Iowa Roofing Contractors Association
Riverside Casino & Golf Resort
September 27, 2013

Update on Roofing Industry Technical Issues

presented by

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National Roofing Contractors Association

Topics

- Polyisocyanurate insulation
- Energy code
- Slip resistance of roofing materials
- TPO membranes
- Water-based and low-VOC bonding adhesives
- Asphalt
- Asphalt shingles
- RCI
- Moisture in concrete roof decks
- Other topics

2

Polyisocyanurate insulation

- New manufacturers:
  - GAF (1 new, 1 being constructed, 1 announced)
  - Soprema (1 new plant announced)
- Personnel
- Revision of PIMA's QualityMark^{CM} program
- Facer sheets

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PIMA QualityMark^{CM} program

- 2004-2013:
  - Polyisocyanurate insulation is labeled using LTTR, determined using CAN/ULC-S770-03
- Beginning on January 1, 2014:
  - Polyisocyanurate insulation is labeled using a new LTTR, determined using CAN/ULC-S770-09 or ASTM C1303-11

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LTTR values

Thickness	LTTR (2004 – 2013)	New LTTR (2014 –)
1 inch	6.0	5.6
1.5 inches	9.0	8.6
2 inches	12.1	11.4
3 inches	18.5	17.4
4 inches	25.0	23.6

5

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Long-term thermal resistance (LTTR)

- LTTR is intended to represent the R-value 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

Is five years "long-term"
in the context of the roofing industry?

6

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LTTR values vs. NRCA recommended design values

Thickness	LTTR (2004 – 2013)	New LTTR (2014 –)	NRCA's recommended R-values	
			Heating conditions	Cooling conditions
1 inch	6.0	5.6	5.0	5.6
1.5 inches	9.0	8.6	7.5	8.4
2 inches	12.1	11.4	10.0	11.2
3 inches	18.5	17.4	15.0	16.8
4 inches	25.0	23.6	20.0	22.4

7

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NRCA recommends….

NRCA recommends designers specify polyisocyanurate insulation by its thickness – not R-value – based upon the required R-value for specific project conditions.

8

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Polyiso. facer sheets

ASTM C1289

ASTM C1289, Type II:

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

9

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NRCA recommends…

When specifying polyisocyanurate insulation, NRCA recommends specifiers use the ASTM C1289 designation followed by the specific type classification and, if applicable, class and grade classifications necessary to identify the intended products' compressive strength and facers.

10

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Energy Code

11

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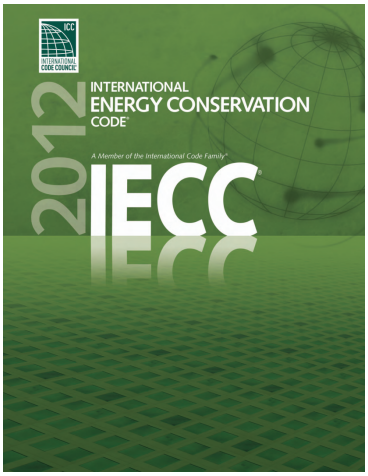
International Energy Conservation Code, 2012 Edition (IECC 2012)



12

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Some background

- IECC is a "model code" 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

13

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IOWA
Incentives/Policies for Renewables & Efficiency

Printable Version

Building Energy Code

Like 0

Last DSIRE Review: 10/05/2012

Program Overview:

State:	Iowa
Incentive Type:	Building Energy Code
Eligible Efficiency Technologies:	Comprehensive Measures/Whole Building
Applicable Sectors:	Commercial, Residential
Residential Code:	2009 IECC mandatory statewide. Can use REScheck to show compliance.
Commercial Code:	2009 IECC, referencing ASHRAE 90.1-2004. Can use COMcheck to show compliance.
Code Change Cycle:	The state energy code is reviewed on a three-year code cycle corresponding to publication of the IECC. Written requests for changes to the state energy code can be submitted to the state Building Code Bureau. All suggested code revisions are processed through the state administrative rule-making process involving publication, public comments, and public hearings. The latest code update was on January 1, 2010.
Web Site:	http://bcap-ocean.org/state-country/iowa

14

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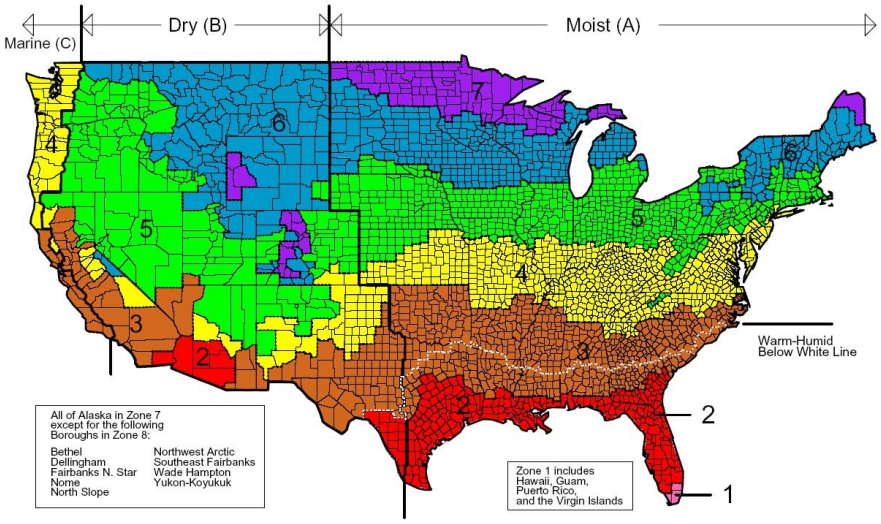
Climate zones

IECC 2012, Section C301—Climate Zones



15

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.

16

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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.

17

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Ch. 4[CE]-Commercial Energy Efficiency

International Energy Conservation Code, 2012 Edition

Minimum 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			
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)

18

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?

19

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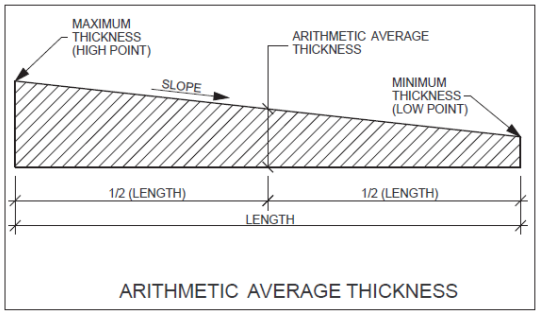
Average R-value

Arithmetic average thickness method



Arithmetic average thickness = LP + [1⁄2 (HP - LP)]

20

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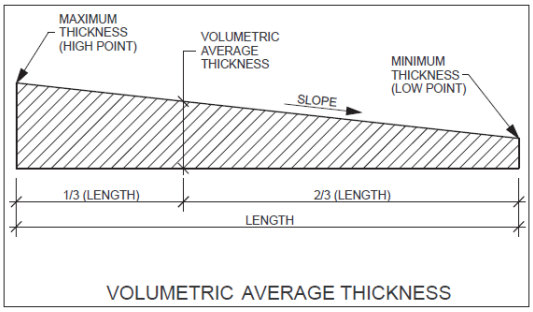
Average R-value

Volumetric average thickness method



Volumetric average thickness = LP +[2⁄3 (HP - LP)]

21

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Average R-value

Volumetric average thickness method – Alternative method

Volumetric average thickness = $\frac{\text{Total board footage - Anticipated waste}}{\text{Roof surface area}}$

22

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Average R-value

Volumetric average thickness method – Another alternative method

Volumetric average thickness = Volume of insulation / Roof surface area

23

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These methods do not comply with the Energy Code's intent.

Codes provide minimum requirements

24

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Ch. 4[CE]-Commercial Energy Efficiency

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.

