CSI Master Specifiers Retreat
January 15-17, 2015 – Scottsdale, AZ

Roof Systems: Choices, Decisions and Performance Implications

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Building Knowledge
Improving Project Delivery

About NRCA

- National trade association of roofing contractors
- Founded in 1886
- Based in Rosemont, IL (suburban Chicago)
- 3,500+ members, all 50 states and 53 countries
- Member company volume varies from <$1 million to $435 million
- Residential and commercial contractors; more than 50% do both
- More than 1/3 have been in business 25+ years
- Many multi-generation family businesses

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About me

- Grew up in a family-run construction business
- Degree in architectural engineering
- Roofing contracting business
- Consulting engineering business
- Last 21 years with NRCA
- Industry involvement includes ASHRAE, ASTM, ICC, NFPA, UL
- Personal web site: www.MarkGrahamNRCA.com
- Twitter: @MarkGrahamNRCA

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Topics

- FM, UL and ASTM classifications
- Energy code requirements
- Polyisocyanurate insulation
- Asphalt
- Roof decks
- Water-based bonding adhesives
- Wind design and wind warrantees
- Questions (other topics)

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FM classifications

FM Global is an insurance company, with a wholly-owed subsidiary, FM Approvals, that is a code-approved testing agency.

“FM 1-60A” classification:

- The “1” designates Class 1 (internal fire) construction
- The “-60” designates 30 psf allowable uplift in the field of the roof
- “A” designates ASTM E108 external fire classification

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UL classifications

Fire classifications (UL 790/ASTM E108 external fire):

- Class A: “Severe” fire test exposure
- Class B: “Moderate” fire test exposure
- Class C: “Light” fire test exposure

What fire class is required? (IBC Sec. 1505):

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]

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UL classifications – cont.

Wind uplift classifications (UL 580, UL 1897)

- Class 30: 30 psf uplift (no safety factor)
- Class 60: 60 psf uplift (no safety factor)
- Class 90: 90 psf uplift (no safety factor)

Be careful no to confuse FM's uplift classifications with UL's classifications

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Wind uplift – Steep-slope products

ASTM D3161/ASTM D7158 testing:

- Class A: 60 mph
- Class D: 90 mph
- Class F: 110 mph
- Class G: 120 mph
- Class H: 150 mph

Note these classification designations are reversed from those used in fire testing…don't get confused.

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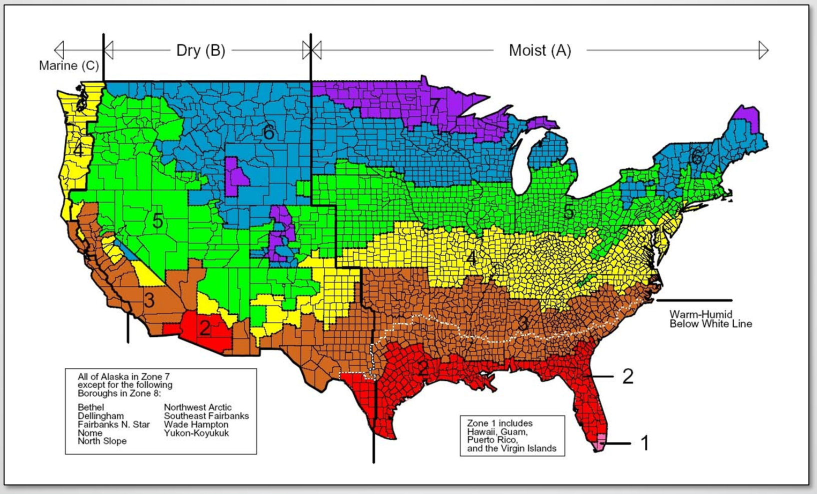
Energy code requirements

Climate zones (IECC 2012, Sec. C301 & R301-Climate Zones)



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Roofing-specific adaptation of Table 502.2(1)

