NRCA
LEGAL RESOURCE CENTER

LegalCon
Rosemont, IL
March 12, 2020

Emerging Technical Issues Posing Liability Risks for your Business

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

1

Moisture in concrete roof decks

2

PORTLAND CEMENT ASSOCIATION
RESEARCH AND DEVELOPMENT LABORATORIES
Development Department • Bulletin D89

Table 1

Drying time in days at 73 F and 50% relative Humidity for a 4-inch-thick specimen to reach 3 lbs/1,000 sq. ft./24 hrs.

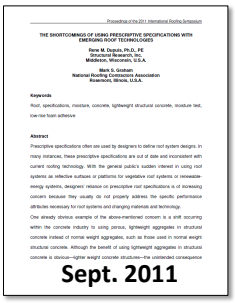
Water-Cement Ratio	Bottom Sealed	Bottom Exposed to Water Vapor	Bottom in Contact with Water
0.4	46	52	54
0.5	85	144	199
0.6	117	365	>>365
0.7	130	>>365	>>365
0.8	148	>>365	>>365
0.9	166	>>365	>>365
1.0	190	>>365	>>365

3

Moisture in concrete roof decks


Moisture in concrete roof decks

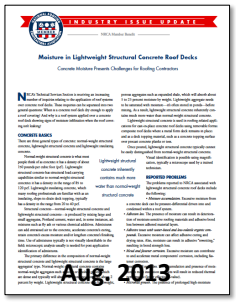
Feb. 2010


THE SHORTCOMINGS OF USING PRESCRIPTIVE SPECIFICATIONS WITH EMERGING ROOF TECHNOLOGIES

Sept. 2011


TECH TODAY
Concrete deck dryness

Dec. 2012


INDUSTRY ISSUE UPDATE
Moisture in Lightweight Structural Concrete Roof Decks

Aug. 2013

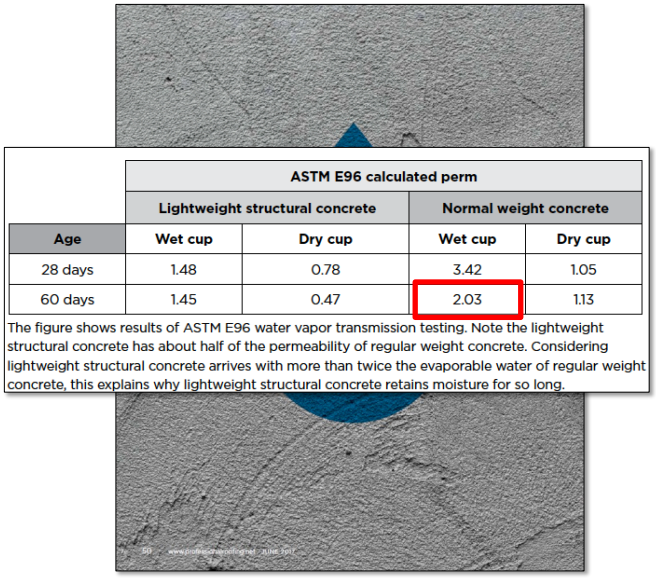

TECH TODAY
A troubling issue

Dec. 2013


RESEARCH+TECH
Moisture in concrete roof decks

Sept. 2017

4



	ASTM E96 calculated perm			
	Lightweight structural concrete		Normal weight concrete	
Age	Wet cup	Dry cup	Wet cup	Dry cup
28 days	1.48	0.78	3.42	1.05
60 days	1.45	0.47	2.03	1.13

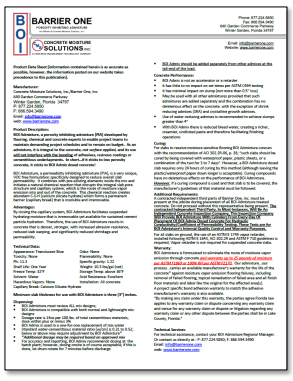
The figure shows results of ASTM E96 water vapor transmission testing. Note the lightweight structural concrete has about half of the permeability of regular weight concrete. Considering lightweight structural concrete arrives with more than twice the evaporable water of regular weight concrete, this explains why lightweight structural concrete retains moisture for so long.

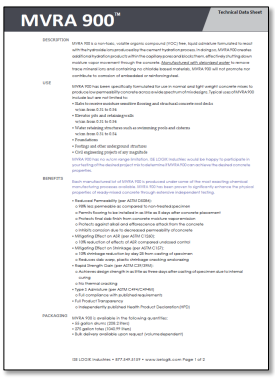
Professional Roofing, June 2017

Professional Roofing, December 2018

5

Moisture vapor reduction admixtures (MVRAs)





NRCA still has not seen an MVRA perform successfully in concrete <u>roof deck</u> applications

6

RESEARCH+TECH

	Deck 1 (no MVRA)		Deck 2 (with an MVRA)		Deck 3 (with an MVRA)	
Specimen No.	1-1	1-2	2-1	2-2	3-1	3-2
Permeability (U.S. perm)	1.9	1.8	3.7	3.4	3.7	3.8

Table: Average tested permeability values

Putting it to the test

NRCA conducts testing of moisture vapor reduction admixtures

by Mark S. Graham

tion admixture intended to minimize a concrete roof deck's ability to pass and release moisture vapor. Some background and an overview of NRCA's testing and results follow.

What's an MVRA?

Concrete admixtures intended as MVRAs are specific chemicals added during concrete's batching and mixing to provide an additional chemical reaction during the concrete's hydration and curing process. MVRAs use the concrete mix's excess water and chlorides to create a calcium silicate hydrate gel within the concrete. The gel is said to fill the small pores and capillary openings in curing concrete, minimizing the concrete's ability to pass and release moisture vapor. The gel is intended to be permanent and integral throughout the concrete thickness.

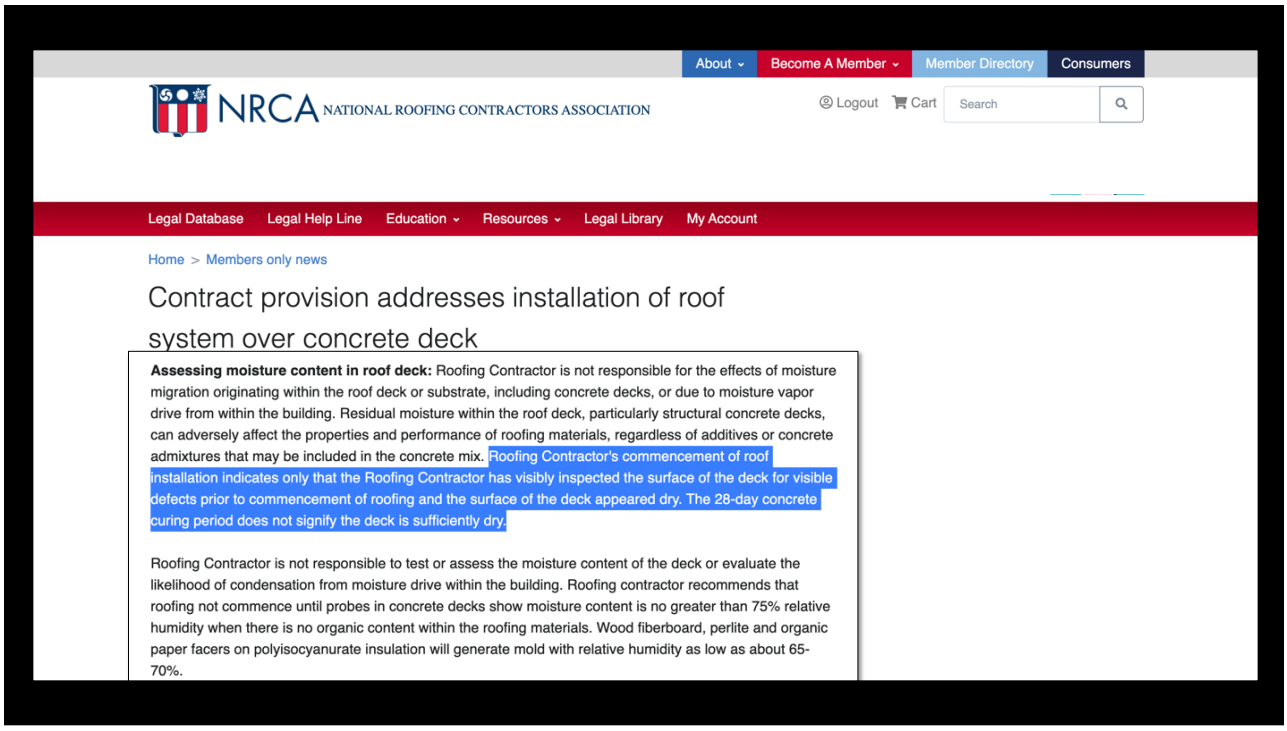
MVRAs are available from numerous suppliers and typically added to a concrete mix at the concrete batch plant separately from any other admixtures. Some MVRA suppliers permit their MVRAs to be added to concrete mixers at job sites provided the concrete mixer's drum is rotated for a supplier's recommended minimum amount of time after dosage and before concrete discharge and placement.