25

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2012 IECC Code and Commentary

"…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…]

26

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2012 IECC Code and Commentary

"…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. "

27

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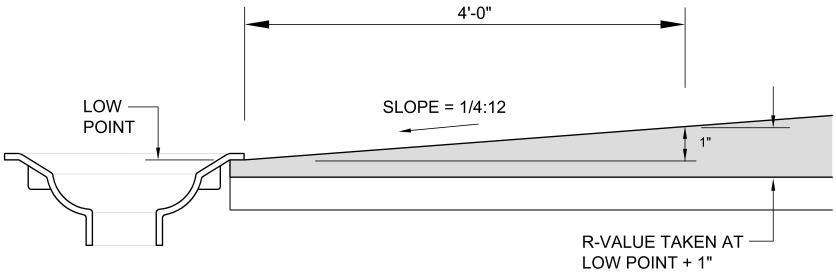
Graphically depicted…



28

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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…]

29

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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 emittancec 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]

30

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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…]

31

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C402.4.1.1 Air barrier construction. The *continuous air barrier* shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. Air barrier penetrations shall be sealed in accordance with Section C402.4.2. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.
3. Recessed lighting fixtures shall comply with Section C404.2.8. Where similar objects are installed which penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.

Exception: Buildings that comply with Section C402.4.1.2.3 are not required to comply with Items 1 and 3.

[Continued…]

32

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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….]

33

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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…]

34

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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.

[Continued…]

35

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C402.4.2 Air barrier penetrations. Penetrations of the air barrier and paths of air leakage shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Joints and seals shall be sealed in the same manner or taped or covered with a moisture vapor-permeable wrapping material. Sealing materials shall be appropriate to the construction materials being sealed. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.

36

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Summary – IECC 2012

- R-value increases
- Mandatory reflectivity requirements in Climate Zones 1-3
- Air barriers in Climate Zone 4-8

37

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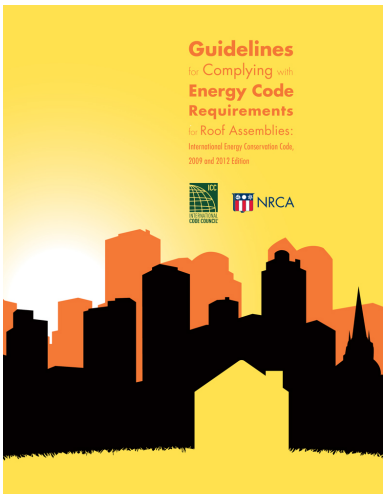
Energy Codes Manual



- 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

38

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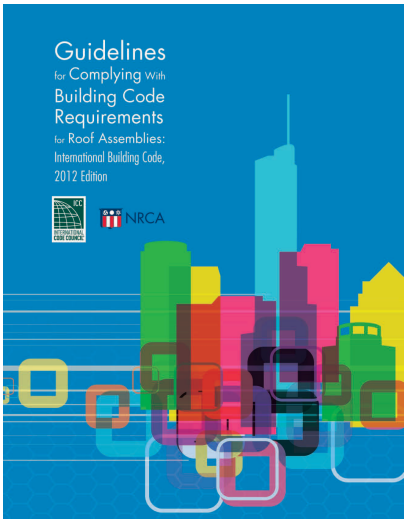
Building Codes Manual (2012 Codes)



- 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
- Available in March 2013

39

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Slip resistance of roofing products

Variable Incidence Tribometer

Applicable standards:

- ASTM F1679, "Standard Test Method for Using a Variable Incidence Tribometer (VIT)"
- ASTM F2508, "Standard Practice for Validation and Calibration of Walkway Tribometers Using Reference Surfaces"

40

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Slip index results

Steep-slope underlayment products (new products)

Product	Dry	Wet
No. 15 underlayment	1.0	0.60
No. 30 underlayment	1.0 +	0.86
Smooth SA	1.0+	1.0+
Sanded-surface SA	0.88	0.78
Smooth-film SA	0.89	0.82
Textured SA	0.85	0.75
Textured SA	0.89	0.66

Tested on horizontal surfaces

41

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Slip index results

Single-ply membrane products (new products)

Product	Dry	Wet
EPDM	0.96	0.29
TPO	0.82	0.18
PVC	0.93	0.10

Tested on horizontal surfaces

A slip index of 0.25 to 0.35 is generally required for safe ambulation of the general population on horizontal surfaces

42

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Summary on slip resistance

- Slip index values vary by product and conditions
- "Wet" conditions a concern for some products
- NRCA will continue testing:
  - Aged, weathered products

43

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TPO membranes

What's new?

44

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Update on TPO membranes

TECH TODAY

Developments with TPO

Revisions to ASTM International's standard show some progress

by Mark S. Graham

The method for measuring TPO membrane thicknesses has changed

Changes have been made to the U.S. product standard for TPO roof membranes that should result in some improvement to their performance. If you are involved in the design and installation of TPO roof systems, you should be knowledgeable of these changes and be aware additional improvements still are necessary.

ASTM D6878

The U.S. product standard for TPO roof membranes is ASTM D6878, "Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing." ASTM International originally published the standard in 2003 and revised it in 2006 and 2008.

This year, ASTM D6878 was revised twice. With the first revision, which was balloted by ASTM International in April, the duration of specimen heat aging before aged physical property testing was increased from 28 days at 240 F to 224 days at 240 F, an eight-fold increase. The physical property evaluation methods after heat aging remain unchanged.

This year's second revision was balloted in May and increased the minimum allowable thickness over scrim from 12 mils to 15 mils. With this change, the method for measuring TPO membrane thicknesses was changed from the previous optical method to a new test method, ASTM D7635, "Test Method for Measurement of Thickness of Coatings Over Fabric Reinforcement." ASTM D7635 is considered more reliable than the optical method.

NRCA considers the increase in the minimum thickness over scrim dimensions and new thickness measurement method to be significant improvements.

This year's two revisions to ASTM D6878 are published in ASTM D6878-11a. The "-11" in this designation denotes the revision being published in 2011, and the "a" denotes the second revision in the same year of publication.

Unfortunately, ASTM D6878-11a was approved too late to be included in ASTM International's *2011 Annual Book of Standards, Volume 4.06, Roofing and Waterproofing*. ASTM D6878-11a can be purchased at www.astm.org.

More improvements needed

Although ASTM D6878 was revised, NRCA believes additional enhancements are needed before it can reasonably be relied on to ensure adequate TPO performance.

A round-robin test program of various manufacturers' TPO membranes is being conducted by a group of ASTM International task group members to evaluate the new heat aging duration and alternative methods of evaluating physical properties after heat aging test specimens.

Currently, TPO membranes' physical properties after heating aging are evaluated using percentages of retained values compared with tested values of non-aged specimens. TPO membranes' breaking strength, elongation and tearing strength are viewed by many, including NRCA, as an assessment of a TPO membrane's reinforcement strength, not the membrane's watertightness. In most instances, a membrane's TPO coating over the reinforcement will crack and, therefore, not be watertight before the reinforcement fails in testing.

As part of the round-robin test program, visual examination of the TPO coating over the reinforcement is being evaluated as a possible evaluation criterion after heat aging. NRCA considers this to be a more appropriate method of evaluating performance and durability because it takes into consideration the membrane's watertightness after heat aging.

Also, ASTM D6878's current physical properties are based on 45-mil-thick TPO membranes and are not necessarily representative of thicker membrane sheets, such as 60-mil-thick membrane sheets. Thicker TPO membranes should exhibit greater puncture resistance and breaking strength values and a thicker thickness over scrim than 45-mil-thick sheets. Given the increased use of 60-mil-thick and thicker TPO membranes, ASTM D6878 needs to be updated to better represent products in the U.S. marketplace.

NRCA has asked the task group responsible for maintaining ASTM D6878 to add criteria to the standard specific to thicker membranes, including 60-mil-thick sheets.

NRCA's recommendations

Although ASTM D6878 has been revised, additional revisions to the standard still are necessary before it can reasonably be relied on to ensure proper performance.

Until ASTM D6878 is further revised, NRCA recommends designers specify TPO membranes by designating the standard's current edition, ASTM D6878-11a, and specifying a minimum 60-mil-thick membrane. ●●●

MARK S. GRAHAM is NRCA's associate executive director of technical services.