International Energy Conservation Code, 2009 Edition (Commercial buildings)

<table>
<tr><th colspan="4">Opaque Thermal Envelope Assembly Requirements</th></tr>
<tr><th rowspan="2">Climate zone</th><th colspan="3">Roof assembly configuration</th></tr>
<tr><th>Insulation entirely above deck</th><th>Metal buildings (with R-5 thermal blocks)</th><th>Attic and other</th></tr>
<tr><td>1</td><td>R-15ci</td><td>R-19</td><td>R-30</td></tr>
<tr><td>2</td><td rowspan="5">R-20ci</td><td rowspan="4">R-13 + R-13</td><td rowspan="6">R-38</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td rowspan="3">R-13 + R-19</td></tr>
<tr><td>7</td><td rowspan="2">R-25ci</td></tr>
<tr><td>8</td><td>R-49</td></tr>
<tr><td colspan="4">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)</td></tr>
</table>

Roofing-specific adaptation of Table C402.2

International Energy Conservation Code, 2012 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-20ci	R-19 + R-11 LS	R-38
2			
3			
4	R-25ci		
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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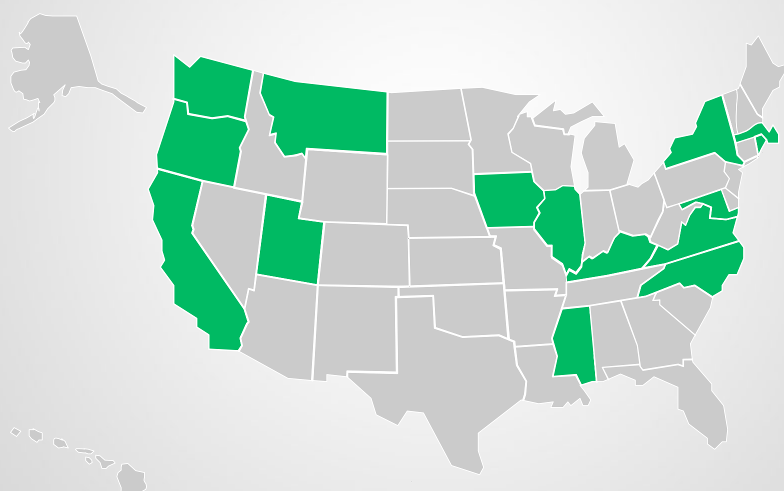
Status of states' adoptions

Adoption of IECC 2012 before Jan. 1, 2015



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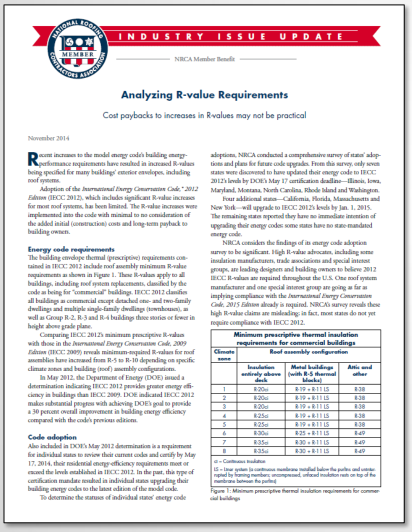
Is there a realistic payback?



INDUSTRY ISSUE UPDATE

NRCA Member Benefit

Analyzing R-value Requirements

Cost paybacks to increases in R-values may not be practical

November 2014

Recent increases to the model energy code's building energy-performance requirements have resulted in increased R-values being specified for many buildings' exterior envelopes, including roof systems.

Adoption of the *International Energy Conservation Code,® 2012 Edition* (IECC 2012), which includes significant R-value increases for most roof systems, has been limited. The R-value increases were implemented into the code with minimal to no consideration of the added initial (construction) costs and long-term payback to building owners.

