SOPREMA Consultant Forum
Gulfport, MS
April 12-14, 2016

Roofing industry update

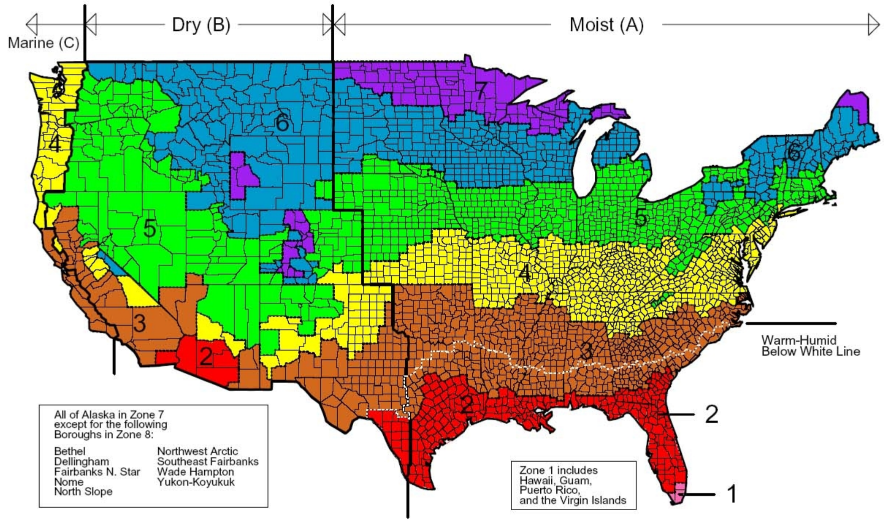
presented by

Mark S. Graham
Vice President, Technical Services
National Roofing Contractors Association

Energy Code

IECC 2015, Fig. C301.1-Climate zones

Fig. R301.1 (residential climate zones) is similar



Comparison of IECC's various editions

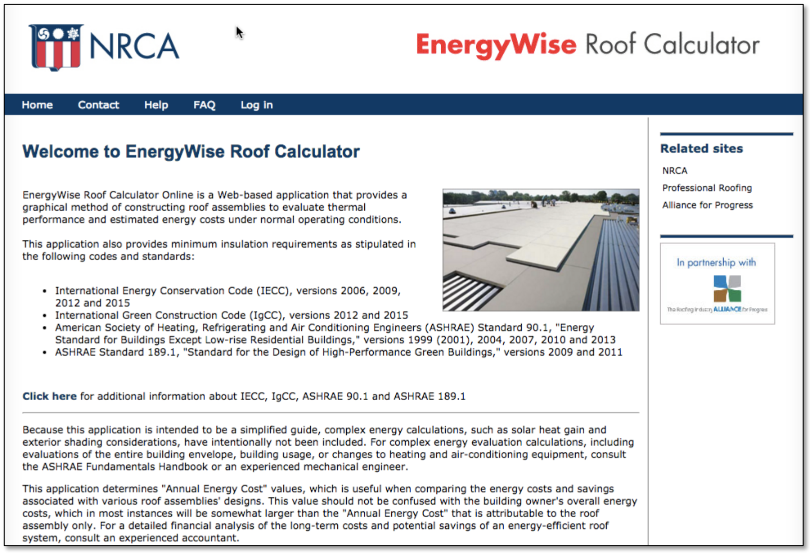
Commercial Buildings (Insulation component R-value-based method)

<table>
<tr><th>Climate Zone</th><th>IECC 2006</th><th>IECC 2009</th><th>IECC 2012*</th><th>IECC 2015*</th></tr>
<tr><td>1</td><td rowspan="4">R-15 ci</td><td>R-15 ci</td><td rowspan="3">R-20 ci</td><td>R-20 ci</td></tr>
<tr><td>2</td><td rowspan="5">R-20ci</td><td rowspan="2">R-25 ci</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="3">R-25 ci</td><td rowspan="3">R-30 ci</td></tr>
<tr><td>5</td><td rowspan="2">R-20 ci</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td><td rowspan="2">R-25 ci</td><td rowspan="2">R-25 ci</td><td rowspan="2">R-30 ci</td><td rowspan="2">R-35 ci</td></tr>
<tr><td>8</td></tr>
</table>