12 www.professionalroofing.net NOVEMBER 2011

***Professional Roofing*, Nov. 11:**

- ASTM D6878 revised:
  - ASTM D7635 optical method
  - Heating aging from 28 days @ 240 F to 224 Days @ 240 F
  - Thickness over scrim increased from 12 mils to 15 mils
- Revisions published as ASTM D6878-11a
- 60 mil (and thicker) sheets still not defined by ASTM D6878

45

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From TPO manufacturers' literature

Product	45 mil		60 mil	
	Tolerance	Thickness over scrim	Tolerance	Thickness over scrim
Carlisle	±10%	0.018 in.	±10%	0.024 in.
Firestone	±10%	0.017 in.	±10%	0.021 in.
GAF	Not indicated			
GenFlex	Not indicated	0.015 in.	Not indicated	0.021 in.
JM	Not indicated	0.015 in.	Not indicated	0.027 in.

46

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Summary on TPO membrane issues

- Some improvements have been made to the TPO membrane standard
- Additional improvements are still necessary
- When using TPO membranes, NRCA recommends the use of 60 mil (minimum)

47

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Water-based bonding adhesives

Why is sticking two materials together,

which we have successfully stuck together for years, getting so complicated?

48

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Water-based bonding adhesives

TECH TODAY

A growing concern

Water-based adhesives face product limitations and reports of problems

by Mark S. Graham

Water-based bonding adhesives are being increasingly specified and used as replacements for conventional solvent-based bonding adhesives in an effort to reduce volatile organic compound (VOC) emissions. However, water-based bonding adhesives have notable temperature and condition limitations, and NRCA has received a number of reports of problems related to such adhesives.

Regulations

As part of an effort to achieve federally mandated standards in the Northeast and Mid-Atlantic, the Ozone Transport Commission (OTC) developed model rules for adhesives and sealants that regulate VOC content. Specific states' regulations and implementation timetables vary slightly, but they generally require adhesives, sealants and primers to contain a maximum of 250 g/L of VOCs by Jan. 1, 2012.

Similar VOC limits occur as targets in some voluntary sustainability programs, including LEED.®

These limits generally exclude the use of most solvent-based adhesives and primers, which have VOC contents two to three times the OTC allowed limit. As a result, manufacturers have been forced to offer alternative adhesives, sealants and primers to achieve the targeted VOC level.

Product limitations

The development and use of water-based bonding adhesives in the roofing industry are causes for some concern.

Water-based bonding adhesives have notably more restrictive limits on their transportation, storage and use.

Review of manufacturers' product literature reveals water-based adhesives need to be protected from freezing during transportation and storage. Manufacturers' recommendations vary; some recommend storing water-based adhesives at ambient temperatures between 60 F and 90 F. Such limits likely necessitate transportation in enclosed trailers and storage in enclosed warehouses. During summer and winter, temperature-controlled trailers and warehouses may be needed to maintain such a temperature range.

Manufacturers' storage temperature recommendations also appear to apply to job-site storage. As a result, storing water-based adhesives on roofs may be significantly restricted.

Most manufacturers also place low-temperature application limits on their products—such as 40 F and rising at the time of application—in recognition that installed adhesives should not freeze during drying and curing. It needs to be noted nighttime roof surface temperatures can be somewhat cooler than ambient temperatures because of radiative cooling, which will affect curing.

Adhesive rates and cure times for water-based adhesives appear to differ from solvent-based adhesives. In addition to being temperature-sensitive, water-based adhesives are humidity-sensitive. Generally, water-based adhesives take longer to reach adequate initial "green" strength compared with solvent-based adhesives, and this time will vary based on temperature and humidity.

The development and use of water-based bonding adhesives in the roofing industry are causes for some concern

Reports of problems

Water-based bonding adhesives have been available in the roofing industry for several years. NRCA is aware of limited, though significant, reports of problems attributable to the use of water-based adhesives.

The reported problems generally involve the loss of adhesion of flashings or membranes in single-ply membrane roof systems from multiple manufacturers. Most of the reported problems became evident six months to two years after installation.

From the reports where NRCA has more detailed information, adhesion and cohesive failures of adhesives have been observed. In many reports, the adhesive appears to have "re-wetted," meaning it reverted to a consistency similar to when it initially was installed.

Relatively high internal building pressures or a predominant vapor drive from the building's interior to its exterior are common factors in several reports.

If you are involved with a project where the use of water-based bonding adhesives appears to be problematic, I encourage you to contact the specific roof system manufacturer and NRCA's Technical Services Section for assistance. ●●●

MARK S. GRAHAM is NRCA's associate executive director of technical services.

12 www.professionalroofing.net DECEMBER 2011

***Professional Roofing* article, Dec. 2011:**

- Reports of problems
- Regulations
- Temperature limitations

NRCA

Water-based bonding adhesives

***Special Report*: New Model Rule for Adhesives and Sealants Affects the Single-ply Roofing Industry (Members Only), January 2012**

As of Jan. 1, new volatile organic compound (VOC) emissions regulations took effect in the Northeast and Mid-Atlantic States. The regulations adopted in Connecticut, Delaware, Maine, Maryland, New Jersey, New York, Pennsylvania, Rhode Island, northern Virginia and the District of Columbia restrict the manufacture, distribution, sale and use of single-ply adhesives, primers and sealants to materials that comply with the Ozone Transport Commission's (OTC's) Model Rule for Adhesives and Sealants. The OTC is a regional advisory body to the Environmental Protection Agency that develops and implements regional strategies to reduce ground-level ozone to national ambient air quality standards.

A similar draft regulation proposed in Massachusetts provides a schedule for seasonal implementation between May 1 and Sept. 30 and permanent implementation on and after May 1, 2013. At this time, the Massachusetts regulation has not been adopted.

The OTC's Model Rule for Adhesives and Sealants is under consideration in New Hampshire and Vermont, but those states have not announced their regulations or adoption schedules.

The restrictions effectively eliminate the use of toluene- and xylene-based single-ply roof membrane adhesives and primers in the affected jurisdictions.

Single-ply roof membrane manufacturers, suppliers and distributors have complied with the rule by replacing xylene- and toluene-based materials with reformulated water-based adhesives and primers and VOC-exempt solvent-based adhesives and primers. However, manufacturers' guidelines for these OTC-compliant materials impose storage, handling and application conditions that may be difficult to meet or impractical during fall, winter and spring in the Northeast and Mid-Atlantic states.

The EPDM Roofing Association has questioned the applicability of the VOC limits, informed individual state regulators of its concerns and asked for modifications in the OTC model rule's implementation.

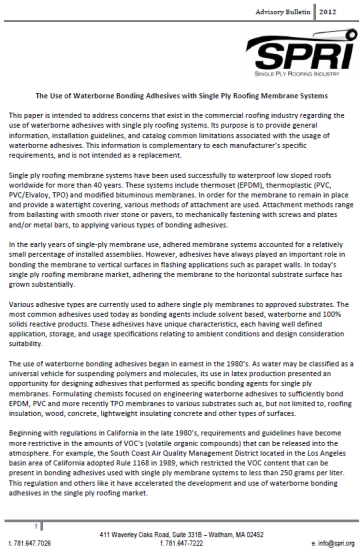
NRCA *Special Report*, Jan. 2012:

Maximum VOC requirements:

- Regulatory background
  - OTC rule
- LEED
- IgCC

NRCA

Water-based bonding adhesives



Advisory Bulletin | 2012

SPRI

Single Ply Roofing Industry

The Use of Waterborne Bonding Adhesives with Single Ply Roofing Membrane Systems

This paper is intended to address concerns that exist in the commercial roofing industry regarding the use of waterborne adhesives with single ply roofing systems. Its purpose is to provide general information, installation guidelines, and catalog common limitations associated with the usage of waterborne adhesives. This information is complementary to each manufacturer's specific requirements, and is not intended as a replacement.

Single ply roofing membrane systems have been used successfully to waterproof low sloped roofs worldwide for more than 40 years. These systems include thermoset (EPDM), thermoplastic (PVC, PVC/Elvaloy, TPO) and modified bituminous membranes. In order for the membrane to remain in place and provide a watertight covering, various methods of attachment are used. Attachment methods range from ballasting with smooth river stone or pavers, to mechanically fastening with screws and plates and/or metal bars, to applying various types of bonding adhesives.

In the early years of single-ply membrane use, adhered membrane systems accounted for a relatively small percentage of installed assemblies. However, adhesives have always played an important role in bonding the membrane to vertical surfaces in flashing applications such as parapet walls. In today's single ply roofing membrane market, adhering the membrane to the horizontal substrate surface has grown substantially.