Energy code requirements

The building envelope thermal (prescriptive) requirements contained in IECC 2012 include roof assembly minimum R-value requirements as shown in Figure 1. These R-values apply to all buildings, including roof system replacements, classified by the code as being for "commercial" buildings. IECC 2012 classifies all buildings as commercial except 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 fewer in height above grade plane.

Comparing IECC 2012's minimum prescriptive R-values with those in the *International Energy Conservation Code, 2009 Edition* (IECC 2009) reveals minimum-required R-values for roof assemblies have increased from R-5 to R-10 depending on specific climate zones and building (roof) assembly configurations.

In May 2012, the Department of Energy (DOE) issued a determination indicating IECC 2012 provides greater energy efficiency in buildings than IECC 2009. DOE indicated IECC 2012 makes substantial progress with achieving DOE's goal to provide a 30 percent overall improvement in building energy efficiency compared with the code's previous editions.

Code adoption

Also included in DOE's May 2012 determination is a requirement for individual states to review their current codes and certify by May 17, 2014, their residential energy-efficiency requirements meet or exceed the levels established in IECC 2012. In the past, this type of certification mandate resulted in individual states upgrading their building energy codes to the latest edition of the model code.

To determine the statuses of individual states' energy code adoptions, NRCA conducted a comprehensive survey of states' adoptions and plans for future code upgrades. From this survey, only seven states were discovered to have updated their energy code to IECC 2012's levels by DOE's May 17 certification deadline—Illinois, Iowa, Maryland, Montana, North Carolina, Rhode Island and Washington.

Four additional states—California, Florida, Massachusetts and New York—will upgrade to IECC 2012's levels by Jan. 1, 2015. The remaining states reported they have no immediate intention of upgrading their energy codes; some states have no state-mandated energy code.

NRCA considers the findings of its energy code adoption survey to be significant. High R-value advocates, including some insulation manufacturers, trade associations and special interest groups, are leading designers and building owners to believe 2012 IECC R-values are required throughout the U.S. One roof system manufacturer and one special interest group are going as far as implying compliance with the *International Energy Conservation Code, 2015 Edition* already is required. NRCA's survey reveals these high R-value claims are misleading; in fact, most states do not yet require compliance with IECC 2012.

Minimum prescriptive thermal insulation requirements for commercial buildings

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	R-20ci	R-19 + R-11 LS	R-38
3	R-20ci	R-19 + R-11 LS	R-38
4	R-25ci	R-19 + R-11 LS	R-38
5	R-25ci	R-19 + R-11 LS	R-38
6	R-30ci	R-25 + R-11 LS	R-49
7	R-35ci	R-30 + R-11 LS	R-49
8	R-35ci	R-30 + R-11 LS	R-49

ci = Continuous insulation

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

Figure 1: Minimum prescriptive thermal insulation requirements for commercial buildings

NRCA "Industry Issue Update," Nov. 2014:

- R-15 to R-20: 14 to 24 yrs.
- R-20 to R-25: 26 to 63 yrs.
- R-25 to R-30: 48 to 133 yrs.

Average roof life is 17.4 yrs.

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Polyisocyanurate insulation

ASTM C1289:

- Type I (wall sheathing)
- Type II (faced roof insulation)
- Type III (perlite board laminate)
- Type IV (wood-fiber board laminate)
- Type V (OSB/plywood laminate)
- Type VII (glass mat-faced gypsum board laminate)

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ASTM C1289, Type II:

- Class 1 (cellulose facers)
  - Grade 1: 16 psi compressive strength
  - Grade 2: 20 psi compressive strength
  - Grade 3: 25 psi compressive strength
- Class 2 (coated-glass facers)
- Class 3 (uncoated-glass facers)
- Class 4 (high-density product)
  - Grade 1: 80 psi compressive strength
  - Grade 2: 110 psi compressive strength
  - Grade 3: 140 psi compressive strength

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When specifying polyiso.