* Applies to roof replacement projects
ci = continuous insulation

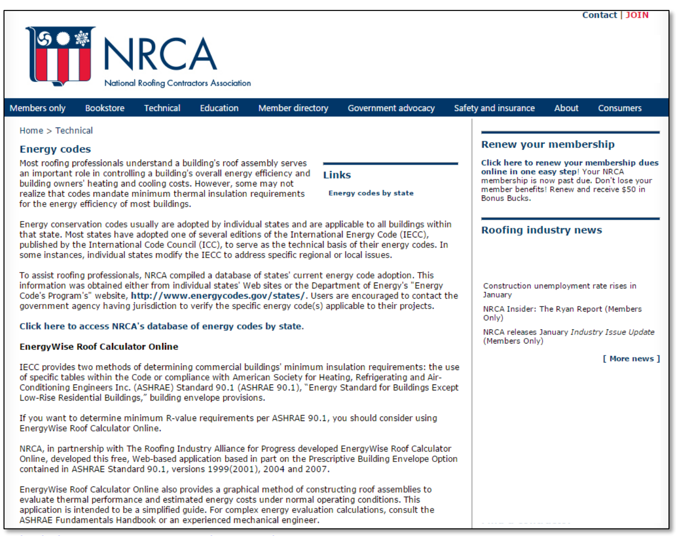
EnergyWise

energywise.nrca.net



NRCA energy code adoption database

www.nrca.net/Technical/EnergyCodes



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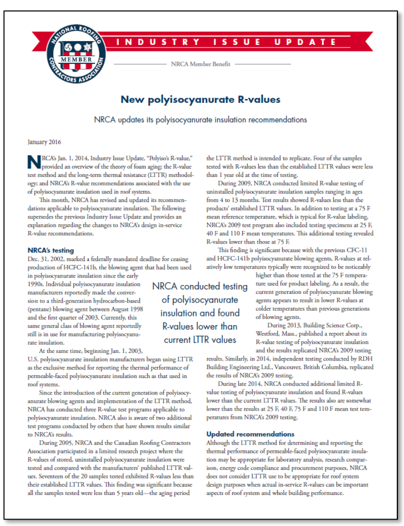
Polyisocyanurate insulation

NRCA's revised polyiso. R-value recommendation



INDUSTRY ISSUE UPDATE

NRCA Member Benefit

New polyisocyanurate R-values

NRCA updates its polyisocyanurate insulation recommendations

January 2016

NRCA's Jan. 1, 2014, Industry Issue Update, "Polyiso's R-value," provided an overview of the theory of foam aging; the R-value test method and the long-term thermal resistance (LTTR) methodology; and NRCA's R-value recommendations associated with the use of polyisocyanurate insulation used in roof systems.

This month, NRCA has revised and updated its recommendations applicable to polyisocyanurate insulation. The following supersedes the previous Industry Issue Update and provides an explanation regarding the changes to NRCA's design in-service R-value recommendations.

NRCA's testing

Dec. 31, 2002, marked a federally mandated deadline for ceasing production of HCFC-141b, the blowing agent that had been used in polyisocyanurate insulation since the early 1990s. Individual polyisocyanurate insulation manufacturers reportedly made the conversion to a third-generation hydrocarbon-based (pentane) blowing agent between August 1998 and the first quarter of 2003. Currently, this same general class of blowing agent reportedly still is in use for manufacturing polyisocyanurate insulation.

At the same time, beginning Jan. 1, 2003, U.S. polyisocyanurate insulation manufacturers began using LTTR as the exclusive method for reporting the thermal performance of permeable-faced polyisocyanurate insulation such as that used in roof systems.

Since the introduction of the current generation of polyisocyanurate blowing agents and implementation of the LTTR method, NRCA has conducted three R-value test programs applicable to polyisocyanurate insulation. NRCA also is aware of two additional test programs conducted by others that have shown results similar to NRCA's results.

During 2005, NRCA and the Canadian Roofing Contractors Association participated in a limited research project where the R-values of stored, uninstalled polyisocyanurate insulation were tested and compared with the manufacturers' published LTTR values. Seventeen of the 20 samples tested exhibited R-values less than their established LTTR values. This finding was significant because all the samples tested were less than 5 years old—the aging period the LTTR method is intended to replicate. Four of the samples tested with R-values less than the established LTTR values were less than 1 year old at the time of testing.

During 2009, NRCA conducted limited R-value testing of uninstalled polyisocyanurate insulation samples ranging in ages from 4 to 13 months. Test results showed R-values less than the products' established LTTR values. In addition to testing at a 75 F mean reference temperature, which is typical for R-value labeling, NRCA's 2009 test program also included testing specimens at 25 F, 40 F and 110 F mean temperatures. This additional testing revealed R-values lower than those at 75 F.

This finding is significant because with the previous CFC-11 and HCFC-141b polyisocyanurate blowing agents, R-values at relatively low temperatures typically were recognized to be noticeably higher than those tested at the 75 F temperature used for product labeling. As a result, the current generation of polyisocyanurate blowing agents appears to result in lower R-values at colder temperatures than previous generations of blowing agents.

