meets or exceeds the levels of IECC 2012

This triggers most states to update their state energy code

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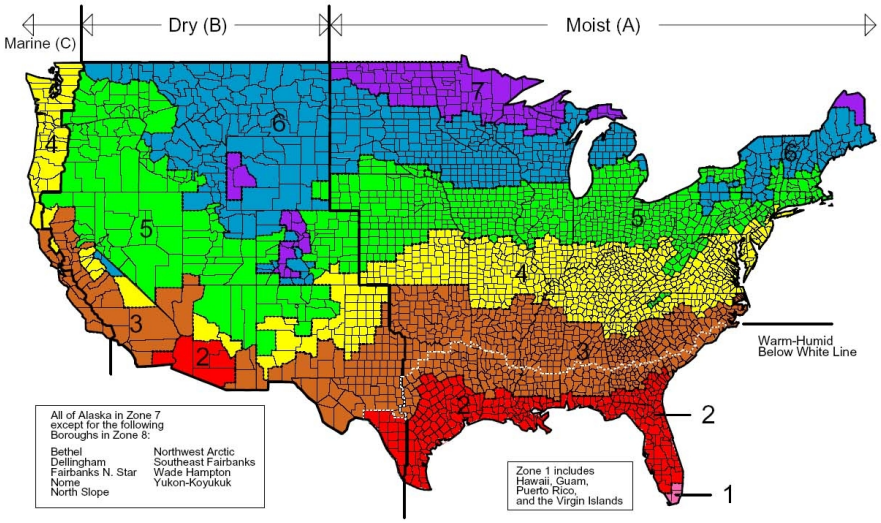
Climate zones

IECC 2009 and IECC 2012



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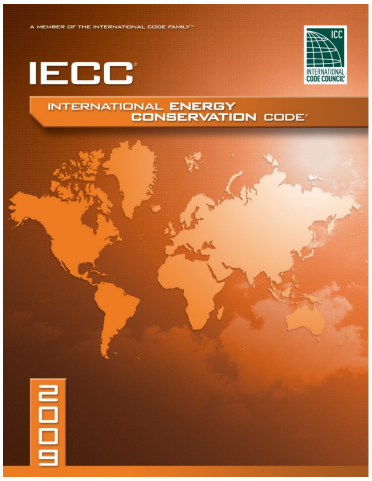
International Energy Conservation Code, 2009 Edition (IECC 2009)



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Roofing-specific adaptation of Table 402.1.1

International Energy Conservation Code, 2009 Edition (Residential buildings)

Insulation and Fenestration Requirements by Component[a]	
Climate zone	**Ceiling R-value**
1	30
2	
3	
4	38
5	
6	49
7	
8	
[a] R-values are minimums. … [Other footnotes omitted for clarity]	

56

Roofing-specific adaptation of Table 502.2(1)

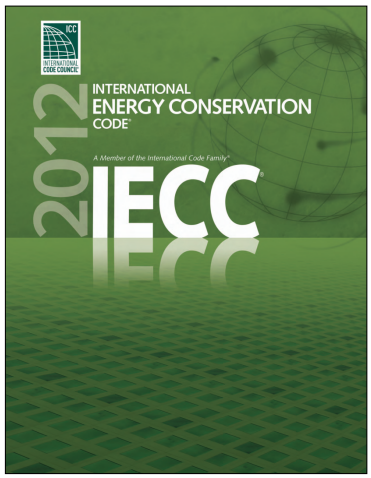
International Energy Conservation Code, 2009 Edition (Commercial buildings)

Opaque Thermal Envelope Assembly Requirements			
Climate zone	**Roof assembly configuration**		
	Insulation entirely above deck	**Metal buildings (with R-5 thermal blocks)**	**Attic and other**
1	R-15ci	R-19	R-30
2	R-20ci	R-13 + R-13	R-38
3			
4			
5			
6		R-13 + R-19	
7	R-25ci		
8			R-49

ci = Continuous insulation
LS = Liner system (a continuous membrane installed below the purlins and uninterrupted by framing members; uncompressed, faced insulation rests on top of the membrane between the purlins)

57 CRA Colorado Roofing Association NRCA

International Energy Conservation Code, 2012 Edition (IECC 2012)



58 CRA Colorado Roofing Association NRCA

Format of IECC 2012

IECC – Commercial

Ch. 1[CE]: Scope and Admin.
Ch. 2[CE]: Definitions
Ch. 3[CE]: General Req.
Ch. 4[CE]: Commercial Energy Efficiency
Ch. 5[CE]: Referenced Stds.
Index

IECC – Residential

Ch. 1[RE]: Scope and Admin.
Ch. 2[RE]: Definitions
Ch. 3[RE]: General Req.
Ch. 4[RE]: Residential Energy Efficiency
Ch. 5[RE]: Referenced Stds.
Index

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Commercial vs. Residential

- Commercial unless Residential
- R202-General Definitions:

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

60

IECC – Residential Provisions

61

Ch. 4[RE]—Residential Energy Efficiency

International Energy Conservation Code, 2012 Edition

- Sec. R401—General
- Sec. R402—Building Thermal Envelope
- Sec. R403—Systems
- Sec. R404—Electrical Power and Lighting Systems
- Sec. R405—Simulated Performance Alternative

62

Minimum thermal insulation requirements

IECC 2012, Section R402-Building Thermal Envelope

R402.1 General (Prescriptive). The *building thermal envelope* shall meet the requirements of Sections R402.1.1 through R402.1.4.