Various adhesive types are currently used to adhere single ply membranes to approved substrates. The most common adhesives used today as bonding agents include solvent based, waterborne and 100% solids reactive products. These adhesives have unique characteristics, each having well defined application, storage, and usage specifications relating to ambient conditions and design consideration suitability.

The use of waterborne bonding adhesives began in earnest in the 1980's. As water may be classified as a universal vehicle for suspending polymers and molecules, its use in latex production presented an opportunity for designing adhesives that performed as specific bonding agents for single ply membranes. Formulating chemists focused on engineering waterborne adhesives to sufficiently bond EPDM, PVC and more recently TPO membranes to various substrates such as, but not limited to, roofing insulation, wood, concrete, lightweight insulating concrete and other types of surfaces.

Beginning with regulations in California in the late 1980's, requirements and guidelines have become more restrictive in the amounts of VOC's (volatile organic compounds) that can be released into the atmosphere. For example, the South Coast Air Quality Management District located in the Los Angeles basin area of California adopted Rule 1168 in 1989, which restricted the VOC content that can be present in bonding adhesives used with single ply membrane systems to less than 250 grams per liter. This regulation and others like it have accelerated the development and use of waterborne bonding adhesives in the single ply roofing market.

1

411 Waverley Oaks Road, Suite 331B – Waltham, MA 02452
t. 781.647.7026 f. 781.647-7222 e. info@spri.org

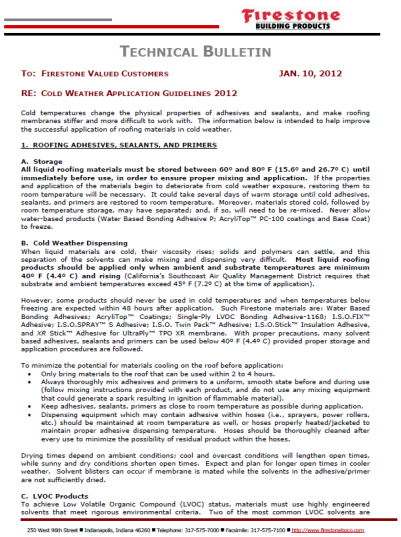
SPRI advisory bulletin, Jan. 2012:

- Protect from freezing
- Extended drying time when humid
- Minimum 40-50 F and rising, no freezing during drying period
- Storage temp. 60-90 F
- Heated vans in winter months…
- Longer to green strength time
- Manufacturer-specific guidelines

51

NRCA

Water-based bonding adhesives



Firestone BUILDING PRODUCTS

TECHNICAL BULLETIN

TO: FIRESTONE VALUED CUSTOMERS **JAN. 10, 2012**

RE: COLD WEATHER APPLICATION GUIDELINES 2012

Cold temperatures change the physical properties of adhesives and sealants, and make roofing membranes stiffer and more difficult to work with. The information below is intended to help improve the successful application of roofing materials in cold weather.

1. ROOFING ADHESIVES, SEALANTS, AND PRIMERS

A. Storage
All liquid roofing materials must be stored between 60º and 80º F (15.6º and 26.7º C) until immediately before use, in order to ensure proper mixing and application. If the properties and application of the materials begin to deteriorate from cold weather exposure, restoring them to room temperature will be necessary. It could take several days of warm storage until cold adhesives, sealants, and primers are restored to room temperature. Moreover, materials stored cold, followed by room temperature storage, may have separated; and, if so, will need to be re-mixed. Never allow water-based products (Water Based Bonding Adhesive P; AcryliTop™ PC-100 coatings and Base Coat) to freeze.

B. Cold Weather Dispensing
When liquid materials are cold, their viscosity rises; solids and polymers can settle, and this separation of the solvents can make mixing and dispensing very difficult. **Most liquid roofing products should be applied only when ambient and substrate temperatures are minimum 40º F (4.4º C) and rising** (California's Southcoast Air Quality Management District requires that substrate and ambient temperatures exceed 45º F (7.2º C) at the time of application).

However, some products should never be used in cold temperatures and when temperatures below freezing are expected within 48 hours after application. Such Firestone materials are: Water Based Bonding Adhesives; AcrylTop™ Coatings; Single-Ply LVOC Bonding Adhesive-1168; I.S.O.FIX™ Adhesive; I.S.O.SPRAY™ S Adhesive; I.S.O. Twin Pack™ Adhesive; I.S.O.Stick™ Insulation Adhesive, and XR Stick™ Adhesive for UltraPly™ TPO XR membrane. With proper precautions, many solvent based adhesives, sealants and primers can be used below 40º F (4.4º C) provided proper storage and application procedures are followed.

To minimize the potential for materials cooling on the roof before application:
- Only bring materials to the roof that can be used within 2 to 4 hours.
- Always thoroughly mix adhesives and primers to a uniform, smooth state before and during use (follow mixing instructions provided with each product, and do not use any mixing equipment that could generate a spark resulting in ignition of flammable material).
- Keep adhesives, sealants, primers as close to room temperature as possible during application.
- Dispensing equipment which may contain adhesive within hoses (i.e., sprayers, power rollers, etc.) should be maintained at room temperature as well, or hoses properly heated/jacketed to maintain proper adhesive dispensing temperature. Hoses should be thoroughly cleaned after every use to minimize the possibility of residual product within the hoses.

Drying times depend on ambient conditions; cool and overcast conditions will lengthen open times, while sunny and dry conditions shorten open times. Expect and plan for longer open times in cooler weather. Solvent blisters can occur if membrane is mated while the solvents in the adhesive/primer are not sufficiently dried.

C. LVOC Products
To achieve Low Volatile Organic Compound (LVOC) status, materials must use highly engineered solvents that meet rigorous environmental criteria. Two of the most common LVOC solvents are

250 West 96th Street ■ Indianapolis, Indiana 46260 ■ Telephone: 317-575-7000 ■ Facsimile: 317-575-7100 ■ http://www.firestonepro.com

Firestone technical bulletin, 1/12:

- Adhesives, sealers and primers:
  - Storage
  - Cold weather dispensing
  - LVOC products
  - Adhesive "blushing" (condensation)*
  - Cold adhesive products
- Membranes:
  - Size
  - TPO installation
  - EPDM Flashings
  - SBS, APP and BUR installation*

52

NRCA

Firestone technical bulletin

Cold Weather Application Guidelines, dated January 10, 2012

D. Adhesive "Blushing"

Blushing occurs when the evaporative cooling of the material during dry time lowers the surface temperature at, or below, the dew-point, resulting in condensation formation on the adhesive/primer film. When "blushing" occurs, the condensation on the adhesive/primer will not allow adhesion. The use of adhesives/primers should be closely monitored when the ambient temperature is relatively close to the dew-point, typically in the early morning and late afternoon. The use of adhesives/primers should be scheduled for midday to take advantage of the best adhesive application conditions of the workday; midday sun; ambient and dew-point temperatures furthest apart.

53

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Firestone technical bulletin

Cold Weather Application Guidelines, dated January 10, 2012

D. SBS, APP, and BUR Installation

SBS and APP modified bitumen products, and BUR ply felts, should be stored between 60º F - 80º F (15.5 °C and 26.6 °C) and installed when ambient and substrate temperatures are 40º F (4.4° C) and rising. Attempting to install these asphalt-based products in colder temperatures can reduce adhesion and cause disbonding or blistering during subsequent heating cycles.

54

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Water-based bonding adhesives

Johns Manville

TECHNICAL BULLETIN — Roofing Systems

Bulletin Number: T11-017
Date: December 21, 2011
Distribution: External

Single Ply Water-Based Adhesive Cold Weather Guidelines

Background
This bulletin is meant to provide clarification and guidance for the installation of single ply membranes (TPO, PVC and EPDM) using water-based adhesive at cooler temperatures (below 50°F, 10°C).

Storage and Use Requirements
Water-based adhesives may only be used when ambient temperatures are expected to remain above 40°F (5°C) for a minimum of 48 hours after application. Water-based adhesives need to be stored in a protected area between 60°F and 80°F (16°C and 27°C). Prior to application (storage) and curing, water-based adhesives must never be exposed or stored at temperatures below 40°F (5°C), including any transportation of the adhesive. Johns Manville's storage and stocking locations conform to these temperature requirements and will ship material when conditions permit.