26 www.professionalroofing.net FEBRUARY 2020

Professional Roofing
February 2020

"…These test results contradict claims an MVRA minimizes concrete's ability to pass and release moisture vapor…"

7



8

Professional Roofing
March 2020

9

Coming soon...

- Publication of the final report on SRI's industry-sponsored concrete moisture research
- NRCA "Industry Issue update," which will summarize the research to date and provide NRCA latest recommendations

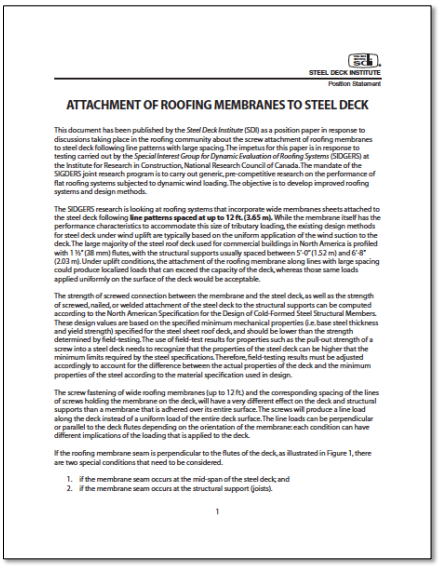
10

Steel roof decks/seam-fastened systems

11

SDI bulletin

2009



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 SIGDERS 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.

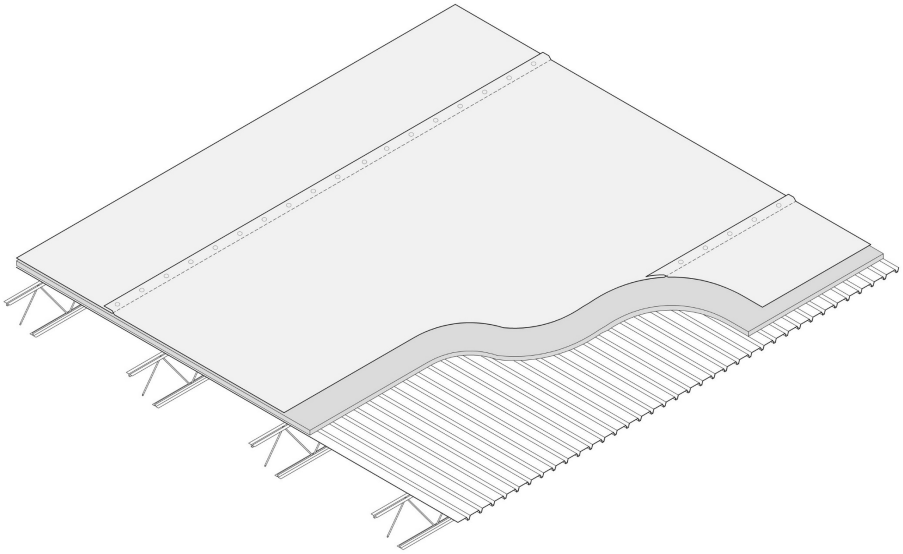
1. if the membrane seam occurs at the mid-span of the steel deck; and
2. if the membrane seam occurs at the structural support (joists).

1

- Decks designed for joist spacing between 5’ and 6’ 8” o.c.
- Deck designed for uniform loading
- Seam-fastened single-ply membranes are a concern

12

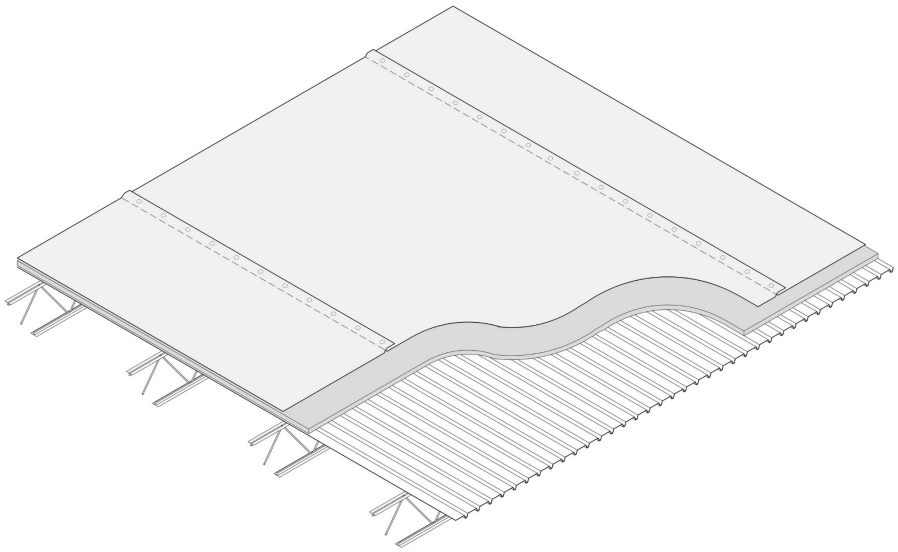
Membrane seams across deck flutes



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

13

Membrane seams in deck flute direction



SDI: 12 X bending moment and shear (deck)

14

SDI bulletin – Conclusion

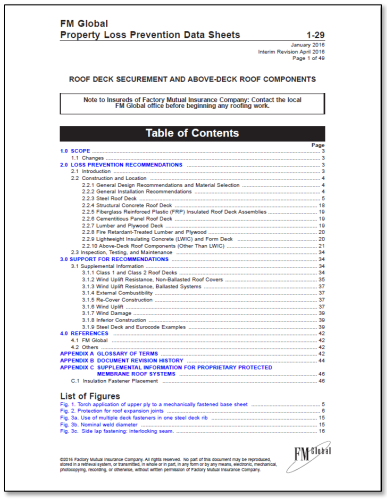
2009 bulletin

"…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."

15

FM Global's Loss Prevention Data Sheet 1-29

April 2016



FM Global
Property Loss Prevention Data Sheets 1-29

January 2016
Interim Revision April 2016
Page 1 of 49

ROOF DECK SECUREMENT AND ABOVE-DECK ROOF COMPONENTS

Note to Insureds of Factory Mutual Insurance Company: Contact the local FM Global office before beginning any roofing work.