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

R402.1.2 *R*-value computation. Insulation material used in layers, such as framing cavity insulation and insulated sheathing, shall be summed to compute the component *R*-value. The manufacturer's settled *R*-value shall be used for blown insulation. Computed *R*-values shall not include an R-value for other building materials or air films

63 CRA Colorado Roofing Association NRCA

Roofing-specific adaptation of Table R402.1.1

International Energy Conservation Code, 2012 Edition

Insulation and Fenestration Requirements by Component[a]	
Climate zone	**Ceiling R-value**
1	30
2	38
3	
4	49
5	
6	
7	
8	
[a] R-values are minimums. … [Other footnotes omitted for clarity]	

64 CRA Colorado Roofing Association NRCA

R402.2 Specific insulation requirements (Prescriptive). In addition to the requirements of Section R402.1, insulation shall meet the specific requirements of Sections R402.2.1 through R402.2.12.

R402.2.1 Ceilings with attic spaces. When Section R402.1.1 would require R-38 in the ceiling, R-30 shall be deemed to satisfy the requirement for R-38 wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Similarly, R-38 shall be deemed to satisfy the requirement for R-49 wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the U-factor alternative approach in Section R402.1.3 and the total UA alternative in Section R402.1.4.

CRA Colorado Roofing Association NRCA 65

R402.2.2 Ceilings without attic spaces. Where Section R402.1.1 would require insulation levels above R-30 and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation for such roof/ceiling assemblies shall be R-30. This reduction of insulation from the requirements of Section R402.1.1 shall be limited to 500 square feet (46 m^2) or 20 percent of the total insulated ceiling area, whichever is less. This reduction shall not apply to the U-factor alternative approach in Section R402.1.3 and the total UA alternative in Section R402.1.4.

R402.2.3 Eave baffle. For air permeable insulations in vented attics, a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain an opening equal 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.

CRA Colorado Roofing Association NRCA 66

Air retarders

IECC 2012, Section R402.4-Air Leakage (Mandatory)

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

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

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

R402.4.1.2 Testing. The building or dwelling unit shall be tested and verified as having an air leakage rate of not exceeding 5 air changes per hour in Climate Zones 1 and 2, and 3 air changes per hour in Climate Zones 3 through 8. Testing shall be conducted…

Roofing-specific adaptation of Table R402.4.1.1

International Energy Conservation Code, 2012 Edition

Air Barrier and Insulation Installation	
Component	**Criteria**
Air barrier and thermal barrier	A continuous air barrier shall be installed in the building envelope. Exterior thermal envelope contains a continuous air barrier. Breaks or joints sin the bar barrier shall be sealed. Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier sealed. Access openings, drop down stair or knee wall doors to unconditioned attic spaces shall be sealed.

68

IECC – Commercial Provisions

69

Ch. 4[CE]—Commercial Energy Efficiency

International Energy Conservation Code, 2012 Edition

- Sec. C401—General
- Sec. C402—Building Envelope Requirements
- Sec. C403—Building Mechanical Systems
- Sec. C404—Service Water Heating
- Sec. C405—Electrical Power and Lighting Systems
- Sec. C406—Additional Efficiency Package Options
- Sec. C407—Total Building Performance

70

Ch. 4—Commercial Energy Efficiency

International Energy Conservation Code, 2012 Edition

C401.2 Application. Commercial buildings shall comply with one of the following:

1. The requirements of ANSI/ASHRAE/IESNA 90.1
2. The requirements of Sections C402, C403, C404 and C405. In addition, commercial buildings shall comply with either Section C406.2, C406.3 or C406.4
3. The requirements of Section C407, C402.4, C403.2, C404, C405.2, C405.3, C405.4, C405.6 and C405.7. The building energy cost shall be equal to or less than 85 percent of the standard reference design building.

[Continued…]

71 CRA Colorado Roofing Association NRCA

C401.2.1 Application to existing buildings. Additions, alterations and repairs to existing buildings shall comply with one of the following:

1. Sections C402, C403, C404 and C405; or
2. ANSI/ASHRAE/IESNA 90.1

72 CRA Colorado Roofing Association NRCA

Minimum thermal insulation requirements

IECC 2009, Section C402.2—Specific insulation Requirements (Prescriptive)

C402.2 Specific insulation requirements (Prescriptive). Opaque assemblies shall comply with Table C402.2. Where two or more layers of continuous insulation board are used in a construction assembly, the continuous insulation boards shall be installed in accordance with Section C303.2. If the continuous insulation board manufacturer's installation instructions do not address installation of two or more layers, the edge joints between each layer of continuous insulation boards shall be staggered.

73 CRA Colorado Roofing Association NRCA

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 C402.2, based on construction materials used in the roof assembly. Skylight curbs shall be insulated to the level of roofs with insulation entirely above deck or R-5, whichever is less.

Exceptions:

1. Continuously insulated roof assemblies where the thickness of insulation varies 1 inch (25 mm) or less and where the area-weighted *U-factor is* equivalent to the same assembly with the *R-value* specified in Table C402.2.
2. Unit skylight curbs included as a component of an NFRC 100 rated assembly shall not be required to be insulated.

Insulation installed on a suspended ceiling with removable ceiling tiles shall not be considered part of the minimum thermal resistance of the roof insulation.

74 CRA Colorado Roofing Association NRCA

Roofing-specific adaptation of Table C402.2

International Energy Conservation Code, 2012 Edition

Opaque Thermal Envelope Assembly Requirements			
Climate zone	**Roof assembly configuration**		
	Insulation entirely above deck	**Metal buildings (with R-5 thermal blocks)**	**Attic and other**
1	R-20ci	R-19 + R-11 LS	R-38
2			
3			
4	R-25 ci		
5			
6	R-30ci	R-25 + R-11 LS	R-49
7	R-35ci	R-30 + R-11 LS	
8			

ci = Continuous insulation
LS = Liner system (a continuous membrane installed below the purlins and uninterrupted by framing members; uncompressed, faced insulation rests on top of the membrane between the purlins)

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R-value determination

IECC 2012, Section C303.1.4-Insulation Product Rating

C303.14 Insulation product rating. The thermal resistance (R-value) of insulation shall be determined in accordance with the U.S. Federal Trade commission R-value rule (CFR Title 16, Part 460) in units of h x ft^2 x ˚F/Btu at a mean temperature of 75˚F (24˚C).