Troubleshooting
It will be very clear that water-base adhesive has become frozen during storage or shipment. When returned to room temperatures (about 70°F [21°C]) the adhesive will remain in a solid state with residual liquid present in the container.
See pictures below for clarification. The adhesive will not be able to be mixed or reconstituted back into a uniform mixture.

Thawed Water-Based Adhesive in Clear Glass Container That Had Been Previously Frozen

JM technical bulletin, 12/21/11:

- Background
- Storage and use:
  - Store: 60 – 80 F
  - "…must never be exposed or stored at temperatures below 40 F, including any transportation…"
  - Use: 40 F minimum for 48 hours
- Troubleshooting

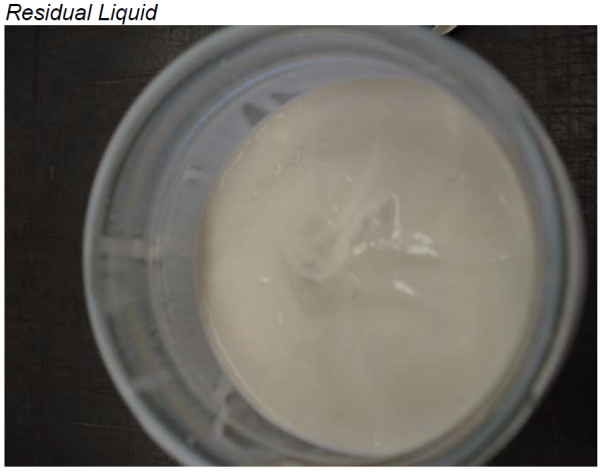
55

NRCA

JM technical bulletin

Single Ply Water-based Adhesive Cold Weather Guidelines, dated Dec. 21, 2011

Thawed Water-Based Adhesive Showing Solid Material and Residual Liquid



56

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JM technical bulletin

Single Ply Water-based Adhesive Cold Weather Guidelines, dated Dec. 21, 2011

Thawed Water-Based Adhesive Showing Solid Consistency

57

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Water-based bonding adhesives

Sika Sarnafil

World Class Roofing and Waterproofing

August 31, 2012

RE: SARNACOL 2121 ADHESIVE BLACKOUT DATES

To Whom It May Concern:

This letter is to inform you that Sarnacol 2170 solvent-based adhesive is used in adhering Sarnafil roofing and flashing membranes to both low sloped and vertical surfaces. The benefit to using 2170 is that it provides immediate green strength upon application and can be installed down to 5 Degrees. As such, Sarnacol 2170 is Sika Sarnafil's primary adhesive and should be the first choice when using adhered applications. Due to an increase in viscosity when outdoor temperatures during installation are below 40º F, add 0.5gal/100ft^2 to rate for estimating purposes. The warranty will not be affected by the installation of the roof system in cold weather. A Sika Sarnafil warranty will be issued upon successful completion and close out of this project.

Sarnacol 2121 is a water-based adhesive for use in adhering Sarnafil roofing on slopes less than 2 in 12 membranes on horizontal surfaces only. The adhesive should be used only on moisture absorbent surfaces. Sarnacol 2121 shall not be used if temperatures below 40º F are expected during application or if the substrate temperature is below 40º F or during subsequent drying time. Initial green strength set time is 72 hours depending on substrate, ambient temperature, and humidity. Set up time increases due to an increase in humidity and/or a decrease in temperature. Newly installed areas of roofing must be protected from exposure to high winds and/or inflation from the underside. This may include edge securement and temporary ballast. It may also be necessary to adhere perimeter areas with Sarnacol 2170 to minimize the possibility of sheet flutter. Full cure time for the Sarnacol 2121 adheisve is one month or longer depending on the humidity and/or decrease in temperature. Please review the blackout dates for 2121 (Attached). Due to blackout dates and the time of year Sarnacol 2121 is no longer available for use or purchase until April 15th of 2010.

If this is a LEED project requiring low VOC it is the recommended to use 2170 VC as long as the project is non-FM insured. 2170 VC has less than the 250 g/l which is acceptable to LEED.

Sincerely,

Eric Hurst
Midwest Regional Technical Manager

DISCLAIMER: The information contained in this document, including but not limited to any recommendations regarding the use and application of Sika Corporation ("Sika" or "Sika Sarnafil") products, is given in good faith based on Sika's current experience and knowledge of its products when properly stored, handled and applied under normal conditions in accordance with Sika's instructions. The information contained in this document is valid only for the applications and uses of Sika products described herein. Any deviation from any of the instructions, uses, applications and recommendations contained in this document regarding the Sika products will void any Sika warranty. The user of the Sika products must test each product for suitability for the intended application and purpose. Prior to each use of any Sika product, the user must always read and follow the warnings and instructions on the product's current Technical Data Sheet, label and Material Safety Data Sheets available at www.sarnafilus.com. All sales of Sika products are subject to its current terms and conditions of sale available at www.sarnafilus.com.

As a membrane manufacturer, Sika Sarnafil, a division of Sika Corporation reviews details prepared by the consultant, architect and/or engineer for a project solely for the purpose of determining if a Sika Sarnafil warranty may be issued for the project. This review is not to be construed as approval of details by Sika Sarnafil and is not being conducted in lieu of sound engineering and architectural practices and judgment and should not be relied upon for that purpose. Sika Corporation assumes no liability with respect to the design of the roofing or waterproofing system. The architect, consultant and/or engineer or design professional for a particular project bears the sole responsibility for the design of the roofing or waterproofing system, for the preparation and approval of the details and shop drawings, and for determining their suitability for a particular project or application.

While Sika Sarnafil provides general instructions for the installation of its membrane as well as training for Sika Sarnafil Authorized applicators, the means and methods used by the contractor for surface preparation as well as the means and methods employed by the contractor in the installation of the Sika Sarnafil membrane are the responsibility of the contractor.

Sika Sarnafil, A Division of Sika Corporation, 16614 W. 159th Street, Suite 303, Lockport, IL 60441
Tel.: 800-532-5123, Office: 815-838-3838, Fax: 815-838-1722, www.sikacorp.com

Sarnafil letter:

- Sarnacol 2170 down to 5F
- Sarnacol 2121:
  - "…shall not be used if temperatures below 40 F are expected during application…"
  - 72 hour initial green strength time.
  - One month+ cure time
  - Blackout dates (see attached map)

58

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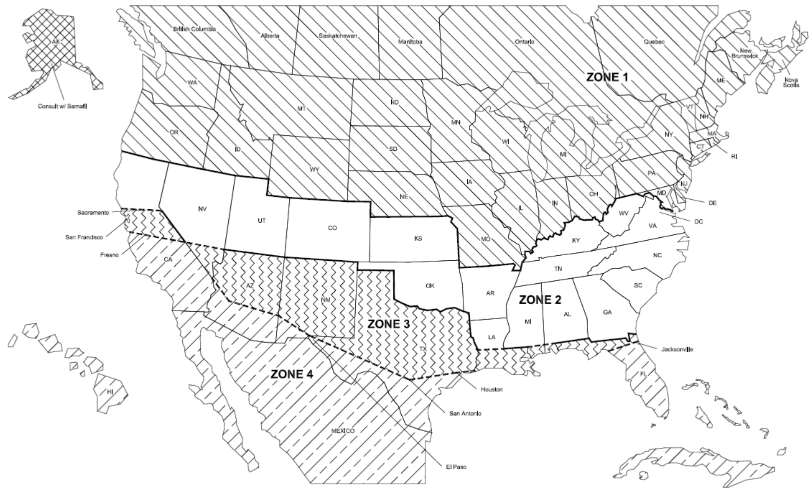
Blackout Dates for Sarnacol 2121 Adhesive



Zone 1: October 1st thru April 15th
Zone 2: October 15th thru April 1st
Zone 3: November 1st thru March 1st
Zone 4: No Blackout Dates

59 NRCA

Water-based bonding adhesives

Sika Sarnafil
World Class Roofing and Waterproofing

August 31, 2012

RE: SARNACOL 2121 ADHESIVE BLACKOUT DATES

To Whom It May Concern:

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If this is a LEED project requiring low VOC it is the recommended to use 2170 VC as long as the project is non-FM insured. 2170 VC has less than the 250 g/l which is acceptable to LEED.