Table of Contents

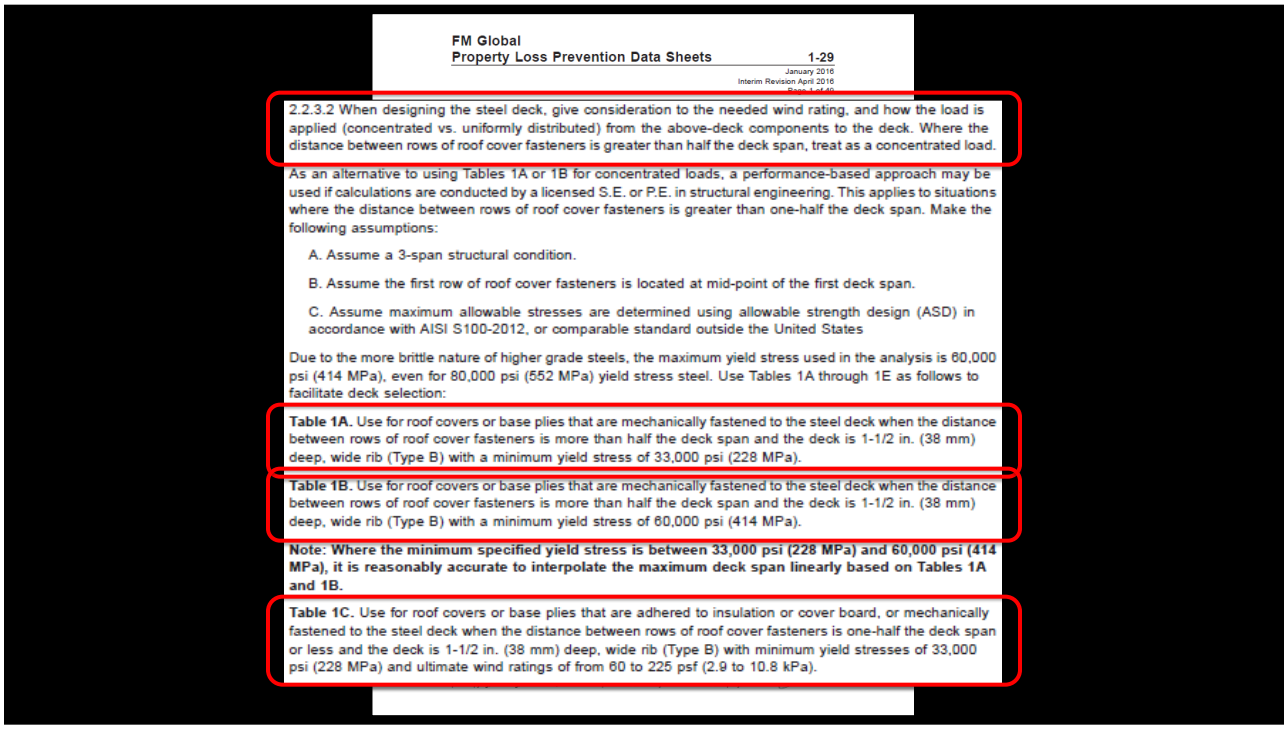
Page

List of Figures

Revised/new criteria:

- Steel roof decks:
  - Uniformly-distributed loading
  - Concentrated loading
- Lightweight structural concrete

16



FM Global
Property Loss Prevention Data Sheets 1-29

January 2016
Interim Revision April 2016

2.2.3.2 When designing the steel deck, give consideration to the needed wind rating, and how the load is applied (concentrated vs. uniformly distributed) from the above-deck components to the deck. Where the distance between rows of roof cover fasteners is greater than half the deck span, treat as a concentrated load.

As an alternative to using Tables 1A or 1B for concentrated loads, a performance-based approach may be used if calculations are conducted by a licensed S.E. or P.E. in structural engineering. This applies to situations where the distance between rows of roof cover fasteners is greater than one-half the deck span. Make the following assumptions:

A. Assume a 3-span structural condition.

B. Assume the first row of roof cover fasteners is located at mid-point of the first deck span.

C. Assume maximum allowable stresses are determined using allowable strength design (ASD) in accordance with AISI S100-2012, or comparable standard outside the United States

Due to the more brittle nature of higher grade steels, the maximum yield stress used in the analysis is 60,000 psi (414 MPa), even for 80,000 psi (552 MPa) yield stress steel. Use Tables 1A through 1E as follows to facilitate deck selection:

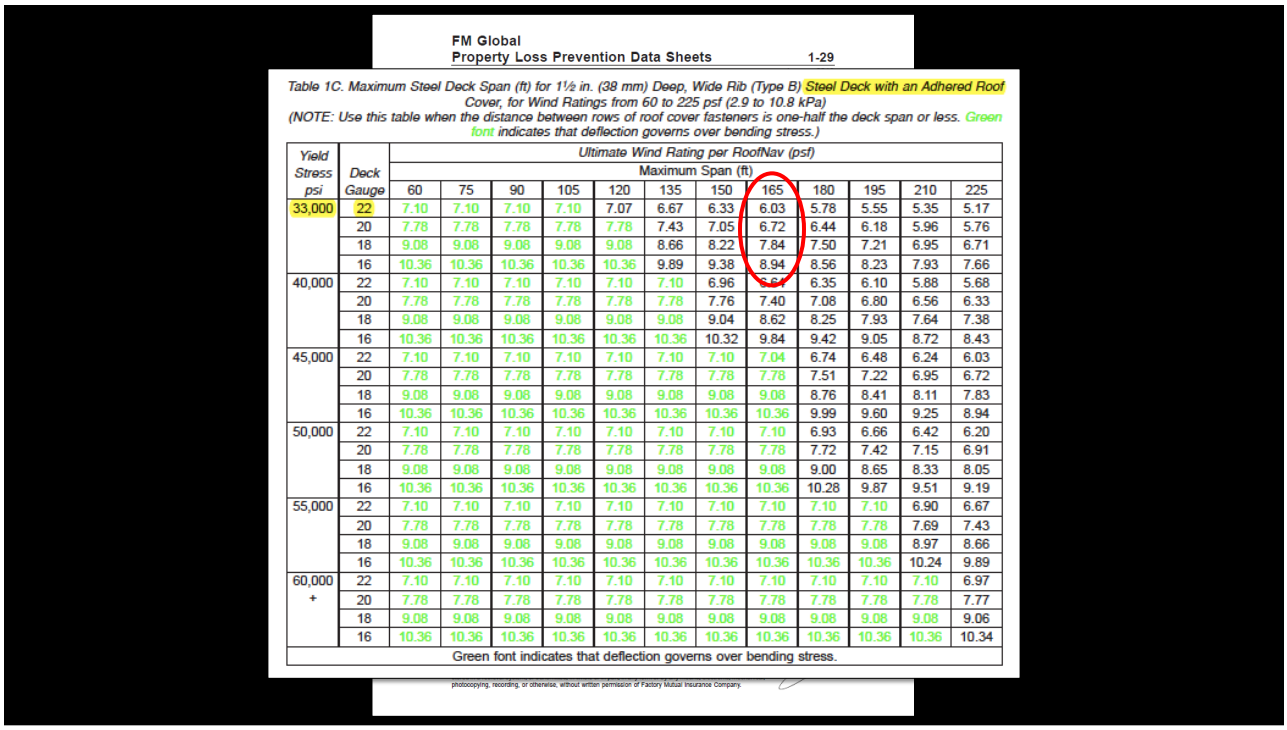
Table 1A. Use for roof covers or base plies that are mechanically fastened to the steel deck when the distance between rows of roof cover fasteners is more than half the deck span and the deck is 1-1/2 in. (38 mm) deep, wide rib (Type B) with a minimum yield stress of 33,000 psi (228 MPa).

Table 1B. Use for roof covers or base plies that are mechanically fastened to the steel deck when the distance between rows of roof cover fasteners is more than half the deck span and the deck is 1-1/2 in. (38 mm) deep, wide rib (Type B) with a minimum yield stress of 60,000 psi (414 MPa).

Note: Where the minimum specified yield stress is between 33,000 psi (228 MPa) and 60,000 psi (414 MPa), it is reasonably accurate to interpolate the maximum deck span linearly based on Tables 1A and 1B.

Table 1C. Use for roof covers or base plies that are adhered to insulation or cover board, or mechanically fastened to the steel deck when the distance between rows of roof cover fasteners is one-half the deck span or less and the deck is 1-1/2 in. (38 mm) deep, wide rib (Type B) with minimum yield stresses of 33,000 psi (228 MPa) and ultimate wind ratings of from 60 to 225 psf (2.9 to 10.8 kPa).