What about tapered insulation?

76 CRA Colorado Roofing Association NRCA

Tapered insulation

International Energy Conservation Code, 2012 Edition

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 C402.2, based on construction materials used in the roof assembly. Skylight curbs shall be insulated to the level of roofs with insulation entirely above deck or R-5, whichever is less.

Exceptions:

1. Continuously insulated roof assemblies where the thickness of insulation varies 1 inch (25 mm) or less and where the area-weighted *U-factor is* equivalent to the same assembly with the *R-value* specified in Table C402.2.
2. …

IECC Commentary indicates Exception 1 applies to tapered insulation systems.

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2012 IECC Code and Commentary

Tapered insulation

"…The exception to this section permits a roof that is "continuously insulated" to have areas that do not meet the required *R*-values, provided that the area-weighted values are equivalent to the specified insulation values. This type of insulation referred to as tapered insulation is where the roof insulation varies to provide slope for drainage…."

[continued…]

78 CRA Colorado Roofing Association NRCA

2012 IECC Code and Commentary

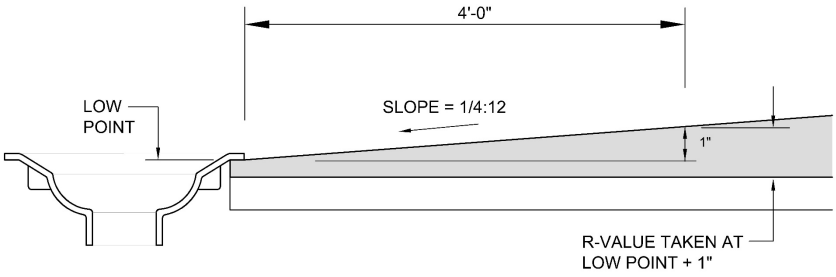
Tapered insulation

"…This 1-inch (25 mm) limitation does not prevent the provisions from being applied to roofs that have a greater variation; it simply does not allow the additional thickness to be factored into the average insulation values. Where the variation exceeds 1 inch (25 mm), it would be permissible to go to the thinnest spot and measure the *R*-value at that point (for the example call this Point "a"). Then go to a point that is 1 inch (25 mm) thicker than Point "a" and measure the *R*-value there (for the example, call this Point "b"). The remaining portions of the roof that are thicker than the additional 1-inch (25 mm) portion (Point "b") would simply be assumed to have the same *R*-value that Point "b" had. All portions of the roof that meet or exceed the Point "b" *R*-value would simply use the Point "b" *R*-value when determining the area weighted *U*-factor for the roof. "

79 CRA Colorado Roofing Association NRCA

What about tapered insulation…?

IBC 2012, Sec. C402.2-Roof Assembly , Exception 1
allows a 1-inch insulation thickness variation



80 CRA Colorado Roofing Association NRCA

Solar reflectance and thermal emittance

IECC 2012, Section C402.2.1.1

C402.2.1.1 Roof solar reflectance and thermal emittance. Low-sloped roofs, with a slope less than 2 units vertical in 12 horizontal, directly above cooled *conditioned spaces* in Climate Zones 1, 2, and 3 shall comply with one or more of the options in Table C402.2.1.1.

Exceptions: The following roofs and portions of roofs are exempt from the requirements in Table C402.2.1.1:

1. Portions of roofs that include or are covered by:
   - 1.1 Photovoltaic systems or components.
   - 1.2 Solar air or water heating systems or components.
   - 1.3 Roof gardens or landscaped roofs.
   - 1.4 Above-roof decks or walkways.
   - 1.5 Skylights.
   - 1.6 HVAC systems, components, and other opaque objects mounted above…

[Continued…]

CRA Colorado Roofing Association NRCA

TABLE C402.2.1.1
MINIMUM ROOF REFLECTANCE AND EMITTANCE OPTIONS[a]

Three-year aged solar reflectance[b] of 0.55 and three-year aged thermal emittance of 0.75
Initial solar reflectance[b] of 0.70 and initial thermal emittance[c] of 0.75
Three-year-aged solar reflectance index[d] of 64
Initial solar reflectance index[d] of 82

[Footnotes omitted for clarity]

CRA Colorado Roofing Association NRCA

Air retarders

IECC 2012, Section C402.4-Air Leakage (Mandatory)

C402.4 Air leakage (Mandatory). The thermal envelope of buildings shall comply with Sections C402.4.1 through C402.4.8.

C402.4.1 Air barriers. A continuous air barrier shall be provided throughout the building thermal envelope. The air barriers shall be permitted to be located on the inside or outside of the building envelope, located within the assemblies composing the envelope, or any combination thereof. The air barrier shall comply with Sections C402.4.1.1 and C402.4.1.2.

Exception: Air barriers are not required in buildings located in Climate Zones 1, 2 and 3.

[Continued…]

Air retarders

IECC 2012, Section C402.4-Air Leakage (Mandatory)

C402.4 Air leakage (Mandatory). The thermal envelope of buildings shall comply with Sections C402.4.1 through C402.4.8.