Sincerely,

Eric Hurst
Midwest Regional Technical Manager

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Tel.: 800-532-5123, Office: 815-838-3838, Fax: 815-838-1722, www.sikacorp.com

Sarnafil letter:

- "…it is recommended to use 2170 VC as long as the project is non-FM insured. 2170 VC has less than the 250 g/l which is acceptable to LEED."

Be careful!
"Seasonal" products may not have the same FM and UL approvals.

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Summary

- Temperature limitations present logistical challenges
- Manufacturers' guidelines vary
- Work closely with manufacturers
- "Seasonal" products may not carry the same listing/approvals
- Contact NRCA Technical Services if you experience problems

61

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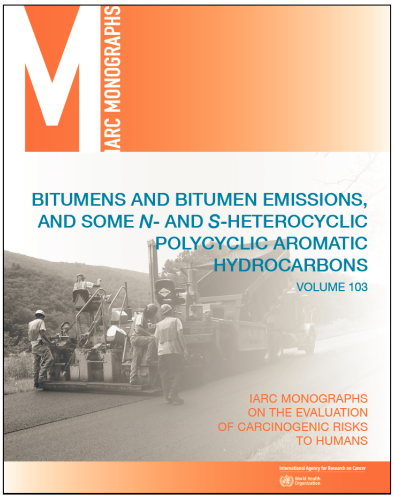
Asphalt



IARC Monograph – 103:

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

No new regulation (yet)

62

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Some terminology…

Flash point (FP): the lowest temperature at which asphalt vapors above a volatile combustible substance can ignite in air when exposed to an ignition source; tested using ASTM D92.

Equiviscous temperature (EVT): the temperature at which asphalt attains proper viscosity (flow rate) for built-up membrane application; tested using ASTM D4402 – 125 cP (mop application) and 75 cP (mechanical spreader application).

63

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NRCA recommends…

"…NRCA recommends designers specify asphalt with a sufficiently high enough FP temperature top provide a minimum 125-degree differential between an asphalt's EVT and FP temperature to allow for proper application of built-up membranes."

64

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Are asphalts currently installable?

- Comply with MSDS
- Comply with manufacturers' installation instructions
- Comply with NRCA's guidelines

65

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Asphalt shingles

- ~~ASTM D225 (organic shingles)~~
- ASTM D3462 (fiberglass shingles)
- ICC-ES AC 438 (alternative asphalt shingles)

66

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Problems and Risks Posed by Concrete Roof Decks

67

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68

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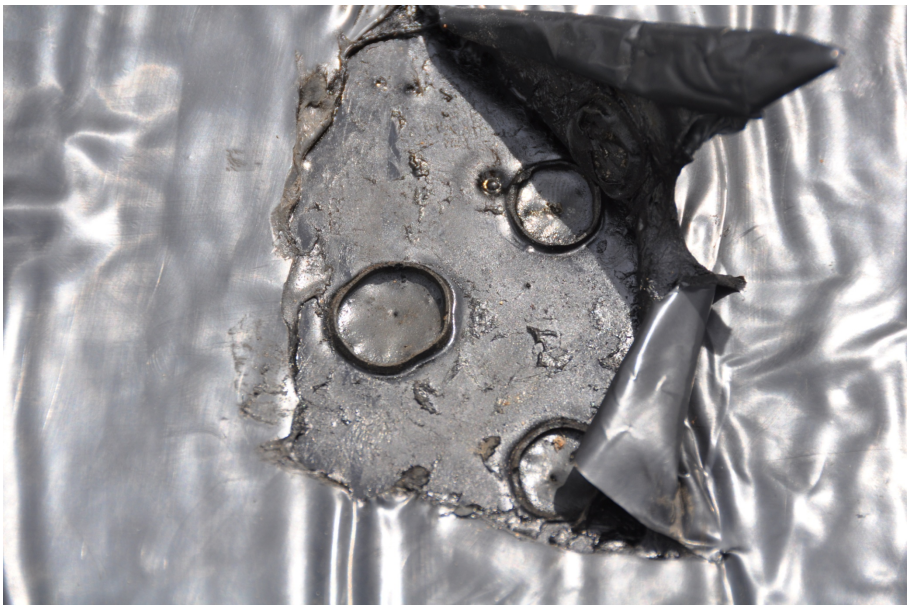

69

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70

71

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Some terminology

- **Structural concrete (normal weight)**
  - 150 lbs/ft^3
- **Lightweight structural concrete**
  - 85–120 lbs/ft^3
- ~~**Lightweight insulating concrete**~~
  - ~~20-40 lbs/ft^3~~

72

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Concrete mix design

- Aggregate:
  - Large aggregate
  - Fine (small) aggregate
- Portland cement
- Water
- Admixtures:
  - Fly ash
  - Air entrainment
  - Curing compounds
  - Etc.

73

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Concrete Aggregates

60-80% of Concrete Mix Design

- Normal-weight aggregates (stone):
  - Dense
  - Absorb about 2% by weight
- Light-weight aggregates (expanded shale):
  - Porous
  - Absorbs from 5 - 25% by weight

Lightweight structural concrete inherently contains more moisture

74

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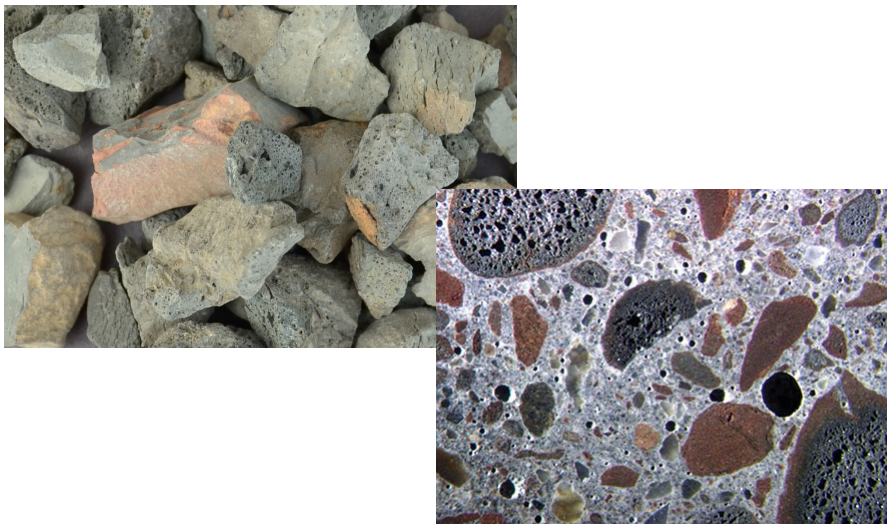
An up-close look



75

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Uses for lightweight structural concrete

- Cast-in-place roof decks (removable forms)
- Composite roof decks (metal form deck stays in-place)
- Deck topping (e.g., topping over precast concrete)

76

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What is the appeal?

Water Tower Place (1975)
Chicago, IL
859 feet tall

- Reduced weight:
  - Transportation
  - Pumping
  - Placement
  - In-place (Dead load)
- Similar strength
- Similar workability:
  - Begin finishing earlier
- Sustainability credit:
  - LEED

77

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Reported roofing-related problems

- Moisture within the roof system
- Loss of adhesion
- Insulation facer delamination
- Adhesive curing issues
- Mold growth
- Fastener/metal corrosion
- R-value loss

78

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When is it OK to roof?