17



FM Global
Property Loss Prevention Data Sheets 1-29

Table 1C. Maximum Steel Deck Span (ft) for 1½ in. (38 mm) Deep, Wide Rib (Type B) Steel Deck with an Adhered Roof Cover, for Wind Ratings from 60 to 225 psf (2.9 to 10.8 kPa)
(NOTE: Use this table when the distance between rows of roof cover fasteners is one-half the deck span or less. Green font indicates that deflection governs over bending stress.)

Yield Stress psi	Deck Gauge	Ultimate Wind Rating per RoofNav (psf) — Maximum Span (ft)											
		60	75	90	105	120	135	150	165	180	195	210	225
33,000	22	7.10	7.10	7.10	7.10	7.07	6.67	6.33	6.03	5.78	5.55	5.35	5.17
	20	7.78	7.78	7.78	7.78	7.78	7.43	7.05	6.72	6.44	6.18	5.96	5.76
	18	9.08	9.08	9.08	9.08	9.08	8.66	8.22	7.84	7.50	7.21	6.95	6.71
	16	10.36	10.36	10.36	10.36	10.36	9.89	9.38	8.94	8.56	8.23	7.93	7.66
40,000	22	7.10	7.10	7.10	7.10	7.10	7.10	6.96	6.64	6.35	6.10	5.88	5.68
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.76	7.40	7.08	6.80	6.56	6.33
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.04	8.62	8.25	7.93	7.64	7.38
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.32	9.84	9.42	9.05	8.72	8.43
45,000	22	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.04	6.74	6.48	6.24	6.03
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.51	7.22	6.95	6.72
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	8.76	8.41	8.11	7.83
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	9.99	9.60	9.25	8.94
50,000	22	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	6.93	6.66	6.42	6.20
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.72	7.42	7.15	6.91
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.00	8.65	8.33	8.05
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.28	9.87	9.51	9.19
55,000	22	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	6.90	6.67
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.69	7.43
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	8.97	8.66
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.24	9.89
60,000 +	22	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	6.97
	20	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.78	7.77
	18	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.08	9.06
	16	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.36	10.34

Green font indicates that deflection governs over bending stress.

18

FM Global
Property Loss Prevention Data Sheets 1-29
January 2016
Interim Revision April 2016

Table 1A. Maximum Steel Deck Span (ft) for 1½ in. (38 mm) Deep, 33,000 psi (228 MPa) Yield Stress with a Mechanically Fastened Roof Cover
(Note: Use this table when the distance between rows of roof cover fasteners is more than one-half the deck span.)

Max Deck Spans By Wind Rating/Fastener Spacing, Sheet Gauge for 33 ksi, 1½ in. Deep Wide Rib Deck

Roof Cover Fastener Row Spacing (ft)	Gauge	Wind Rating [psf]																		
		330	315	300	285	270	255	240	225	210	195	180	165	150	135	120	105	90	75	60
3.5	18	4.5	5.5	5.5	5.5	5.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	-	4	4	4.5	4.5	4.5	5	5.5	5.5	5.5	6	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	4	4	4.5	4.5	4.5	5.5	5.5	5.5	6	6	6	6	6	6
4	18	4.5	4.5	5	5	5	6	6	6	6	6	6	6	6	6	6	6		6	6
	20	-	-	-	-	4	4.5	4.5	5	5	5.5	6	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	4	4.5	5	5	6	6	6	6	6	6	6
4.5	18	-	4	4	4.5	5	5	5.5	6	6	6	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	4	4	5	5	5.5	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	4	4.5	5	5.5	6	6	6	6	6
5	18	-	-	-	4	4	4.5	5	5	5.5	6	6	6	6	6	6	6	6	6	6
	20									4	4.5	5	5.5	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6	6	6
5.5	18	-	-	-	-	-	-	4	4.5	5	5.5	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5	6	6	6	6
6	18	-	-	-	-	-	-	-	-	4	5	5.5	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5.5	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5.5	6	6	6
6.5	18	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5.5	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	5.5	6	6
7	18	-	-	-	-	-	-	-	-	-	-	-	4	5.5	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.5	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	6	6
7.5	18	-	-	-	-	-	-	-	-	-	-	-	-	4	5.5	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	6	6

19

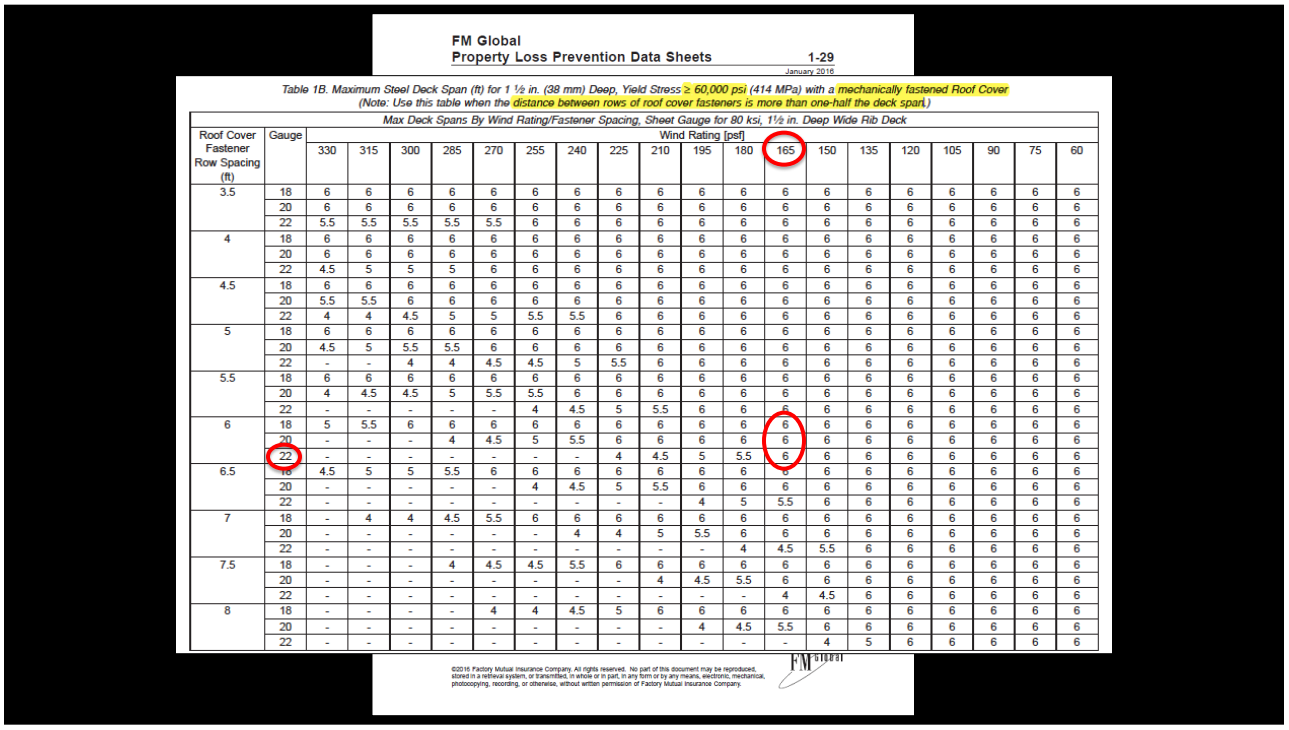
FM Global
Property Loss Prevention Data Sheets 1-29
January 2016
Interim Revision April 2016
Page 1 of 49

Table 1B. Maximum Steel Deck Span (ft) for 1½ in. (38 mm) Deep, Yield Stress ≥ 60,000 psi (414 MPa) with a mechanically fastened Roof Cover (continued)
(Note: Use this table when the distance between rows of roof cover fasteners is more than one-half the deck span.)