NRCA conducted testing of polyisocyanurate insulation and found R-values lower than current LTTR values

During 2013, Building Science Corp., Westford, Mass., published a report about its R-value testing of polyisocyanurate insulation and the results replicated NRCA's 2009 testing results. Similarly, in 2014, independent testing conducted by RDH Building Engineering Ltd., Vancouver, British Columbia, replicated the results of NRCA's 2009 testing.

During late 2014, NRCA conducted additional limited R-value testing of polyisocyanurate insulation and found R-values lower than the current LTTR values. The results also are somewhat lower than the results at 25 F, 40 F, 75 F and 110 F mean test temperatures from NRCA's 2009 testing.

Updated recommendations

Although the LTTR method for determining and reporting the thermal performance of permeable-faced polyisocyanurate insulation may be appropriate for laboratory analysis, research comparison, energy code compliance and procurement purposes, NRCA does not consider LTTR use to be appropriate for roof system design purposes when actual in-service R-values can be important aspects of roof system and whole building performance.

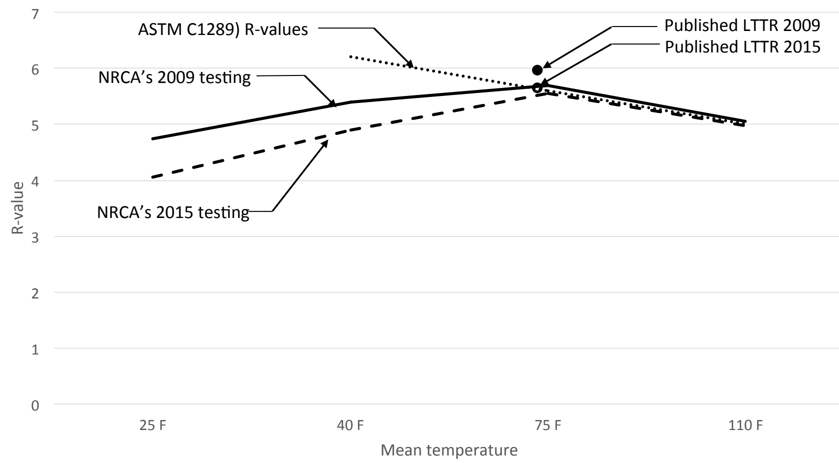
NRCA recommends designers:

- Use an in-serve design R-value of 5.0 per inch thickness for polyiso.
- Specify insulation by its thickness, not its R-value

NRCA's recommendation is based upon our own testing, and confirming replicate testing by:

- Building Science Corp.
- RDH Building Engineering, Ltd.

NRCA's R-value testing



Polyisocyanurate insulation testing

Physical property testing

Purpose

NRCA's polyisocyanurate insulation testing

Analyze critical physical properties of faced polyisocyanurate insulation products and compare results to applicable the ASTM product standard and past test results

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Past testing

NRCA's polyisocyanurate insulation testing

2002 testing:

- HCFC-141b blowing agent
- Hydrocarbon-based blowing agent (current)

2009 testing:

- Hydrocarbon-based blowing agent (current)

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2015 testing

NRCA's polyisocyanurate insulation testing

- Density (not in ASTM C1289)
- Compressive strength
- Dimensional stability
- Flexural strength
- Tensile strength
- Knit line assessment (not in ASTM C1289)

Sample	Facer type	Density (lb/ft³)	
		Apparent overall density	Apparent foam core density
1-A	Cellulosic (Class 1)	2.16	1.57
1-B	Coated fiberglass (Class 2)	3.80	1.68
2	Cellulosic (Class 1)	2.25	1.56
3	Cellulosic (Class 1)	2.26	1.65
4	Cellulosic (Class 1)	2.25	1.64
5	Coated fiberglass (Class 2)	3.16	1.79
6	Cellulosic (Class 1)	2.39	1.68

Sample	Compressive strength (psi)		
	With facers	Machine direction	Cross-machine direction
1-A	22.3	16.1	26.5
1-B	28.4	21.2	29.8
2	24.4	16.7	22.0
3	24.5	17.5	19.4
4	23.5	18.5	21.0
5	24.4	20.6	19.8
6	24.5	18.9	21.1
ASTM C1289, Type II requirement	Grade 1: 16 (minimum) Grade 2: 20 (minimum) Grade 3: 25 (minimum)	No requirement	