C402.4.1 Air barriers. A continuous air barrier shall be provided throughout the building thermal envelope. The air barriers shall be permitted to be located on the inside or outside of the building envelope, located within the assemblies composing the envelope, or any combination thereof. The air barrier shall comply with Sections C402.4.1.1 and C402.4.1.2.

Exception: Air barriers are not required in buildings located in Climate Zones 1, 2 and 3.

[Continued…]

C402.4.1.2 Air barrier compliance options. A continuous air barrier for the opaque building envelope shall comply with Section C402.4.1.2.1, C402.4.1.2.2, or C402.4.1.2.3.

C402.4.1.2.1 Materials. Materials with an air permeability no greater than 0.004 cfm/ft^2 (0.02 L/s · m^2) under a pressure differential of 0.3 inches water gauge (w.g.) (75 Pa) when tested in accordance with ASTM E 2178 shall comply with this section. Materials in Items 1 through 15 shall be deemed to comply with this section provided joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

1. Plywood with a thickness of not less than 3/8 inch (10 mm).
2. Oriented strand board having a thickness of not less than 3/8 inch (10 mm).
3. Extruded polystyrene insulation board having a thickness of not less than 1/2 inch (12 mm).
4. Foil-back polyisocyanurate insulation board having a thickness of not less than 1/2 inch (12 mm).
5. Closed cell spray foam a minimum density of 1.5 pcf (2.4 kg/m^3) having a thickness of not less than 1-1/2 inches (36 mm).

[Continued….]

6. Open cell spray foam with a density between 0.4 and 1.5 pcf (0.6 and 2.4 kg/m^3) and having a thickness of not less than 4.5 inches (113 mm).
7. Exterior or interior gypsum board having a thickness of not less than ½ inch (12 mm).
8. Cement board having a thickness of not less than 1/2 inch (12 mm).
9. Built up roofing membrane.
10. Modified bituminous roof membrane.
11. Fully adhered single-ply roof membrane.
12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than 5/8 inch (16 mm).
13. Cast-in-place and precast concrete.
14. Fully grouted concrete block masonry.
15. Sheet steel or aluminum.

[Continued…]

C402.4.1.2.2 Assemblies. Assemblies of materials and components with an average air leakage not to exceed 0.04 cfm/ft^2 (0.2 L/s · m^2) under a pressure differential of 0.3 inches of water gauge (w.g.)(75 Pa) when tested in accordance with ASTM E 2357, ASTM E 1677 or ASTM E 283 shall comply with this section. Assemblies listed in Items 1 and 2 shall be deemed to comply provided joints are sealed and requirements of Section C402.4.1.1 are met.

1. Concrete masonry walls coated with one application either of block filler and two applications of a paint or sealer coating;

2. A Portland cement/sand parge, stucco or plaster minimum 1/2 inch (12 mm) in thickness.

C402.4.1.2.3 Building test. The completed building shall be tested and the air leakage rate of the *building envelope* shall not exceed 0.40 cfm/ft^2 at a pressure differential of 0.3 inches water gauge (2.0 L/s · m^2 at 75 Pa) in accordance with ASTM E 779 or an equivalent method approved by the code official.

So….

- Do increased R-values make sense?
- Is there a realistic payback?

…we've done some calculations

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In a mixed heating/cooling climate

10,000 sq. ft. single-story building in Denver, CO

R-value increase	Annual Btu savings	Payback time
R-10 to R-15	52,120,379 Btu	12.1 years
R-15 to R-20	28,732,017 Btu	25.1 years
R-20 to R-25	16,526,782 Btu	40.5 years
R-25 to R-30	11,646,024 Btu	88.2 years

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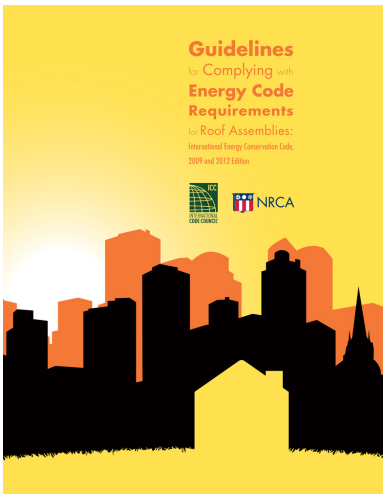
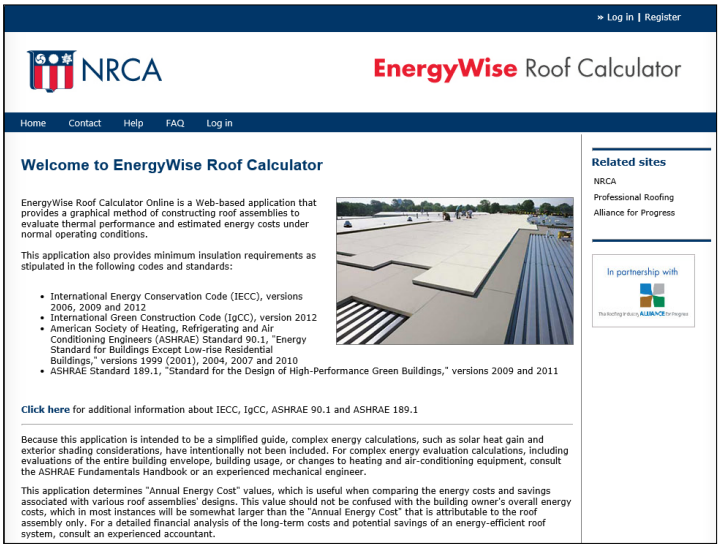
Energy Codes Manual (2009 & 2012 Codes)