Max Deck Spans By Wind Rating/Fastener Spacing, Sheet Gauge for 80 ksi, 1½ in. Deep Wide Rib Deck

Roof Cover Fastener Row Spacing (ft)	Gauge	Wind Rating [psf]																		
		330	315	300	285	270	255	240	225	210	195	180	165	150	135	120	105	90	75	60
8.5	18	-	-	-	-	-	4	4	4.5	5	5.5	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	4	4	4.5	5.5	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6	6
9	18	-	-	-	-	-	-	4	4	4.5	5	5.5	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	4	4.5	5	5.5	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6
9.5	18	-	-	-	-	-	-	4	4	4	4.5	5	5.5	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	4	4	4.5	5	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6
10	18	-	-	-	-	-	-	-	4	4	4.5	4.5	5	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	4	4.5	4.5	5.5	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	4.5	5.5	6	6
10.5	18	-	-	-	-	-	-	-	4	4	4.5	4.5	5	5.5	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	4	4	4.5	5	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6
11	18	-	-	-	-	-	-	-	-	4	4	4.5	5	5	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	5.5	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6
11.5	18	-	-	-	-	-	-	-	-	-	4	4	4.5	5	5.5	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	5.5	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6
12	18	-	-	-	-	-	-	-	-	-	4	4	4.5	5	5.5	66		6	6	6
	20	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4.5	5	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5	5.5	6
Roof Cover Fastener Row Spacing	Gauge	330	315	300	285	270	255	240	225	210	195	180	165	150	135	120	105	90	75	60
		Wind Rating [psf]																		

20



FM Global
Property Loss Prevention Data Sheets 1-29
January 2016

Table 1B. Maximum Steel Deck Span (ft) for 1 ½ in. (38 mm) Deep, Yield Stress ≥ 60,000 psi (414 MPa) with a mechanically fastened Roof Cover (Note: Use this table when the distance between rows of roof cover fasteners is more than one-half the deck span.)

Max Deck Spans By Wind Rating/Fastener Spacing, Sheet Gauge for 80 ksi, 1½ in. Deep Wide Rib Deck

Roof Cover Fastener Row Spacing (ft)	Gauge	Wind Rating [psf]																		
		330	315	300	285	270	255	240	225	210	195	180	165	150	135	120	105	90	75	60
3.5	18	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	22	5.5	5.5	5.5	5.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6
4	18	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	22	4.5	5	5	5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
4.5	18	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	5.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	22	4	4	4.5	5	5	5.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6
5	18	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	4.5	5	5.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	22	-	-	4	4	4.5	4.5	5	5.5	6	6	6	6	6	6	6	6	6	6	6
5.5	18	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	4	4.5	4.5	5	5.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	4	4.5	5	5.5	6	6	6	6	6	6	6	6	6	6
6	18	5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	-	-	-	4	4.5	5	5.5	6	6	6	6	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	4	4.5	5	5.5	6	6	6	6	6	6	6	6
6.5	18	4.5	5	5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	4	4.5	5	5.5	6	6	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	4	5	5.5	6	6	6	6	6	6	6
7	18	-	4	4	4.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	4	4	5	5.5	6	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6	6	6	6
7.5	18	-	-	-	4	4.5	4.5	5.5	6	6	6	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	4	4.5	6	6	6	6	6	6
8	18	-	-	-	-	4	4	4.5	5	6	6	6	6	6	6	6	6	6	6	6
	20	-	-	-	-	-	-	-	-	-	4	4.5	5.5	6	6	6	6	6	6	6
	22	-	-	-	-	-	-	-	-	-	-	-	-	4	5	6	6	6	6	6

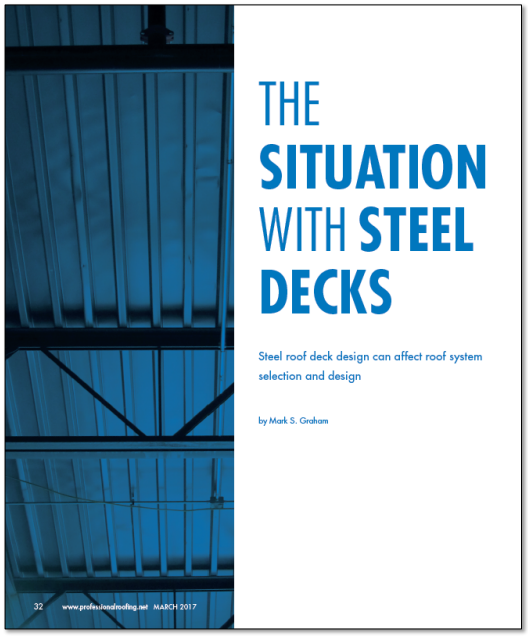
21

Summary of steel roof deck analysis

Assumption: 22 ga, 1-1/2-in.-thick steel roof deck on 6 ft. joist spacing (unless otherwise noted)

- Adhered membrane roof system:
  - 33 ksi deck (Table 1C): 165 psf max. uplift
- Mechanically-attached membrane system:
  - 33 ksi deck, 6 ft seam spacing (Table 1A): 90 psf max. uplift
  - 80 ksi deck, 9.5 ft. seam spacing (Table 1B): 90 psf max. uplift
  - 80 ksi deck, 6 ft seam spacing (Table 1B): 165 psf max. uplift

22



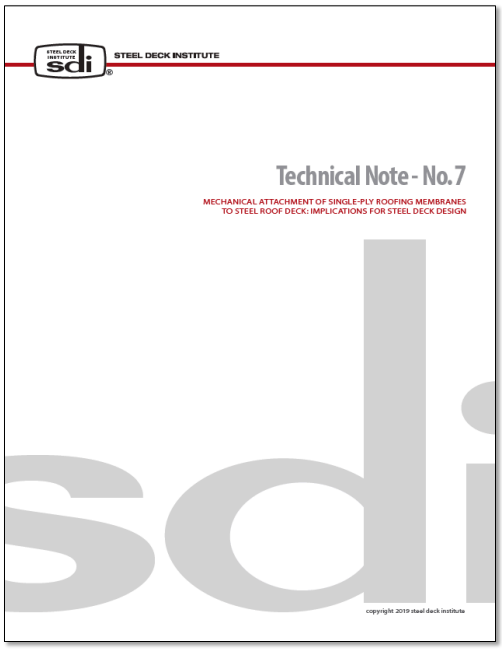
Professional Roofing
March 2017
www.professionalroofing.net

23

Fastener pull-out tests…

There is little correlation between fastener pull-out resistance and a steel roof deck's yield strength and uplift (bending) strength