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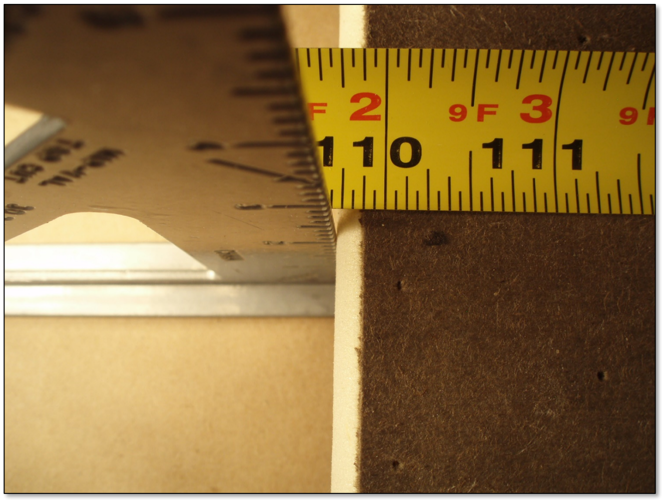
Sample	Dimensional stability (Percent linear change after seven days at 158 F and 97 percent relative humidity)		
	Machine direction	Cross-machine direction	Thickness
1-A	1.22	1.27	1.77
1-B	0.54	1.31	5.88
2	3.35	2.91	-1.11
3	2.42	1.53	3.19
4	2.14	2.24	1.21
5	0.56	0.75	3.74
6	2.52	1.96	1.68
ASTM C1289, Type II requirement	2.0 (maximum)		4.0 (maximum)

Shaded cells denote values in excess of maximal ASTM allowable requirement

NRCA

Dimensional stability – "Edge growth"



View from board topside (top facer) looking down.

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Sample	Flexural strength Modulus of rupture (psi)	Break strength (lbf)	Tensile strength perpendicular to surface (lbf/ft³)
1-A	MD: 79.6 XMD: 61.2	MD: 64.8 XMD: 49.3	3259
1-B	MD: 127.9 XMD: 135.5	MD: 102.4 XMD: 108.2	2590
2	MD: 93.0 XMD: 64.1	MD: 75.4 XMD: 51.1	3080
3	MD: 98.4 XMD: 59.5	MD: 75.8 XMD: 47.2	3083
4	MD: 73.0 XMD: 52.6	MD: 58.1 XMD: 42.2	2904
5	MD: 121.1 XMD: 93.6	MD: 92.9 XMD: 76.9	3668
6	MD: 96.3 XMD: 55.8	MD: 71.3 XMD: 41.7	2657
ASTM C1289, Type II requirement	40	17	500

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Surface depressions—"rutting"

Correspond to knit lines

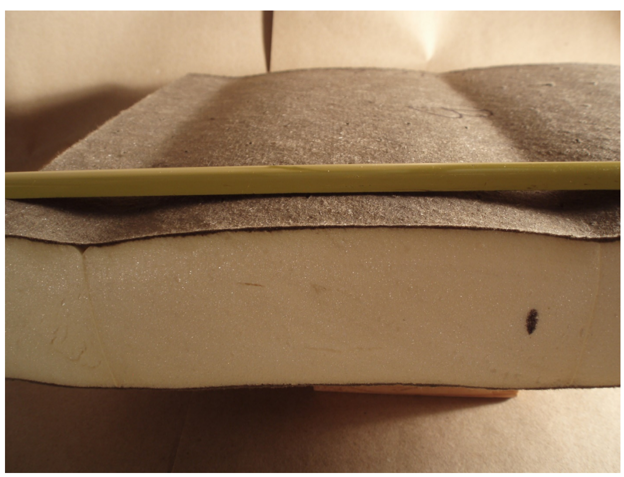
Sample	Board side indication	Knit line depth (inch)							
		Line 1	Line 2	Line 3	Line 4	Line 5	Line 6	Line 7	Line 8
1-A	None	-0.084	-0.078	-0.068	—	—	—	—	—
	"This side down"	-0.061	-0.137	-0.110					
1-B	None	-0.038	-0.030	-0.048	—	—	—	—	—
	None	-0.049	-0.085	-0.041					
2	None	-0.015	-0.059	-0.060	-0.028	-0.020	-0.028	-0.010	-0.005
	"This side down"	-0.130	-0.167	-0.161	-0.193	-0.210	-0.166	-0.171	-0.143
3	None	-0.023	-0.049	-0.046	-0.051	-0.047	—	—	—
	None	-0.015	-0.031	-0.045	-0.036	-0.021			
4	None	-0.035	-0.038	-0.068	-0.055	-0.062	—	—	—
	"This side down"	-0.091	-0.112	-0.122	-0.114	-0.072			
5	None	-0.023	-0.036	-0.045	-0.040	-0.025	—	—	—
	None	-0.013	-0.016	-0.013	-0.013	-0.012			
6	None	-0.136	-0.169	-0.189	-0.170	-0.171	-0.173	-0.165	-0.146
	None	-0.035	-0.015	-0.017	-0.007	-0.005	-0.018	-0.036	-0.037