Use ASTM C1289 and the specific
Type, Class and Grade for the desired product

Footer text can be set to customize bottom slide content on a case by case basis

Polyisocyanurate insulation

- R-value versus LTTR

	ASTM C518	ASTM C1303
1 inch	6.2	5.6 / inch
2 inch	12.3	5.7 / inch
3 inch	--	5.8 / inch
4 inch	--	5.9 / inch

- LTTR represents a 15-year time-weighted-average of R-value; corresponds to the estimated R-value after 5-years of aging.

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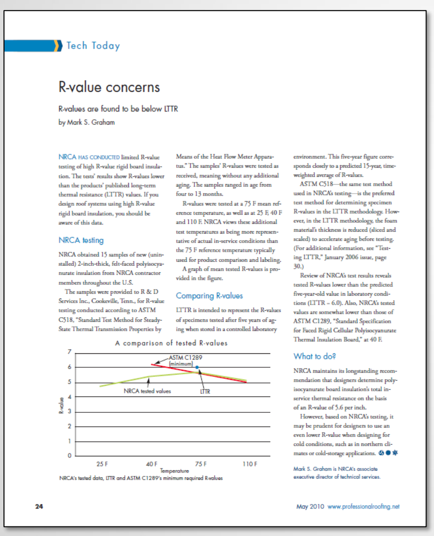
Polyisocyanurate insulation


Tech Today

R-value concerns

R-values are found to be below LTTR

by Mark S. Graham

NRCA HAS CONDUCTED limited R-value testing of high R-value rigid board insulation. The tests' results show R-values lower than the products' published long-term thermal resistance (LTTR) values. If you design roof systems using high R-value rigid board insulation, you should be aware of this data.

NRCA testing

NRCA obtained 15 samples of new (uninstalled) 2-inch-thick, felt-faced polyisocyanurate insulation from NRCA contractor members throughout the U.S.

The samples were provided to R & D Services Inc., Cookeville, Tenn., for R-value testing conducted according to ASTM C518, "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus." The samples' R-values were tested as received, meaning without any additional aging. The samples ranged in age from four to 13 months.

R-values were tested at a 75 F mean reference temperature, as well as at 25 F, 40 F and 110 F. NRCA views these additional test temperatures as being more representative of actual in-service conditions than the 75 F reference temperature typically used for product comparison and labeling.

A graph of mean tested R-values is provided in the figure.

Comparing R-values

LTTR is intended to represent the R-values of specimens tested after five years of aging when stored in a controlled laboratory environment. This five-year figure corresponds closely to a predicted 15-year, time-weighted average of R-values.

ASTM C518—the same test method used in NRCA's testing—is the preferred test method for determining specimen R-values in the LTTR methodology. However, in the LTTR methodology, the foam material's thickness is reduced (sliced and scaled) to accelerate aging before testing. (For additional information, see "Testing LTTR," January 2006 issue, page 30.)

Review of NRCA's test results reveals tested R-values lower than the predicted five-year-old value in laboratory conditions (LTTR = 6.0). Also, NRCA's tested values are somewhat lower than those of ASTM C1289, "Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board," at 40 F.

NRCA's tested data, LTTR and ASTM C1289's minimum required R-values

What to do?

NRCA maintains its longstanding recommendation that designers determine polyisocyanurate board insulation's total in-service thermal resistance on the basis of an R-value of 5.6 per inch.

However, based on NRCA's testing, it may be prudent for designers to use an even lower R-value when designing for cold conditions, such as in northern climates or cold-storage applications.

Mark S. Graham is NRCA's associate executive director of technical services.