Historical guidelines

- After 28 days
- Application of hot bitumen
- Plastic film test
  - ASTM D4263, "Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method"

These are not appropriate for current generations of concrete mixes

79

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Flooring industry

ASTM Committee F06—Resilient Floor Coverings

- ASTM F1869, "Standard Test Method for Measuring Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride"
- ASTM F2170, "Standard Test Method for Determining Humidity in Concrete Floor Slabs Using In-situ Probes"

80

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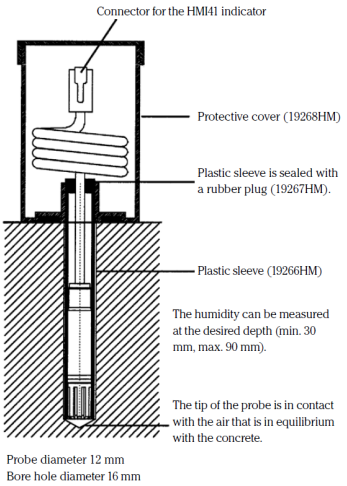
ASTM F2170 apparatus

Measure relative humidity (RH %) and temperature



81

Trial ASTM F2170 tests

Existing lightweight structural concrete roof decks

	Roof 1	Roof 2	Roof 3
Roof age (yrs)	4	7	7
Area (ft^2)	13,200	23,840	14,760
Thickness (in.)	6.5	7.5	7.3
No. of readings	13	10	8
High reading	99% RH	99% RH	99% RH
Low reading	63% RH	96% RH	84% RH
Median reading	97% RH	99% RH	99% RH
Mean reading	89% RH	99% RH	95% RH

Values of 65-85% RH are considered acceptable in the flooring industry depending upon the specific floor covering type.

82

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Concrete Floors and Moisture, 2nd Edition

Howard M. Kanare, CTL Group

75% internal RH can be achieved:

- Normal weight structural concrete
  - Less than 90 days
- Lightweight structural concrete
  - Almost 6 months

83

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Conclusions

- Concrete roof decks – normal weight and light-weight structural – present challenging moisture-related considerations.
- Further complicated by the use of admixtures and method of finishing.
- NRCA does not support the 28-day drying period or the plastic sheet test

84

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Conclusions - continued

- Roofing contractors can only visually assess the dryness of the concrete's top surface
- Roofing contractors cannot readily assess any remaining free moisture within concrete or its likely release

Roofing contractors are not privy to and may not be knowledgeable about the information necessary to make "…when to roof…" decisions

85

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Additional information

***Professional Roofing*, Feb. 2010**

Tech Today

Moisture in concrete roof decks

Concrete's curing and drying rates can affect roof systems

by Mark S. Graham

Lately, NRCA has experienced an increase in reports of moisture-related problems with low-slope membrane roof systems applied to newly poured, normal-weight or lightweight structural concrete roof decks.

In the reported instances, significant amounts of water have been found within roof systems within several months to up to three years after construction. In most of the situations reported, it was determined the roof membrane was watertight and not the source of moisture infiltration. Nevertheless, NRCA has some recommendations for resolving such problems.

Concrete decks

When mixed, poured and formed, normal-weight and lightweight structural concrete contain significant amounts of water. As concrete cures and hardens, it consumes large amounts of this water through hydration and evaporation. For example, a 4-inch-thick concrete slab will release about 1 quart of water for each square foot of surface area.

Historically, the roofing industry has used a minimum 28-day period as a guideline for applying roofing materials over newly poured concrete roof decks. The 28-day period coincides with the curing time of concrete before it is tested for design compression strength. There is little correlation between this 28-day period and concrete's true "dryness."

In some instances, a plastic sheet test has been used to determine concrete's dryness. With this test, a plastic sheet (4-mil-thick polyethylene) is taped to the concrete surface and the plastic sheet's underside is monitored for the presence of condensation.

Up to the publication of *The NRCA Roofing and Waterproofing Manual, Fourth Edition* in 1996, NRCA recommended the plastic sheet test as a method for determining a concrete surface's dryness.

However, with the publication of *The NRCA Roofing and Waterproofing Manual, Fifth Edition* in 2001 and continuing with the publication of The NRCA Roofing Manual this year, NRCA no longer considers the plastic sheet test a viable assessment of concrete's dryness.

Similar to the roofing industry, the concrete industry has seen significant advances in technology regarding concrete mix designs, placement and curing.

For example, the use of concrete additives in concrete mix designs and curing compounds during concrete placement greatly can accelerate or retard concrete's curing and release of free moisture. Similarly, weather conditions, covering newly poured concrete, timing of concrete form removal, and temporary heating or ventilating of a building's interior after concrete placement can affect the rate of concrete's upward or downward release of free moisture.

For these reasons, NRCA no longer supports the 28-day drying period or plastic sheet test.

NRCA's recommendations

NRCA considers the decision of when it is appropriate to cover a newly poured concrete substrate to be beyond roofing contractors' control. Because of the numerous variables associated with concrete mix design, placement, curing and drying, roofing contractors are not privy to and may not be knowledgeable of the information necessary to make such a decision.

Also, though a roofing contractor can assess the dryness of concrete's topmost surface, he or she cannot readily assess any remaining free moisture within the concrete and its likely direction of release.

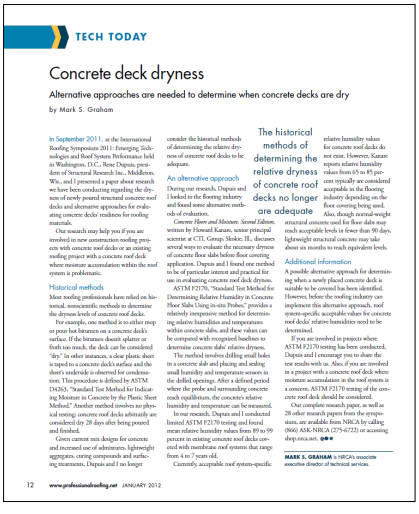
NRCA recommends the decision of when a newly poured concrete substrate is ready to be covered with a new roof system be made with the project or roof system designer, roof system manufacturer and roofing contractor. It also would be useful for designers to consult structural engineers, general contractors, concrete suppliers and concrete placement contractors who likely have more knowledge of concrete's curing and moisture-release rates.

Additional information regarding concrete roof decks is contained in *The NRCA Roofing Manual: Membrane Roof Systems—2007*.

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

Professional Roofing February 2010 23

Professional Roofing, Jan. 2012



TECH TODAY

Concrete deck dryness

Alternative approaches are needed to determine when concrete decks are dry

by Mark S. Graham

In September 2011, at the International Roofing Symposium 2011: Emerging Technologies and Roof System Performance held in Washington, D.C., Rene Dupuis, president of Structural Research Inc., Middleton, Wis., and I presented a paper about research we have been conducting regarding the dryness of newly poured structural concrete roof decks and alternative approaches for evaluating concrete decks' readiness for roofing materials.

Our research may help you if you are involved in new construction roofing projects with concrete roof decks or an existing roofing project with a concrete roof deck where moisture accumulation within the roof system is problematic.

Historical methods

Most roofing professionals have relied on historical, nonscientific methods to determine the dryness levels of concrete roof decks.

For example, one method is to either mop or pour hot bitumen on a concrete deck's surface. If the bitumen doesn't splatter or froth too much, the deck can be considered "dry." In other instances, a clear plastic sheet is taped to a concrete deck's surface and the sheet's underside is observed for condensation. This procedure is defined by ASTM D4263, "Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method." Another method involves no physical testing: concrete roof decks arbitrarily are considered dry 28 days after being poured and finished.

Given current mix designs for concrete and increased use of admixtures, lightweight aggregates, curing compounds and surfacing treatments, Dupuis and I no longer consider the historical methods of determining the relative dryness of concrete roof decks to be adequate.

An alternative approach

During our research, Dupuis and I looked to the flooring industry and found some alternative methods of evaluation.

Concrete Floors and Moisture, Second Edition, written by Howard Kanare, senior principal scientist at CTL Group, Skokie, Ill., discusses several ways to evaluate the necessary dryness of concrete floor slabs before floor covering application. Dupuis and I found one method to be of particular interest and practical for use in evaluating concrete roof deck dryness.

ASTM F2170, "Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in-situ Probes," provides a relatively inexpensive method for determining relative humidities and temperatures within concrete slabs, and these values can be compared with recognized baselines to determine concrete slabs' relative dryness.

The method involves drilling small holes in a concrete slab and placing and sealing small humidity and temperature sensors in the drilled openings. After a defined period where the probe and surrounding concrete reach equilibrium, the concrete's relative humidity and temperature can be measured.

In our research, Dupuis and I conducted limited ASTM F2170 testing and found mean relative humidity values from 89 to 99 percent in existing concrete roof decks covered with membrane roof systems that range from 4 to 7 years old.