- Based upon IECC 2012 with ASHRAE 90.1-07 option and IECC 2012 with ASHRAE 90.1-10 option
- Includes roofing-related code text and NRCA commentary on each section
- Appendix has county-specific prescriptive R-value tables
- Co-branded with ICC; NRCA promotes to industry and ICC promotes to code officials

90

energywise.nrca.net



91

Update on technical issues

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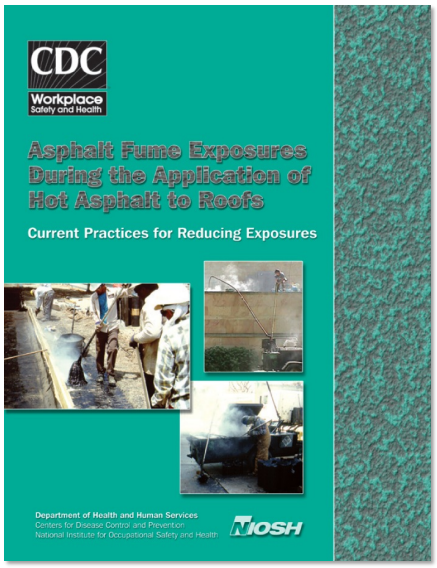
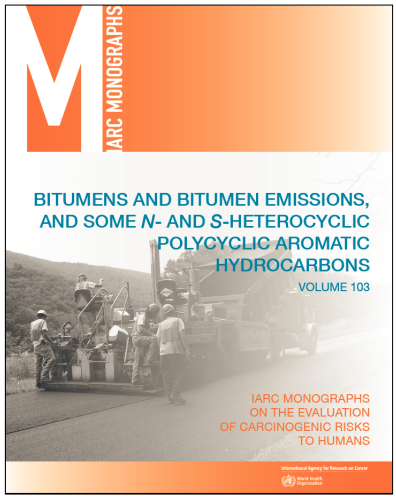
Asphalt

June 2003



Asphalt

May 2013



IARC Monograph – 103:

- Group 2A –Probably carcinogenic to humans
- Pgs. 160 – 165 specific to "Roofing workers exposed to bitumens"

No new regulation (yet)

94

NRCA asphalt testing -- 1989

- 26 asphalt samples
- EVTs:
  - Type III (125 cps) 400 – 430 F
  - Type III (75 cps) 420 – 470 F
  - Type IV (125 cps) 420 – 455 F
  - Type IV (75 cps) 445 – 485 F
- FPs:
  - Not reported

95

NRCA asphalt testing -- 2000

- 19 asphalt lots sampled
- EVTs:
  - Type III (mop) 390 – 440 F
  - Type III (spreader) 415 – 475 F
- FPs: 585 – 640 F
- ASTM D312 compliance:
  - 10 of 19 did not comply

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NRCA asphalt testing – 2014

- 14 asphalt lots (7 suppliers) sampled
- EVTs:
  - Type III (mop) 424 – 462 F
  - Type III (spreader) 452 – 486 F
  - Type IV (mop) 455 – 482 F
  - Type IV (spreader) 480 – 506 F
- FPs: 615 – 660 F
- 10 of 14 do not comply with ASTM D312's physical property requirements

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Revision to ASTM D312

Will be published as ASTM D312-15

- Maximum heating temp.: 550 F (575 F min. FP)
- Maximum EVTs:
  - Type III (mop) 430 F
  - Type III (spreader) 455 F
  - Type IV (mop) 470 F
  - Type IV (spreader) 485 F
- Lot-specific package labeling of EVT

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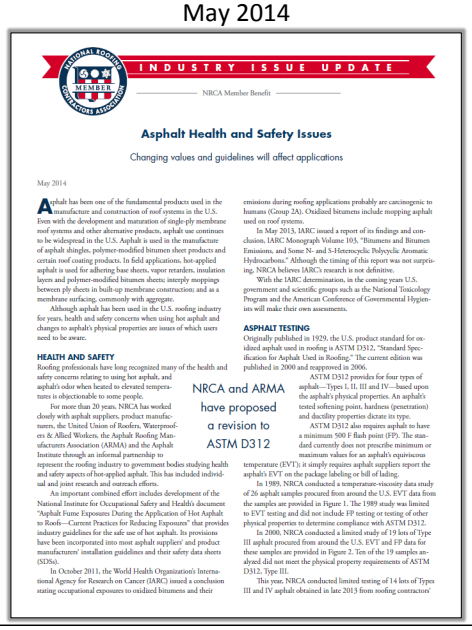
Industry Issue Update

May 2014



INDUSTRY ISSUE UPDATE

NRCA Member Benefit

Asphalt Health and Safety Issues

Changing values and guidelines will affect applications

May 2014

Asphalt has been one of the fundamental products used in the manufacture and construction of roof systems in the U.S. Even with the development and maturation of single-ply membrane roof systems and other alternative products, asphalt use continues to be widespread in the U.S. Asphalt is used in the manufacture of asphalt shingles, polymer-modified bitumen sheet products and certain roof coating products. In field applications, hot-applied asphalt is used for adhering base sheets, vapor retarders, insulation layers and polymer-modified bitumen sheets; interply moppings between ply sheets in built-up membrane construction; and as a membrane surfacing, commonly with aggregate.

Although asphalt has been used in the U.S. roofing industry for years, health and safety concerns when using hot asphalt and changes to asphalt's physical properties are issues of which users need to be aware.

HEALTH AND SAFETY

Roofing professionals have long recognized many of the health and safety concerns relating to using hot asphalt, and asphalt's odor when heated to elevated temperatures is objectionable to some people.