Shaded cells denote values greater than ⅛-inch depth

Combining dimensional stability and knit lines issues

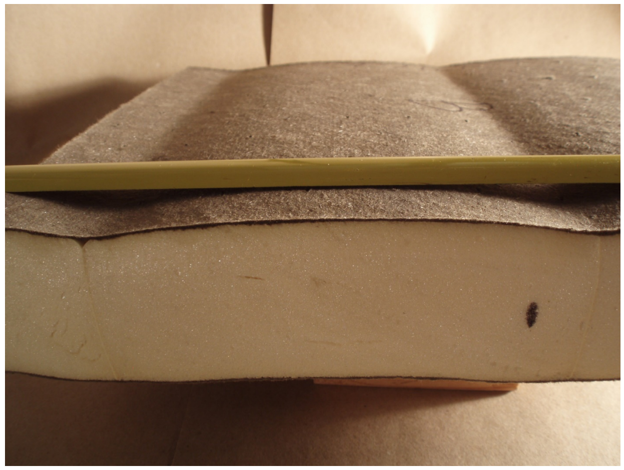
As delivered by manufacturer.

Combining dimensional stability and knit lines issues – cont.



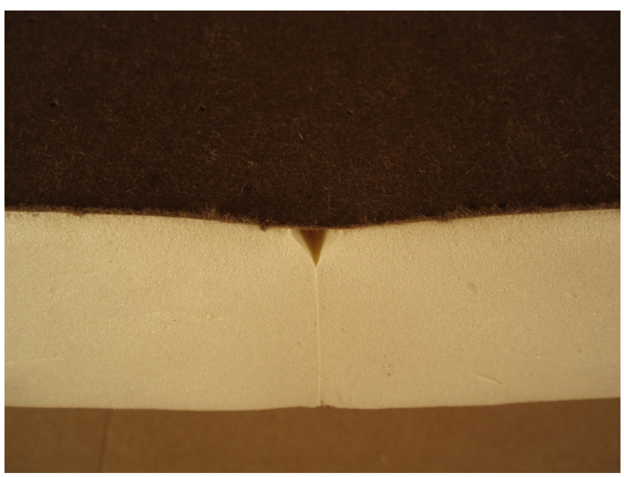
After conditioning

Combining dimensional stability and knit lines issues – cont.



After conditioning

Combining dimensional stability and knit lines issues – cont.



Knit line and V-groove close-up (after conditioning)

Conclusions

NRCA's polyisocyanurate insulation testing

- Only 2 of the 7 products tested comply with ASTM C1289
- Revisions to ASTM C1289 are needed:
  - Address knit lines and "rutting"

NRCA has already met with several polyisocyanurate insulation manufacturers… and we look forward to working constructively with individual manufacturers at ASTM International and elsewhere in the industry to address these issues.

Modified bitumen sheet testing

Purpose

NRCA's MB sheet testing

Analyze critical physical properties of popular MB sheet products and compare results to applicable ASTM product standards and past test results

Modified bitumen sheet testing

ASTM D5147-Test methods for MB sheet materials

Low-temperature flexibility test:

- 1” diameter mandrel
- 180° bend
- Visually observe cracking

Granule loss test:

- Weigh specimen
- 50 scrub cycles
- Re-weigh specimen
- Calculate difference

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NRCA’s 2011 MB testing

Polymer-modified bitumen test results

Product (manufacturer and product)	Low-temperature flexibility		Granule embedment (as received)
	As received	Heat aged (90 days at 158 F)	
SBS products			
1-1	-5	+5	0.8
1-2	-15	-10	1.0
2-1	+5	+20	1.4
2-2	-20	-15	1.8
2-3	-5	+20	3.2
2-4	+10	+15	1.2
3-1	+30	+45	0.3
3-2	-5	0	0.3
3-3	+25	+40	1.5
4-1	-5	+5	1.1
5-1	+5	+10	0.5
6-1	-5	-5	0.7
6-2	+10	+20	1.7
APP products			
1-3	+30	+15	1.5
3-4	+35	+20	0.4
7-1	+15	+15	1.6

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Summary of results

NRCA's 2011 MB testing

- 9 of 13 SBS products did not comply with ASTM's low-temp. flex requirement (0 F max.)
- 1 of 3 APP products did not comply with ASTM's low-temp. flex requirement (32 F max.)
- 1 of 16 products did not comply with ASTM's granule loss requirement (2 grams max.)