Currently acceptable roof system-specific relative humidity values for concrete roof decks do not exist. However, Kanare reports relative humidity values from 65 to 85 percent typically are considered acceptable in the flooring industry depending on the floor covering being used. Also, though normal-weight structural concrete used for floor slabs may reach acceptable levels in fewer than 90 days, lightweight structural concrete may take about six months to reach equivalent levels.

The historical methods of determining the relative dryness of concrete roof decks no longer are adequate

Additional information

A possible alternative approach for determining when a newly placed concrete deck is suitable to be covered has been identified. However, before the roofing industry can implement this alternative approach, roof system-specific acceptable values for concrete roof decks' relative humidities need to be determined.

If you are involved in projects where ASTM F2170 testing has been conducted, Dupuis and I encourage you to share the test results with us. Also, if you are involved in a project with a concrete roof deck where moisture accumulation in the roof system is a concern, ASTM F2170 testing of the concrete roof deck should be considered.

Our complete research paper, as well as 28 other research papers from the symposium, are available from NRCA by calling (866) ASK-NRCA (275-6722) or accessing shop.nrca.net.

MARK S. GRAHAM is NRCA's associate executive director of technical services.

12 www.professionalroofing.net JANUARY 2012

86

Recommendations

Normal weight structural concrete

In new construction:

- Designer should specify "…when to roof…" criteria
  - Consult with CM/GC, concrete supplier and placement contractor, and roof system manufacturer

In reroofing:

- If evidence of moisture-related problems associated with the deck, treat the deck as lightweight structural concrete

87 NRCA

Recommendations – cont.

Lightweight structural concrete

In new construction:

- NRCA recommends lightweight structural concrete not be used for roof deck construction.
- If lightweight structural concrete is used, the Designer should specifically identify concrete drying parameters/when to apply roofing

88 NRCA

Recommendations – cont.

Existing concrete roof decks (known to be lightweight structural concrete or where moisture-related problems are evident):

- Above-deck venting design (e.g., venting base sheet)
- Adhered vapor retarder (e.g., two-part epoxy 12-15 mils)

Adhered or loosely-laid, ballasted roof systems

89

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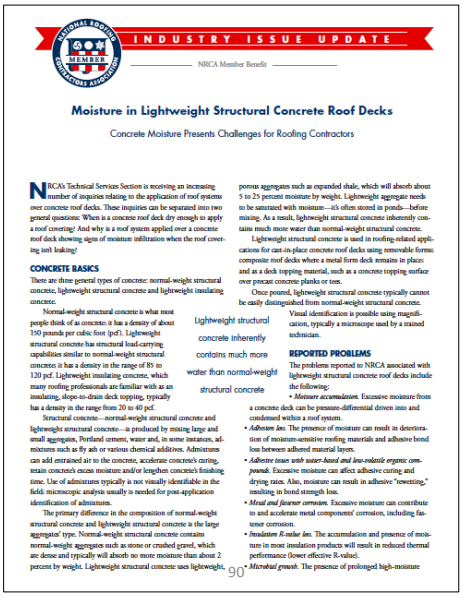
NRCA Industry Issue Update, August 2013



INDUSTRY ISSUE UPDATE

NRCA Member Benefit

Moisture in Lightweight Structural Concrete Roof Decks

Concrete Moisture Presents Challenges for Roofing Contractors

NRCA's Technical Services Section is receiving an increasing number of inquiries relating to the application of roof systems over concrete roof decks. These inquiries can be separated into two general questions: When is a concrete roof deck dry enough to apply a roof covering? And why is a roof system applied over a concrete roof deck showing signs of moisture infiltration when the roof covering isn't leaking?

CONCRETE BASICS

There are three general types of concrete: normal-weight structural concrete, lightweight structural concrete and lightweight insulating concrete.

Normal-weight structural concrete is what most people think of as concrete: it has a density of about 150 pounds per cubic foot (pcf). Lightweight structural concrete has structural load-carrying capabilities similar to normal-weight structural concrete; it has a density in the range of 85 to 120 pcf. Lightweight insulating concrete, which many roofing professionals are familiar with as an insulating, slope-to-drain deck topping, typically has a density in the range from 20 to 40 pcf.

Lightweight structural concrete inherently contains much more water than normal-weight structural concrete

Structural concrete—normal-weight structural concrete and lightweight structural concrete—is produced by mixing large and small aggregates, Portland cement, water and, in some instances, admixtures such as fly ash or various chemical additives. Admixtures can add entrained air to the concrete, accelerate concrete's curing, retain concrete's excess moisture and/or lengthen concrete's finishing time. Use of admixtures typically is not visually identifiable in the field; microscopic analysis usually is needed for post-application identification of admixtures.

The primary difference in the composition of normal-weight structural concrete and lightweight structural concrete is the large aggregates' type. Normal-weight structural concrete contains normal-weight aggregates such as stone or crushed gravel, which are dense and typically will absorb no more moisture than about 2 percent by weight. Lightweight structural concrete uses lightweight, porous aggregates such as expanded shale, which will absorb about 5 to 25 percent moisture by weight. Lightweight aggregate needs to be saturated with moisture—it's often stored in ponds—before mixing. As a result, lightweight structural concrete inherently contains much more water than normal-weight structural concrete.

Lightweight structural concrete is used in roofing-related applications for cast-in-place concrete roof decks using removable forms; composite roof decks where a metal form deck remains in place; and as a deck topping material, such as a concrete topping surface over precast concrete planks or tees.

Once poured, lightweight structural concrete typically cannot be easily distinguished from normal-weight structural concrete. Visual identification is possible using magnification, typically a microscope used by a trained technician.

REPORTED PROBLEMS

The problems reported to NRCA associated with lightweight structural concrete roof decks include the following:

- *Moisture accumulation.* Excessive moisture from a concrete deck can be pressure-differential driven into and condensed within a roof system.
- *Adhesion loss.* The presence of moisture can result in deterioration of moisture-sensitive roofing materials and adhesive bond loss between adhered material layers.
- *Adhesive issues with water-based and low-volatile organic compound.* Excessive moisture can affect adhesive curing and drying rates. Also, moisture can result in adhesive "rewetting," resulting in bond strength loss.
- *Metal and fastener corrosion.* Excessive moisture can contribute to and accelerate metal components' corrosion, including fastener corrosion.
- *Insulation R-value loss.* The accumulation and presence of moisture in most insulation products will result in reduced thermal performance (lower effective R-value).
- *Microbial growth.* The presence of prolonged high-moisture

90

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NRLRC's Contract Provisions, Vol. III

"Roofing Contractor's commencement of the roof installation indicates only that the Roofing Contractor has visually inspected the surface of the roof deck for visible defects and has accepted the surface of the roof deck. Roofing Contractor is not responsible for the construction, structural sufficiency, durability, fastening, moisture content, suitability, or physical properties of the roof deck or other trades' work or design. Roofing Contractor is not responsible to test or assess moisture content of the deck or substrate."

91

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92

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RCI

- Member
- Registered Roof Observer (RRO)
- Registered Roof Consultant (RRC)
- Registered Waterproofing Consultant (RWC)
- Registered Exterior Wall Consultants (REWC)
- Registered Building Envelope Consultant (RBEC)

93

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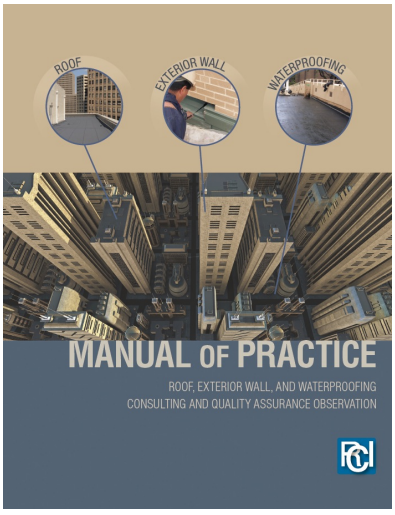

Manual of Practice:

- Sec. 1: Introduction
- Sec. 2: Recommended practices for consulting
- Sec. 3: Recommended practices for QAO
- Sec. 4: Specialized areas of practice
- Appendixes

94

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Questions?

95

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96