For more than 20 years, NRCA has worked closely with asphalt suppliers, product manufacturers, the United Union of Roofers, Waterproofers & Allied Workers, the Asphalt Roofing Manufacturers Association (ARMA) and the Asphalt Institute through an informal partnership to represent the roofing industry to government bodies studying health and safety aspects of hot-applied asphalt. This has included individual and joint research and outreach efforts.

An important combined effort includes development of the National Institute for Occupational Safety and Health's document "Asphalt Fume Exposures During the Application of Hot Asphalt to Roofs—Current Practices for Reducing Exposures" that provides industry guidelines for the safe use of hot asphalt. Its provisions have been incorporated into most asphalt suppliers' and product manufacturers' installation guidelines and their safety data sheets (SDSs).

In October 2011, the World Health Organization's International Agency for Research on Cancer (IARC) issued a conclusion stating occupational exposures to oxidized bitumens and their emissions during roofing applications probably are carcinogenic to humans (Group 2A). Oxidized bitumens include mopping asphalt used on roof systems.

In May 2013, IARC issued a report of its findings and conclusion, IARC Monograph Volume 103, "Bitumens and Bitumen Emissions, and Some N- and S-Heterocyclic Polycyclic Aromatic Hydrocarbons." Although the timing of this report was not surprising, NRCA believes IARC's research is not definitive.

With the IARC determination, in the coming years U.S. government and scientific groups such as the National Toxicology Program and the American Conference of Governmental Hygienists will make their own assessments.

ASPHALT TESTING

Originally published in 1929, the U.S. product standard for oxidized asphalt used in roofing is ASTM D312, "Standard Specification for Asphalt Used in Roofing." The current edition was published in 2000 and reapproved in 2006.

ASTM D312 provides for four types of asphalt—Types I, II, III and IV—based upon the asphalt's physical properties. An asphalt's tested softening point, hardness (penetration) and ductility properties dictate its type.

ASTM D312 also requires asphalt to have a minimum 500 F flash point (FP). The standard currently does not prescribe minimum or maximum values for an asphalt's equiviscous temperature (EVT); it simply requires asphalt suppliers report the asphalt's EVT on the package labeling or bill of lading.

In 1989, NRCA conducted a temperature-viscosity data study of 26 asphalt samples procured from around the U.S. EVT data from the samples are provided in Figure 1. The 1989 study was limited to EVT testing and did not include FP testing or testing of other physical properties to determine compliance with ASTM D312.

In 2000, NRCA conducted a limited study of 19 lots of Type III asphalt procured from around the U.S. EVT and FP data for these samples are provided in Figure 2. Ten of the 19 samples analyzed did not meet the physical property requirements of ASTM D312, Type III.

This year, NRCA conducted limited testing of 14 lots of Types III and IV asphalt obtained in late 2013 from roofing contractors'

NRCA and ARMA have proposed a revision to ASTM D312

NRCA's recommendations

Asphalt

- Seek out asphalt complying with ASTM D312-15
- Consider asking for certificates of compliance
- Do not overheat asphalt
  - 550 F maximum kettle/tanker temperature
- Apply at EVT (BUR application)
- Make field crews aware
- Contact NRCA with any questions or issues

100

Concerns with steel roof decks

- Probable underdesign for wind uplift
- Deck overstress
  - Seam-fastened mechanically-attached single–plies
- Possible structural overload
  - Seam-fastened mechanically-attached single–plies

101

Steel deck design

Prior to 2010:

- SDI's *Design Manual for Composite Decks, Form Decks and Roof Decks*
- ANSI/SDI RD1.0-2006, "Standard for Steel Roof Deck" (referenced in IBC 2009)

30-pound-per-square-foot (psf) uplift
and 45-psf uplift at roof overhangs

102

Steel deck design

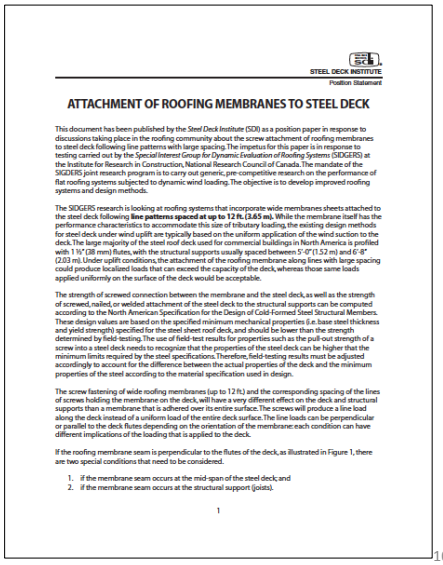
Since 2010:

- ANSI/SDI RD1.0-2010, "Standard for Steel Roof Deck" (referenced in IBC 2012 and IBC 2015)

"… be anchored to resist the required net uplift forces, but not less than…"
30 psf and 45 psf for eave overhangs

103

SDI bulletin



STEEL DECK INSTITUTE
Position Statement

ATTACHMENT OF ROOFING MEMBRANES TO STEEL DECK

This document has been published by the *Steel Deck Institute* (SDI) as a position paper in response to discussions taking place in the roofing community about the screw attachment of roofing membranes to steel deck following line patterns with large spacing. The impetus for this paper is in response to testing carried out by the *Special Interest Group for Dynamic Evaluation of Roofing Systems* (SIDGERS) at the Institute for Research in Construction, National Research Council of Canada. The mandate of the SIDGERS joint research program is to carry out generic, pre-competitive research on the performance of flat roofing systems subjected to dynamic wind loading. The objective is to develop improved roofing systems and design methods.