NRCA's 2015 MB testing

Polymer-modified bitumen test results

Sample (manufacturers and product)	Low-temperature flexibility (F)		Granule embedment as received (grams)
	As received	Heat aged (90 days at 158 F)	
SBS products			
1-A	-25	-25	0.9
2-A	-20	-15	1.6
2-B	0	15	0.7
2-C	-35	-15	1.3
3-A	10	20	1.8
4-A	-30	-30	1.1
4-B	-15	-5	0.8
5-A	-5	0	0.6
5-B	10	10	0.7
6-A	-20	-15	1.1
9-A	-30	-15	0.6
ASTM International's maximum allowable values	0	0	2
APP products			
3-B	20	20	0.7
8-A	20	35	3.4
ASTM International's maximum allowable values	32	32	2

Summary of results

NRCA's 2015 MB testing

- 3 of 11 SBS products did not comply with ASTM's low-temp. flex requirement (0 F max.)
- 1 of 2 APP products did not comply with ASTM's low-temp. flex requirement (32 F max.)
- 1 of 13 products did not comply with ASTM's granule loss requirement (2 grams max.)

Recommendations

NRCA's 2011 and 2015 MB testing

Seek third-party certifications of compliance with the applicable ASTM product standard:

– UL product certification
– ICC-ES evaluation report
– Miami-Dade County product approval

Wind design for roof assemblies

Specifying a wind warrantee, in itself, is not proper wind design

Proper wind design

- Determine wind loads
  - IBC Ch. 16-Structural Design
  - ASCE 7-10, "Minimum Design Loads for Buildings and Other Structures"
- Design for resistance
  - FM 4474
  - UL 580 or UL 1897

IBC requires (Sec. 1603) design wind loads to be shown in the Construction Documents

Design wind load determination

www.roofwinddesigner.com

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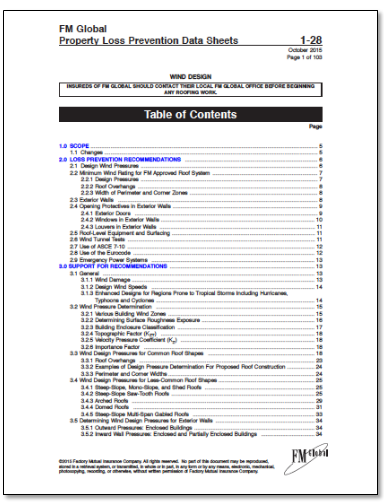
FM 1-28 has been updated

www.fmglobaldatasheets.com



- October 2015 update
- Based upon ASCE 7-05 with enhancements
- Reformatted
- Be cautious of FM-insured projects
- See *Professional Roofing*, March 2016

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Professional Roofing, March 2016

TECH TODAY

A new consideration

FM 1-28 has been updated, further complicating wind designs

by Mark S. Graham

FM Global recently updated its Property Loss Prevention Data Sheet 1-28, "Wind Design" (FM 1-28). The data sheet provides general guidance to building designers regarding wind considerations for highly protected buildings insured by FM Global.

FM 1-28's revisions

The new edition of FM 1-28 is dated October 2015 and was first publicly distributed in late November 2015. The document's previous edition was published in April 2011.

FM 1-28 has been completely revised and reformatted and expanded. The current edition consists of 103 pages; the previous edition had 72 pages.

FM 1-28 typically results in higher design wind pressures and recommended resistance ratings

FM 1-28's wind design guidance continues to be based on ASCE 7-05, "Minimum Design Loads for Buildings and Other Structures," though FM 1-28 contains some enhancements that typically result in higher design wind pressures and recommended resistance ratings. Conversely, the 2012 and 2015 editions of the International Building Code® (IBC) reference ASCE 7's 2010 edition, which can result in notably different design wind loads from those derived using FM 1-28.

FM 1-28 recommends roof field, perimeter and corner design wind pressures be determined using the ratings calculator in FM Approvals' RoofNav® online application (www.RoofNav.com). FM 1-28's previous editions included specific calculation procedures and tables for determining design wind pressures.

Not included in FM 1-28's new edition is Table 8 from FM 1-28's previous edition, which provided FM Global's recommended resistance ratings based on design wind pressures. When determining recommended resistance ratings, FM 1-28 now directs users to multiply basic uplift pressures by the applicable pressure coefficients, apply a 2.0 safety factor and round up the resulting values to the next highest 15-pound-per-square-foot increment. This procedure likely will cause some user confusion. The RoofNav ratings calculator already includes the recommended safety factor and rounding.