24 May 2010 www.professionalroofing.net

Professional Roofing, May 2010:

- Tested "aged" R-values are less than LTTR
- Polyiso's LTTR and R-values are temperature sensitive
- NRCA's recommendation:
  - R_{Aged} = 5.0/inch (heating)
  - R_{Aged} = 5.6/inch (cooling)

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When specifying insulation…

…NRCA recommends insulation be specified by its thickness (and ASTM designation), not by its R-value or LTTR…

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Asphalt

- IARC has classified oxidized asphalt as "Group 2A", that is, "probably carcinogenic to humans"
- ASTM D312 has been revised:
  - Maximum kettle temperature of 550 F
  - Maximum EVT values (430 F to 485 F)
  - Lot-specific labeling of EVT
- NRCA recommends specifying "…ASTM D312-15…"

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Water-based bonding adhesives

Professional Roofing, August 2012

CSI

Temperature/humidity limitations

Professional Roofing, December 2012:

- Manufacturers:
  - Store at 60F - 90F
  - Install at 40F and rising
  - Longer green time
- NRCA:
  - Don't freeze
  - Dew point differential of 5F or more

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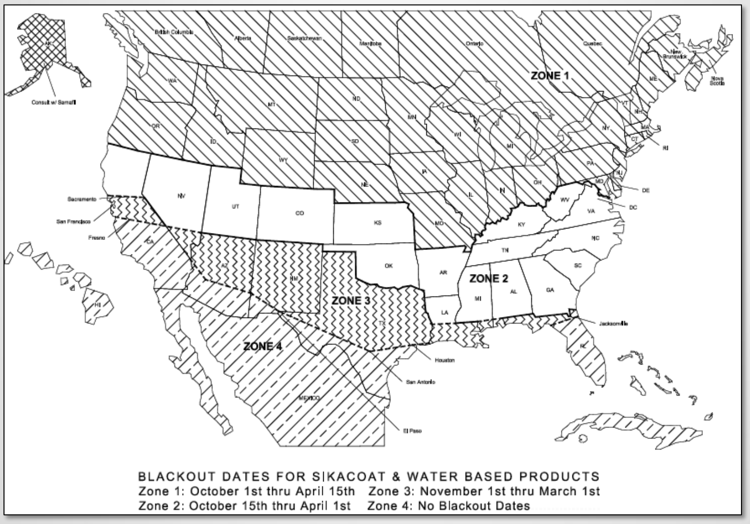
Sika/Sarnafil



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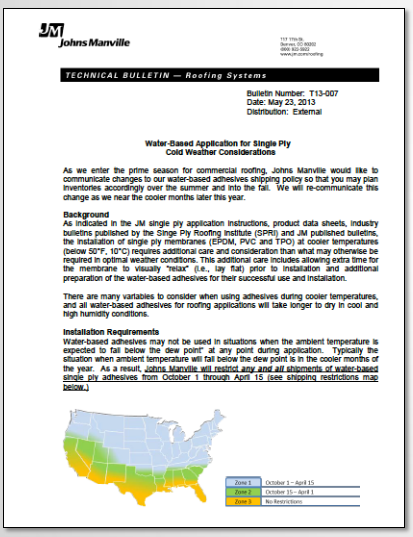
JM technical bulletin



Johns Manville

TECHNICAL BULLETIN — Roofing Systems

Bulletin Number: T13-007
Date: May 23, 2013
Distribution: External

Water-Based Application for Single Ply Cold Weather Considerations

As we enter the prime season for commercial roofing, Johns Manville would like to communicate changes to our water-based adhesives shipping policy so that you may plan inventories accordingly over the summer and into the fall. We will re-communicate this change as we near the cooler months later this year.

Background
As indicated in the JM single ply application instructions, product data sheets, industry bulletins published by the Singe Ply Roofing Institute (SPRI) and JM published bulletins, the installation of single ply membranes (EPDM, PVC and TPO) at cooler temperatures (below 50°F, 10°C) requires additional care and consideration than what may otherwise be required in optimal weather conditions. This additional care includes allowing extra time for the membrane to visually "relax" (i.e., lay flat) prior to installation and additional preparation of the water-based adhesives for their successful use and installation.

There are many variables to consider when using adhesives during cooler temperatures, and all water-based adhesives for roofing applications will take longer to dry in cool and high humidity conditions.