The SIDGERS research is looking at roofing systems that incorporate wide membranes sheets attached to the steel deck following **line patterns spaced at up to 12 ft. (3.65 m).** While the membrane itself has the performance characteristics to accommodate this size of tributary loading, the existing design methods for steel deck under wind uplift are typically based on the uniform application of the wind suction to the deck. The large majority of the steel roof deck used for commercial buildings in North America is profiled with 1 ½" (38 mm) flutes, with the structural supports usually spaced between 5'-0" (1.52 m) and 6'-8" (2.03 m). Under uplift conditions, the attachment of the roofing membrane along lines with large spacing could produce localized loads that can exceed the capacity of the deck, whereas those same loads applied uniformly on the surface of the deck would be acceptable.

The strength of screwed connection between the membrane and the steel deck, as well as the strength of screwed, nailed, or welded attachment of the steel deck to the structural supports can be computed according to the North American Specification for the Design of Cold-Formed Steel Structural Members. These design values are based on the specified minimum mechanical properties (i.e. base steel thickness and yield strength) specified for the steel sheet roof deck, and should be lower than the strength determined by field-testing. The use of field-test results for properties such as the pull-out strength of a screw into a steel deck needs to recognize that the properties of the steel deck can be higher that the minimum limits required by the steel specifications. Therefore, field-testing results must be adjusted accordingly to account for the difference between the actual properties of the deck and the minimum properties of the steel according to the material specification used in design.

The screw fastening of wide roofing membranes (up to 12 ft.) and the corresponding spacing of the lines of screws holding the membrane on the deck, will have a very different effect on the deck and structural supports than a membrane that is adhered over its entire surface. The screws will produce a line load along the deck instead of a uniform load of the entire deck surface. The line loads can be perpendicular or parallel to the deck flutes depending on the orientation of the membrane: each condition can have different implications of the loading that is applied to the deck.

If the roofing membrane seam is perpendicular to the flutes of the deck, as illustrated in Figure 1, there are two special conditions that need to be considered.

1. if the membrane seam occurs at the mid-span of the steel deck; and
2. if the membrane seam occurs at the structural support (joists).

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- Decks designed for joist spacing between 5' and 6' 8" o.c.
- Steel decks designed for uniform loading
- Seam-fastened single-ply membranes are a concern

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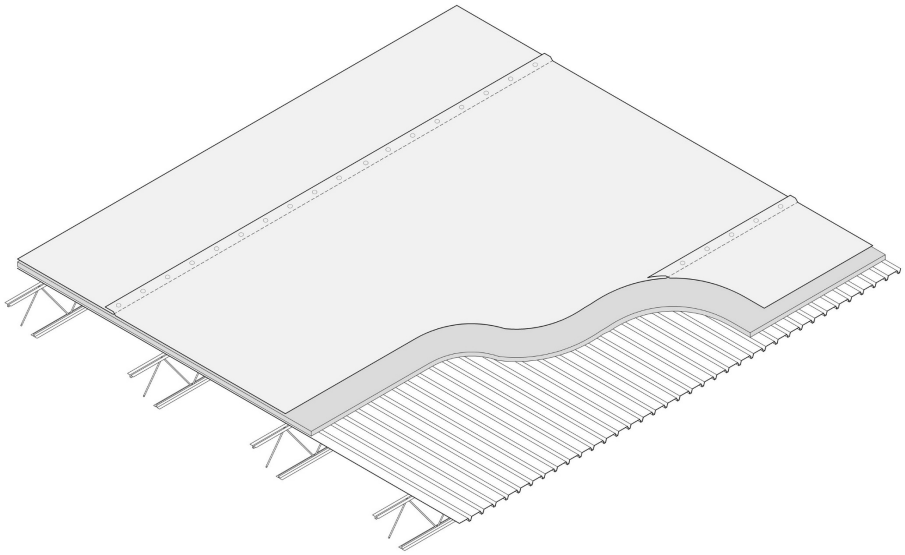
Membrane seams across deck flutes



SDI: 3.8 X moment (deck); 2 X load (joists)

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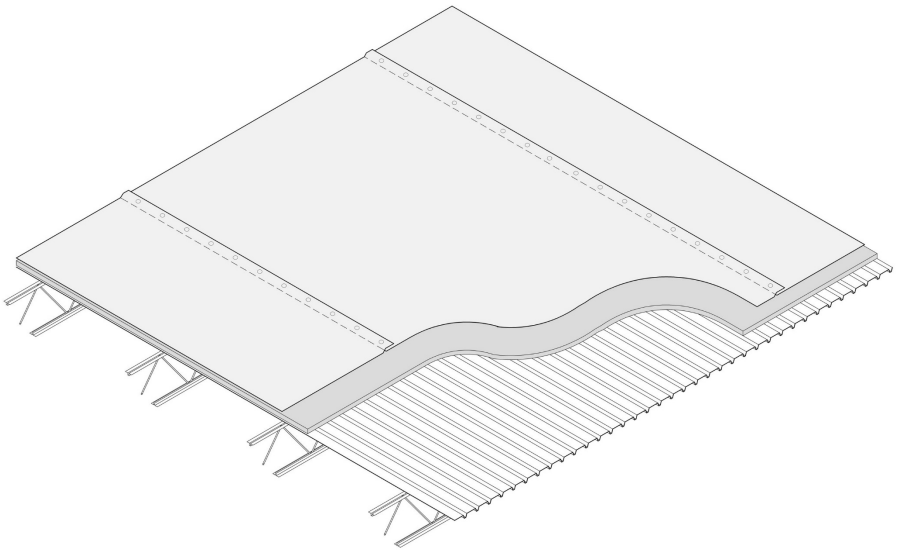
Membrane seams in deck flute direction



SDI: 12 X bending moment and shear (deck)

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SDI bulletin -- Conclusion

"…SDI does not recommend the use of roofing membranes attached to the steel deck using line patterns with large spacing unless a structural engineer has reviewed the adequacy of the steel deck and the structural supports to resist to wind uplift loads transmitted along the lines of attachment. Those lines of attachment shall only be perpendicular to the flutes of the deck."