FM 1-28's recommendations for roof overhangs have been reworked, and some roof overhang factors (Table 7) have been increased, which will result in higher design wind pressures at roof overhangs with roof slopes of 1.5:12 and greater.

FM 1-28's Section 3.7-Designing for Windborne Debris includes a specific calculation procedure for determining separation distances between buildings in locations prone to tropical storms where aggregate roof surfacings are used.

FM 1-28's Section 3.8-Roof-mounted Equipment adds guidance to determine resistance to uplift, sliding and overturning in high winds for rooftop equipment. The guidelines for roof-mounted equipment generally are consistent with ASCE 7-10.

FM 1-28's Appendix D-Optional Guidance for Tornado-resistant Design and Construction provides optional guidance for important facilities that may warrant additional property protection in locations subject to tornadoes.

FM 1-28 and ASCE 7-10

FM 1-28 includes a discussion and example comparisons of the differences in design wind pressures using FM 1-28 and ASCE 7-10 (as well as IBC 2012 and IBC 2015).

FM 1-28 uses basic wind speeds based on a 50-year mean recurrence interval (MRI) and approaching a 100-year MRI along coastal areas, as well as an importance factor of 1.15 and recommended safety factor of 2.0. Conversely, ASCE 7-10's strength design method for components and claddings uses ultimate wind speeds based on 300-, 700- and 1,700-year MRIs.

ASCE 7-10 also provides a method for converting strength design method results to allowable stress design (ASD) method values, which are more comparable to FM 1-28's results.

FM 1-28 typically results in higher—sometimes notably higher—design wind pressures and recommended resistance ratings than those derived using ASCE 7-10's strength design or ASD methods.

Closing thoughts

The revision of FM 1-28 has resulted in changes to FM Global's recommendations to designers of highly protected buildings insured by FM Global.

Designers using FM 1-28 need to realize it typically results in higher design wind pressures and recommended resistance ratings than when using ASCE 7-10, IBC 2012 and IBC 2015.

MARK S. GRAHAM is NRCA's vice president of technical services.

ON the WEB

For a link to download FM 1-28 and example calculations comparing the differences between FM 1-28 and ASCE 7-10, log on to www.professionalroofing.net.

14 www.professionalroofing.net MARCH 2016

- Use RoofNav's ratings calculator
- Apply a 2.0 safety factor
- Roof overhang factors (Table 7)
- Windborne debris separation distances
- Roof-mounted equipment (ASCE 7-10)
- Tornado-resistant design (Appendix)

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Comparing FM 1-28 to ASCE 7-05 and ASCE 7-10

Example: A manufacturing building located in New Orleans, LA. The building is an enclosed structure with a low-slope roof system and a roof height of 33 ft. The building is located in an area that is categorized as Exposure Category C.

Document	Basic wind speed (mph)	Design wind pressure (psf)		
		Zone 1 (Field)	Zone 2 (Perimeter)	Zone 3 (Corner)
FM 1-28 (without SF)	v = 120	43	72	108
FM 1-28 (w/ 2.0 SF)		86	144	216
ASCE 7-05 (without SF)	v = 120	38	63	95
ASCE 7-05 (w/ 2.0 SF)		76	126	190
ASCE 7-10 Strength design	v_{ULT} = 150	59	99	148
ASCE 7-10 ASD (without SF)	v_{ASD} = 116	35	59	89
ASCE 7-10 ASD (w/ 2.0 SF)		71	118	178

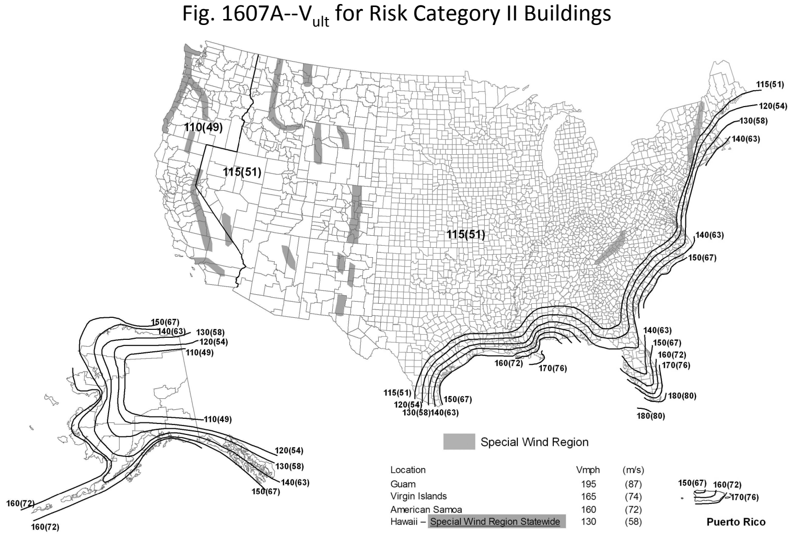
ASCE 7-16 (public review draft)