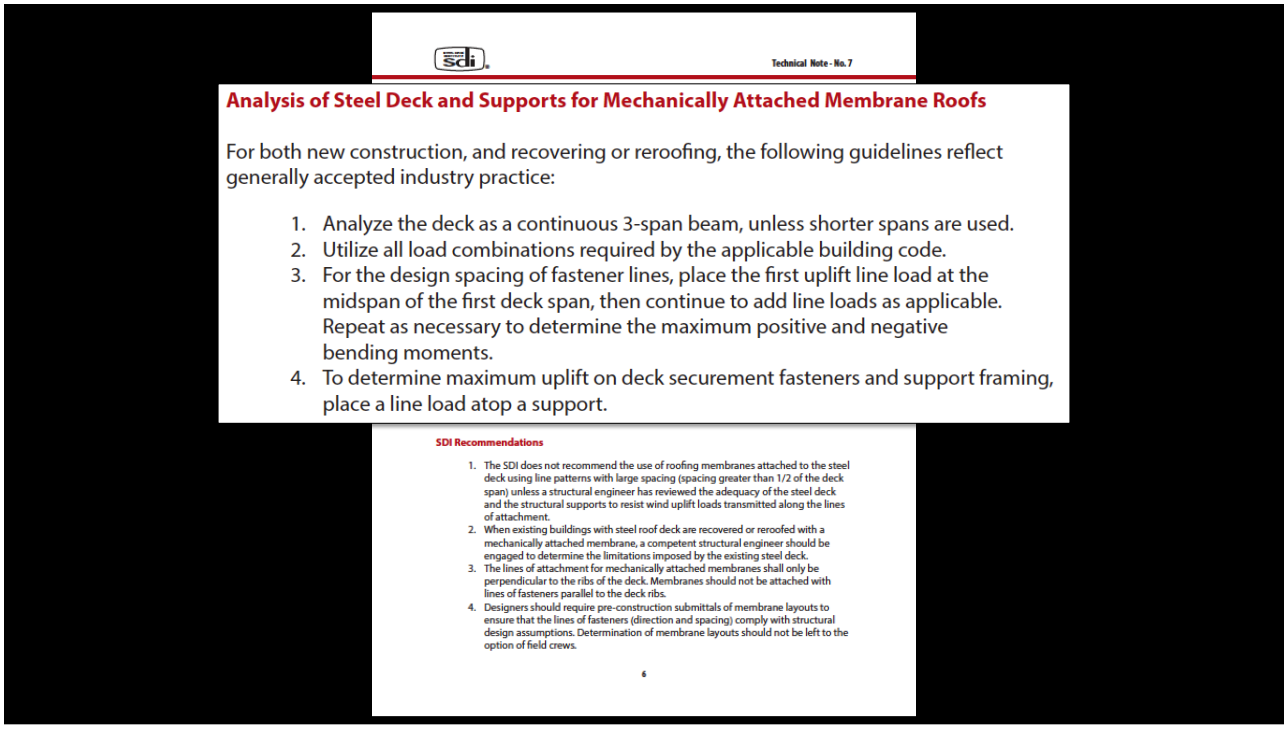
24



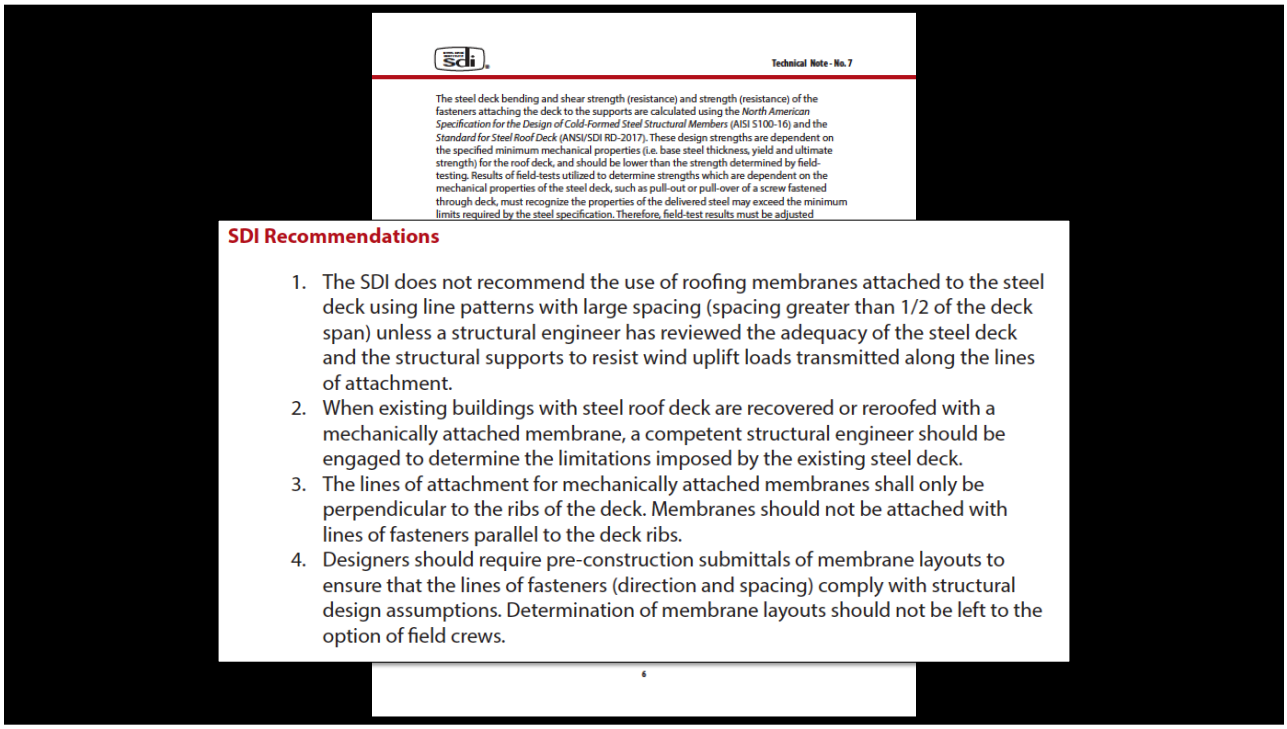
SDI Technical Note-No. 7 (Nov. 2019)

Mechanical attachment of single-ply roofing membranes to steel roof deck: Implications for steel deck design

25



26



27

Expect additional scrutiny of seam-fastened, mechanically-attached, single-ply membrane roof systems

28

RESEARCH+TECH

Consider the deck

SDI provides additional guidance for steel roof deck designers

by Mark S. Graham

In November 2019, the Steel Deck Institute issued new guidance for steel roof decks that features seam-fastened, mechanically attached, single-ply membranes. Although this guidance is directed toward roof deck designers, single-ply membrane manufacturers and suppliers, roof system designers and roofing contractors also should be aware of SDI's latest guidelines.

Previous guidance

In May 2009, SDI issued a position statement, "Attachment of Roofing Membranes to Steel Deck," indicating seam-fastened, mechanically attached, single-ply membrane roof systems apply wind-uplift loads to roof decks differently than adhered membrane roof systems. Although adhered membrane roof systems apply uplift loads uniformly across a roof deck, seam-fastened membrane systems result in concentrated line loads along the deck. Such line loads can result in excess bending moment and shear applied to the deck or a doubling of uplift loads on specific structural supports (joists) depending on the orientation of the membrane sheets relative to the deck flutes and joists.

SDI's document goes on to recommend structural engineers should review the adequacy of steel roof decks and their underlying

20 www.professionalroofing.net JANUARY 2020

Professional Roofing
January 2020

29

NUCOR VULCRAFT

VULCRAFT HOME | ABOUT US | BIM TECHNOLOGY | JOISTS & JOIST GIRDERS | DECKS | CONTACT US | DESIGN TOOLS

Factory Mutual

Home / Decks / Factory Mutual

Loss-Prevention Requirements For Vulcraft Steel Deck Systems

Should the project require Factory Mutual insurance underwriting, the Specifying Professional for the project should consult with the FM Regional Engineer to determine any provisions they may require be met as part of the design of the structural system. The Specifying Professional remains responsible for the interpretation of these requirements on the job. The following guidelines outline Vulcraft's understanding of two possible approaches that may be taken concerning additional roof deck design requirements FM may require:

1. FM Wind Rating Specified only: In this situation, the FM Regional Engineer specifies that the roof must have a wind rating such as 1-60, 1-75, or 1-90. This may be all that is specified. In this case, the Specifying Professional may refer to the Vulcraft document "Vulcraft FM Deck Data" (available at www.vulcraft.com) and determine needed information as follows:

- The Specifying Professional will refer to Section 9.1.1 for mechanical support fasteners and 9.1.2 for welds. Definition of the fastener patterns at both the supports and sidelaps is provided in the initial paragraph of each of these sections. This fastener pattern is appropriate for Zone 1, Field, only.
  - The fastener pattern in Zone 2, Edge, should be two times the requirement in Zone 1.
  - The fastener pattern in Zone 3, Corner, should be two-and-one-half times the requirement in Zone 1.
- Once the appropriate table for the desired deck type is located within the section chosen in Step 1, choose deck gages for the secondary support spacing desired and that match the FM wind rating specified. Values are provided for one, two, and three-span conditions. Please note that these maximum span values include consideration of:

FM Data

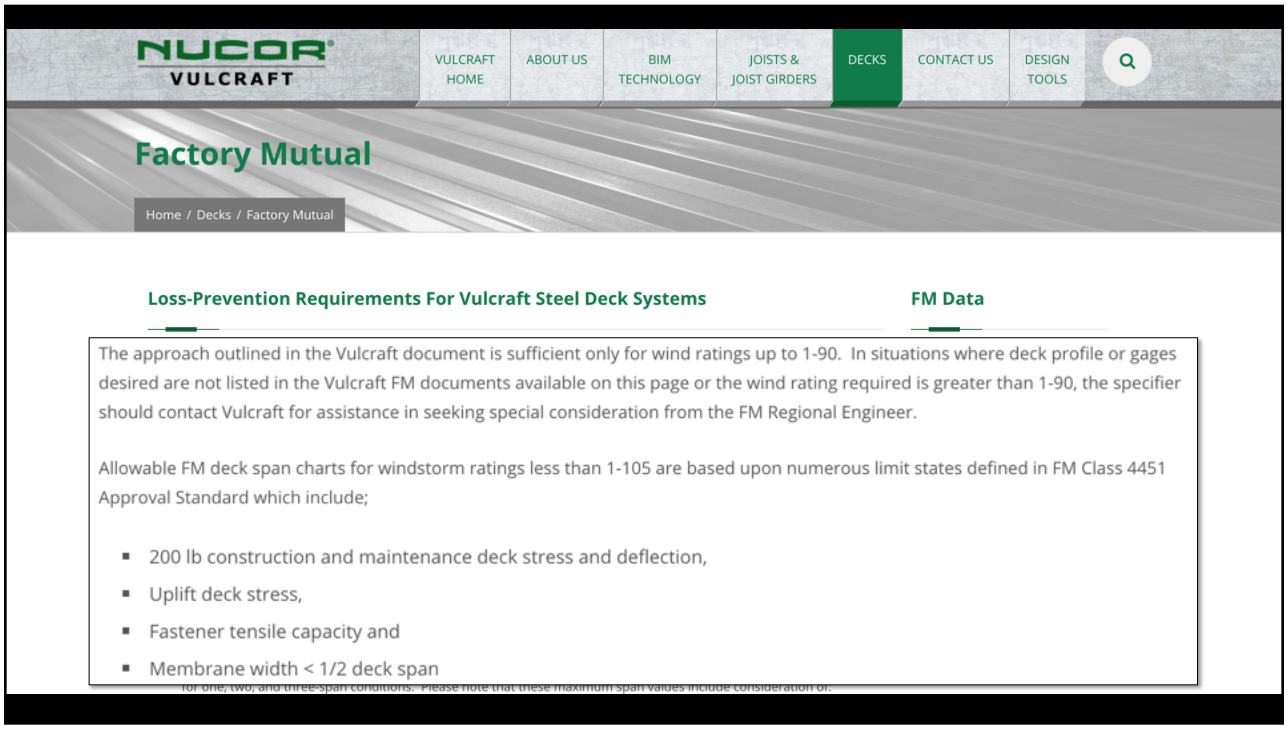
VULCRAFT FM DECK REPORTS
Download

32" 3N DECK FM REPORT
Download

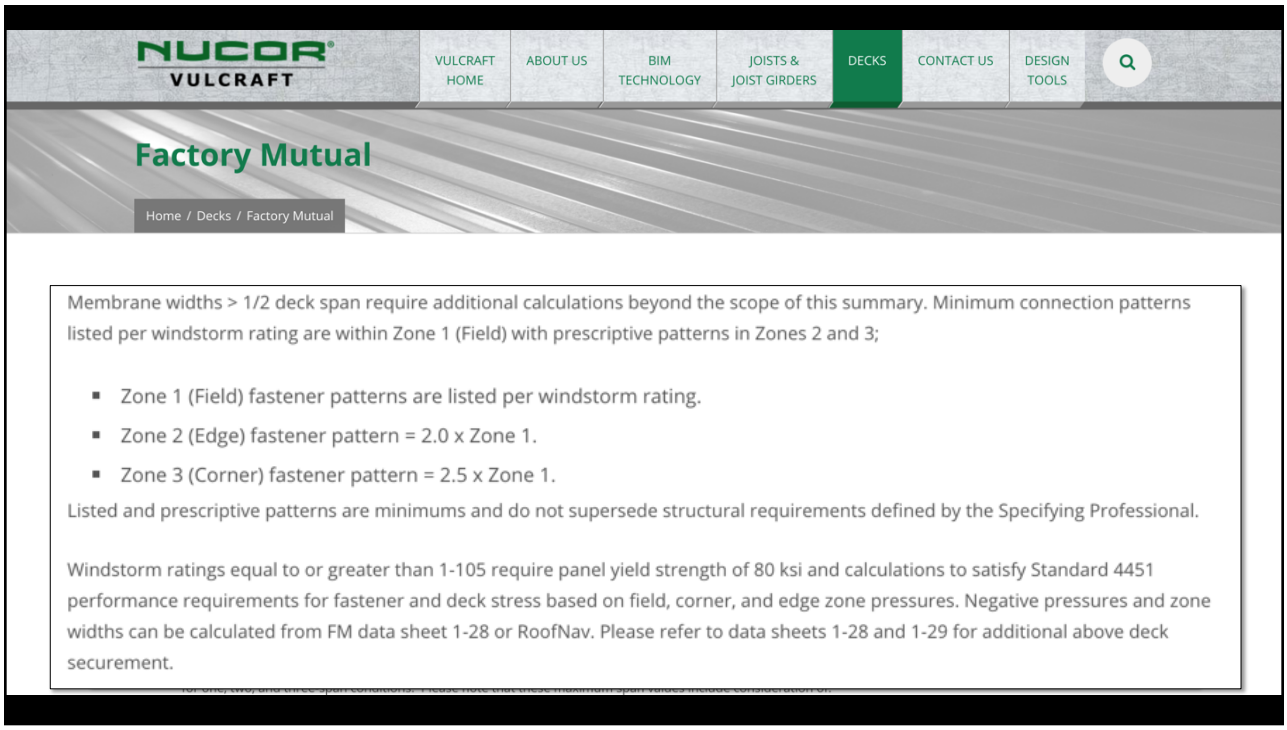
DOVETAIL DECK FM REPORT
Download

VULCRAFT FM DECK REPORTS (UPDATED FOR PUNCHLOK)
Download

30


NUCOR VULCRAFT
VULCRAFT HOME
ABOUT US
BIM TECHNOLOGY
JOISTS & JOIST GIRDERS
DECKS
CONTACT US
DESIGN TOOLS
Factory Mutual
Home / Decks / Factory Mutual
Loss-Prevention Requirements For Vulcraft Steel Deck Systems
FM Data
The approach outlined in the Vulcraft document is sufficient only for wind ratings up to 1-90. In situations where deck profile or gages desired are not listed in the Vulcraft FM documents available on this page or the wind rating required is greater than 1-90, the specifier should contact Vulcraft for assistance in seeking special consideration from the FM Regional Engineer.
Allowable FM deck span charts for windstorm ratings less than 1-105 are based upon numerous limit states defined in FM Class 4451 Approval Standard which include;
200 lb construction and maintenance deck stress and deflection,
Uplift deck stress,
Fastener tensile capacity and
Membrane width < 1/2 deck span

31


NUCOR VULCRAFT
VULCRAFT HOME
ABOUT US
BIM TECHNOLOGY
JOISTS & JOIST GIRDERS
DECKS
CONTACT US
DESIGN TOOLS
Factory Mutual
Home / Decks / Factory Mutual
Membrane widths > 1/2 deck span require additional calculations beyond the scope of this summary. Minimum connection patterns listed per windstorm rating are within Zone 1 (Field) with prescriptive patterns in Zones 2 and 3;
Zone 1 (Field) fastener patterns are listed per windstorm rating.
Zone 2 (Edge) fastener pattern = 2.0 x Zone 1.
Zone 3 (Corner) fastener pattern = 2.5 x Zone 1.
Listed and prescriptive patterns are minimums and do not supersede structural requirements defined by the Specifying Professional.
Windstorm ratings equal to or greater than 1-105 require panel yield strength of 80 ksi and calculations to satisfy Standard 4451 performance requirements for fastener and deck stress based on field, corner, and edge zone pressures. Negative pressures and zone widths can be calculated from FM data sheet 1-28 or RoofNav. Please refer to data sheets 1-28 and 1-29 for additional above deck securement.