Installation Requirements
Water-based adhesives may not be used in situations when the ambient temperature is expected to fall below the dew point* at any point during application. Typically the situation when ambient temperature will fall below the dew point is in the cooler months of the year. As a result, Johns Manville will restrict *any and all* shipments of water-based single ply adhesives from October 1 through April 15 (see shipping restrictions map below.)

Zone 1	October 1 – April 15
Zone 2	October 15 – April 1
Zone 3	No Restrictions

- Shipment restrictions from 10/1 to 4/15
- Storage 60F – 80F
- Should not be applied:
  - Below 40F
  - RH 90%+
  - DP separation < 5F
  - Temp. = DP within 6 hrs.
  - Temp. < 32F within 48 hrs.

MRCA/NRCA testing

Water-based bonding adhesives

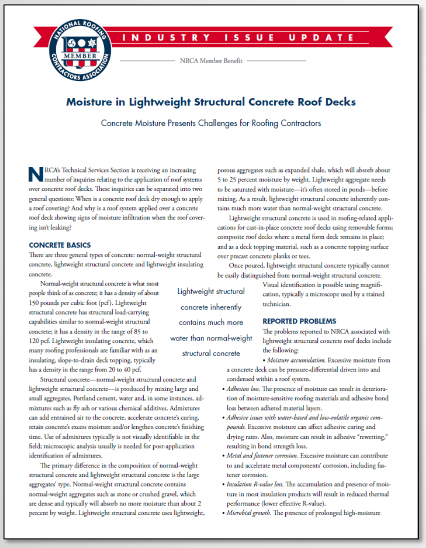
- Products vary
- Pail variability
- Long times to develop strengths
- Peel strengths are relatively low, particularly with paper-faced polyisocyanurate insulation

NRCA's interim recommendations

Water-based bonding adhesives

- Manufacturers need to take a more active role
- Designers should specify Class 2 (coated glass) facers when using water-based adhesives
  - Polyiso.: ASTM C1289, Type II, Class 2
- Designers need to consider/offer alternatives
- Make field crews aware of limitations
- Consider alternative products/systems

Lightweight structural concrete



NRCA "Industry Issue Update," August 2013:

- Reports of moisture-related roof problems
- "Dry times" far beyond practical
- Lightweight structural concrete should not be used for roof decks

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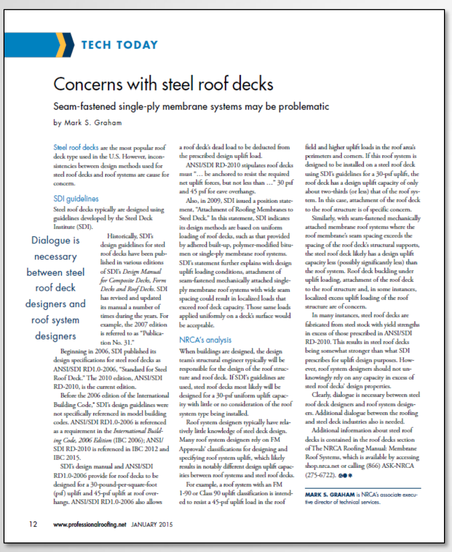
Steel roof decks



Professional Roofing, Jan. 2015:

- SDI manual: 30 psf
- ANSI/SDI RD-2010: ≥ 30 psf
- Decks are designed for uniform loading
- Seam-fastened mechanically-attached single-ply membrane roof systems:
  - Possible deck overstress
  - Possible excess moment
  - Possible joist overload

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Wind design and warrantees

- Wind speed vs. wind uplift
- Proper wind design:
  - Wind load prediction by IBC Ch. 16 or ASCE 7
  - Wind-resistance testing by FM 4474, UL 580 or UL 1897
- A "wind warrantee" or "wind rider" is not a substitute for proper wind design
- Pay-out on a wind warrantee/rider is very unlikely

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Questions… and additional topics

Roof Systems: Choices, Decisions and Performance Implications

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