NRCA's recommendations

- Beware of the situation
- Roof system designers should not rely on "excess capacity" in steel roof decks
- Be cautious of "accepting" responsibility for the roof deck; use NRLRC recommended proposal/ contract language
- Better communication is needed between Roof system designers and roof deck designers

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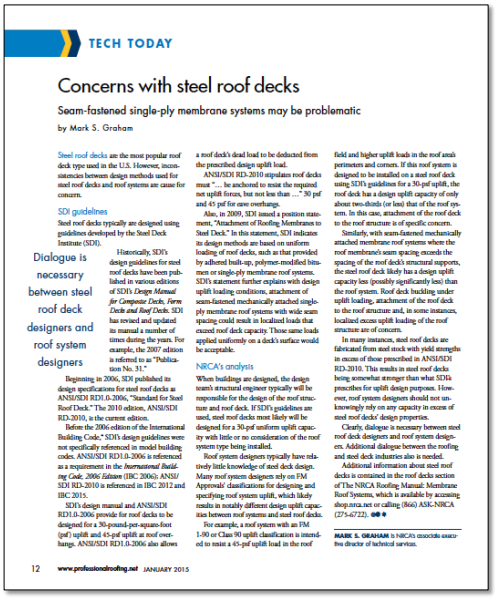

TECH TODAY

Concerns with steel roof decks

Seam-fastened single-ply membrane systems may be problematic

by Mark S. Graham

Steel roof decks are the most popular roof deck type used in the U.S. However, inconsistencies between design methods used for steel roof decks and roof systems are cause for concern.

SDI guidelines

Steel roof decks typically are designed using guidelines developed by the Steel Deck Institute (SDI).

Historically, SDI's design guidelines for steel roof decks have been published in various editions of SDI's *Design Manual for Composite Decks, Form Decks and Roof Decks*. SDI has revised and updated its manual a number of times during the years. For example, the 2007 edition is referred to as "Publication No. 31."

Dialogue is necessary between steel roof deck designers and roof system designers

Beginning in 2006, SDI published its design specifications for steel roof decks as ANSI/SDI RD1.0-2006, "Standard for Steel Roof Deck." The 2010 edition, ANSI/SDI RD-2010, is the current edition.

Before the 2006 edition of the International Building Code," SDI's design guidelines were not specifically referenced in model building codes. ANSI/SDI RD1.0-2006 is referenced as a requirement in the *International Building Code, 2006c Edition* (IBC 2006); ANSI/SDI RD-2010 is referenced in IBC 2012 and IBC 2015.

SDI's design manual and ANSI/SDI RD1.0-2006 provide for roof decks to be designed for a 30-pound-per-square-foot (psf) uplift and 45-psf uplift at roof overhangs. ANSI/SDI RD1.0-2006 also allows a roof deck's dead load to be deducted from the prescribed design uplift load.

ANSI/SDI RD-2010 stipulates roof decks must "... be anchored to resist the required net uplift forces, but not less than ...." 30 psf and 45 psf for eave overhangs.

Also, in 2009, SDI issued a position statement, "Attachment of Roofing Membranes to Steel Deck." In this statement, SDI indicates its design methods are based on uniform loading of roof decks, such as that provided by adhered built-up, polymer-modified bitumen or single-ply membrane roof systems. SDI's statement further explains with design uplift loading conditions, attachment of seam-fastened mechanically attached single-ply membrane roof systems with wide seam spacing could result in localized loads that exceed roof deck capacity. Those same loads applied uniformly on a deck's surface would be acceptable.

NRCA's analysis

When buildings are designed, the design team's structural engineer typically will be responsible for the design of the roof structure and roof deck. If SDI's guidelines are used, steel roof decks most likely will be designed for a 30-psf uniform uplift capacity with little or no consideration of the roof system type being installed.

Roof system designers typically have relatively little knowledge of steel deck design. Many roof system designers rely on FM Approvals' classifications for designing and specifying roof system uplift, which likely results in notably different design uplift capacities between roof systems and steel roof decks.

For example, a roof system with an FM 1-90 or Class 90 uplift classification is intended to resist a 45-psf uplift load in the roof field and higher uplift loads in the roof area's perimeters and corners. If this roof system is designed to be installed on a steel roof deck using SDI's guidelines for a 30-psf uplift, the roof deck has a design uplift capacity of only about two-thirds (or less) that of the roof system. In this case, attachment of the roof deck to the roof structure is of specific concern.

Similarly, with seam-fastened mechanically attached membrane roof systems where the roof membrane's seam spacing exceeds the spacing of the roof deck's structural supports, the steel roof deck likely has a design uplift capacity less (possibly significantly less) than the roof system. Roof deck buckling under uplift loading, attachment of the roof deck to the roof structure and, in some instances, localized excess uplift loading of the roof structure are of concern.

In many instances, steel roof decks are fabricated from steel stock with yield strengths in excess of those prescribed in ANSI/SDI RD-2010. This results in steel roof decks being somewhat stronger than what SDI's prescribes for uplift design purposes. However, roof system designers should not unknowingly rely on any capacity in excess of steel roof decks' design properties.

Clearly, dialogue is necessary between steel roof deck designers and roof system designers. Additional dialogue between the roofing and steel deck industries also is needed.

Additional information about steel roof decks is contained in the roof decks section of The NRCA Roofing Manual: Membrane Roof Systems, which is available by accessing shop.nrca.net or calling (866) ASK-NRCA (275-6722).

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