32

Who in your company "accepts" steel roof deck?

33

The roofing industry needs to re-think the concept of "deck acceptance."

Deck acceptance should be limited to:
- Its physical presence
- Top surface is visually dry
- Surface is broom clean

If we do not limit deck acceptance, we do nothing other than incur someone else's liability (and not get paid for it).

34

New FM Global Loss Prevention Data Sheets

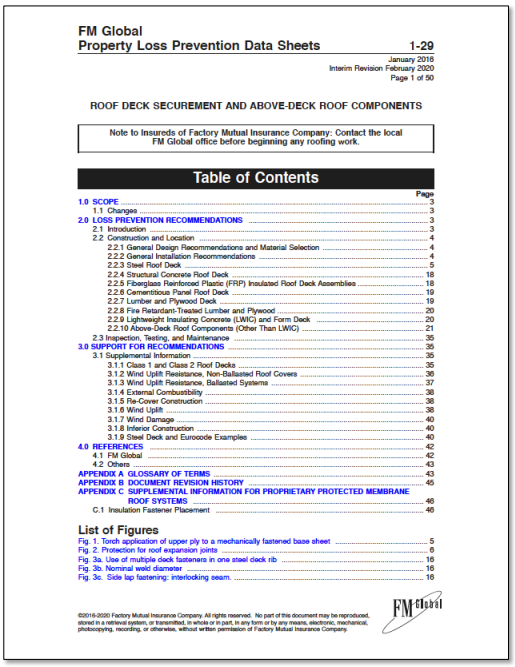
35

New FM Global Loss Prevention Data Sheets

February 26, 2020 – Accessible at www.fmglobaldatasheets.com

- FM 1-15, “Roof-Mounted Solar Photovoltaic Panels
- FM 1-28, “Wind Design”
- FM 1-29, “Roof Deck Securement and Above-deck Roof Components”
- FM 1-30, “Repair of Wind-damaged Single- and Multi-ply Roof Systems
- FM 1-31, “Roof Panel Systems”
- FM 1-34, “Hail Damage”
- FM 1-35, “Vegetative Roof Systems
- FM 1-49, “Perimeter Flashing”
- FM 1-52, “Field Verification of Roof Wind Uplift Resistance”

36



FM Global
Property Loss Prevention Data Sheets 1-29

January 2016
Interim Revision February 2020
Page 1 of 50

ROOF DECK SECUREMENT AND ABOVE-DECK ROOF COMPONENTS

Note to Insureds of Factory Mutual Insurance Company: Contact the local FM Global office before beginning any roofing work.

Table of Contents

List of Figures

FM 1-28
January 2016
Interim Revision February 2020

37

Red text denotes changes (sometimes)

Roof Deck Securement and Above-Deck Roof Components 1-29
FM Global Property Loss Prevention Data Sheets Page 3

1.0 SCOPE

This data sheet provides guidance on the following subjects:

A. Wind resistance, including:

1. The proper span and securement of steel roof decks to supporting members. This is appropriate information for the Structural Engineer of Record (SER).

2. The proper design and installation of above-deck roof components. This is appropriate information for the roofing professional.

B. Fire classification of roofs

Items covered include:

- roof covers
- insulation
- cover boards
- vapor retarders
- air barriers
- fasteners
- re-roof and re-cover assemblies

This data sheet is intended to be used in conjunction with RoofNav and Data Sheet 1-28, *Wind Design*.

See the following data sheets for guidance on subjects that are not covered in this data sheet:

Data Sheet 1-15, *Roof-Mounted Solar Photovoltaic Panels*

Data Sheet 1-42, *Maximum Foreseeable Loss Limiting Factors, for guidance on roofs of buildings divided by MFL fire walls*

Data Sheet 1-31, *Panel Roof Systems*, for guidance on panel roofs, including lap seam, standing seam, and insulated metal panels

Data Sheet 1-33, *Safeguarding Torch-Applied Roof Installations*

Data Sheet 1-34, *Hail Damage*

Data Sheet 1-49, *Perimeter Flashing*

Data Sheet 1-54, *Roof Loads For New Construction*, for guidance on gravity loads (e.g., snow, ponding)

Clients of FM Global should contact their local FM Global office before beginning any roofing design or construction.

1.1 Changes

January 2020. Interim Revision. The following changes were made:

A. Updated tables and examples throughout to reflect changes made to Data Sheet 1-28.

B. Changed the terms used for roof areas from field, perimeter, and corner to Zone 1, Zone 2, and Zone 3, respectively.

C. Added new interior roof Zone 1'.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

The recommendations provided in this document are not intended to supersede the requirements of any FM Approval (see Appendix A for definition). FM Approval listings in RoofNav, an online resource of FM Approvals, describe the requirements for a specific wind uplift rating, as well as ratings for hail, interior fire

38

Significant changes in FM 1-28, Feb. 2020

- Wind load determination tables have been removed from FM 1-28; now use the ratings calculator in RoofNav
- FM 1-28 now uses ASCE 7-16's pressure coefficients and zones
- FM 1-28 still uses ASCE 7-05's 100-year MRI maps
- FM 1-28 still uses the allowable strength design (ASD) method
- FM 1-28 uses (adds) an Importance Factor of 1.15

39

Comparing ASCE 7-05, FM 1-28, ASCE 7-10 and ASCE 7-16

Example: A low-rise office building (Risk Category II) is located in Chicago, IL. The building is an enclosed structure with a mean roof height of 60 ft. The building is located in an open terrain area that can be categorized as Exposure Category C.

Document	Basic wind speed (mph)	Design wind pressure (psf)			
		Zone 1' (Center)	Zone 1 (Field)	Zone 2 (Perimeter)	Zone 3 (Corners)
ASCE 7-05	V_{ASD} = 90	--	24	40	58
FM 1-28 (old)	V_{ASD} = 90	--	27	FM 1-60	69
FM 1-28 (new)	V_{ASD} = 90	24	43	FM 1-90	77
ASCE 7-10 Ult.	V_{ULT} = 115	--	39	65	97
ASCE 7-10 ASD	V_{ASD} = 90	--	23	39	58
ASCE 7-16 Ult.	V_{ULT} = 105	30	51	67	92
ASCE 7-16 ASD	V_{ASD} = 90	18	31	41	55

40

Comparing ASCE 7-05, FM 1-28, ASCE 7-10 and ASCE 7-16

Example: A high-rise office building (Risk Category II) is located in Chicago, IL. The building is an enclosed structure with a mean roof height of 150 ft. The building is located in an open terrain area that can be categorized as Exposure Category C.

Document	Basic wind speed (mph)	Design wind pressure (psf)			
		Zone 1' (Center)	Zone 1 (Field)	Zone 2 (Perimeter)	Zone 3 (Corners)
ASCE 7-05	V_{ASD} = 90	--	38	60	82
FM 1-28 (old)	V_{ASD} = 90	--	44	69	94
FM 1-28 (new)	V_{ASD} = 90	--	44	FM 1-90	94
ASCE 7-10 (Ult.)	V_{ULT} = 115	--	63	98	134
ASCE 7-10 ASD	V_{ASD} = 90	--	38	59	80
ASCE 7-16 Ult.	V_{ULT} = 105	--	52	82	112
ASCE 7-16 ASD	V_{ASD} = 90	--	31	49	67

41

The values derived from FM 1-28 are not consistent with ASCE 7-16's ASD values (IBC 2018). Using FM 1-28 typically results in higher design wind loads.

Complying with the code is a minimum legal requirement.

- Where FM 1-28 is lower, use the code's required wind loads
- Where the codes values are lower, FM 1-28's values may be a project-specific contract requirement

42

FM Global intends FM 1-28 to be effective immediately (i.e., as of February 26, 2020) upon publication

43

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

44