- Revised basic wind speed map
- Changes (and new) pressure coefficients
- Revised perimeter and corner zones

Expect higher field, perimeter and corner uplift pressures

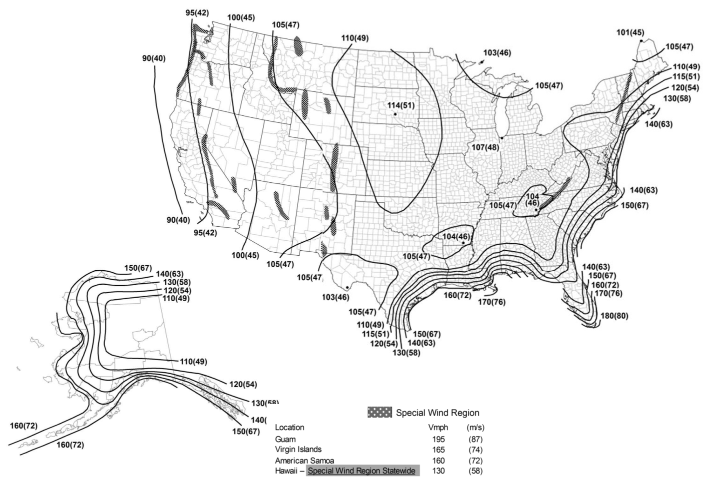
ASCE 7-10 basic wind speed map

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



ASCE 7-16 (draft) basic wind speed map

Risk Category II Buildings



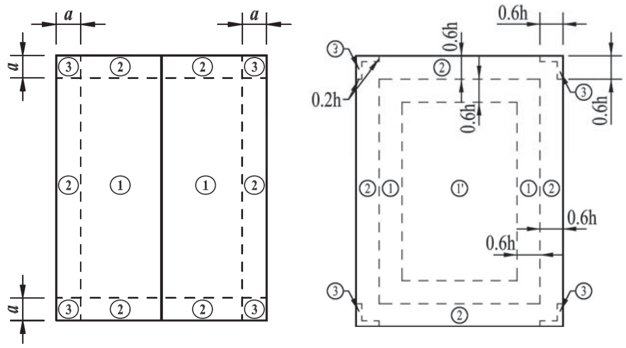
GC_p pressure coefficients

h ≤ 60 ft., gable roofs ≤ 7 degrees

Zone	ASCE 7-10	ASCE 7-16 (draft)
1’	--	-0.9
1	-1.0	-1.7
2 (perimeter)	-1.8	-2.3
3 (corners)	-2.8	-3.2

Zones

h ≤ 60 ft., gable roofs ≤ 7 degrees



ASCE 7-10 **ASCE 7-16 (draft)**

Proper wind design is oftentimes avoided…

and it's only going to get more complicated

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The NRCA Roofing Manual

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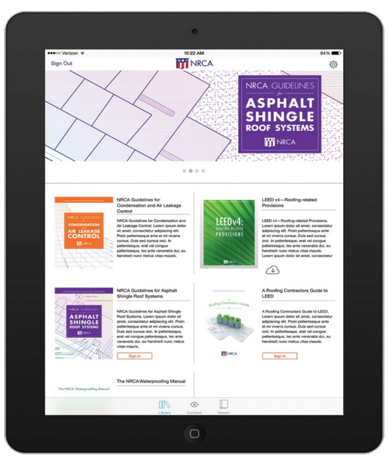
NRCA App



- NRCA App available on the Apple Store and Google Play Store for tablets
- iPhone App also available
- Register within App as being an NRCA member
- The NRCA Roofing Manual is viewable to NRCA members
- Favorite and send pages features

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Manual online

www.nrca.net

- Available to all NRCA member registered users (multiple users per member company)
- "Members only" section, click on "My account", the "Electronic file"
- View, download and print

Questions

Mark S. Graham
Vice President, Technical Services
National Roofing Contractors Association
10255 West Higgins Road, 600
Rosemont, Illinois 60018-5607

(847) 299-9070
mgraham@nrca.net
www.nrca.net

Twitter: @MarkGrahamNRCA
Personal website: www.MarkGrahamNRCA.com