2014 CRCA Trade Show & Seminars
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Code and technical update

presented by

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New LTTR values for polyiso.

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New minimum LTTR values

PIMA Quality Mark[cm] program (minimum values)

Revised LTTR values		
Thickness (inches)	**New LTTR values per inch thickness**	**New LTTR values per thickness**
1	5.6	5.6
2	5.7	11.4
3	5.8	17.4
4	5.9	23.6

"Tech today," *Professional Roofing,* August 2013

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Comparing existing vs. new 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

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Some concerns

Design/bid/construction scenarios:

- Projects designed in 2013, but will be constructed in 2014
- Projects bid in 2013, but will be constructed in 2014
- Projects designed and bid in 2014 using outdated LTTR values

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NRCA recommends designers specify polyisocyanurate insulation by thickness – not R-value or LTTR.

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Some words of caution…

Do not use the terms "R-value" and "LTTR" interchangeably.

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Some additional cautions…

- Is the "long-term" in LTTR really long term in the context of a roof system service life?
- LTTR may not appropriate for use for vapor retarder design.
- LTTR may not be appropriate for use for building energy calculations.

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NRCA has not endorsed the LTTR concept

"Although the LTTR method of R-value determination and reporting may be appropriate for laboratory analysis, research comparison and procurement purposes, NRCA does not consider LTTR to be appropriate for design and in-service purposes…"

--The NRCA Roofing Manual: Membrane Roof Systems-2011

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NRCA's recommended design R-values

The NRCA Roofing Manual: Membrane Roof System-2011

Polyisocyanurate			
Thickness, in.	LTTR	NRCA Recommended Design R-values	
		Heating Conditions	Cooling Conditions
1.0	6.0	5.0	5.6
1.25	7.5	6.3	7.0
1.5	9.0	7.5	8.4
1.75	10.5	8.8	9.8
2.0	12.1	10.0	11.2
2.3	14.0	11.5	12.9
2.5	15.3	12.5	14.0
2.8	17.2	14.0	15.7
3.0	18.5	15.0	16.8
3.25	20.1	16.3	18.2
3.5	21.7	17.5	19.6
3.75	23.4	18.8	21.0
4.0	25.0	20.0	22.4

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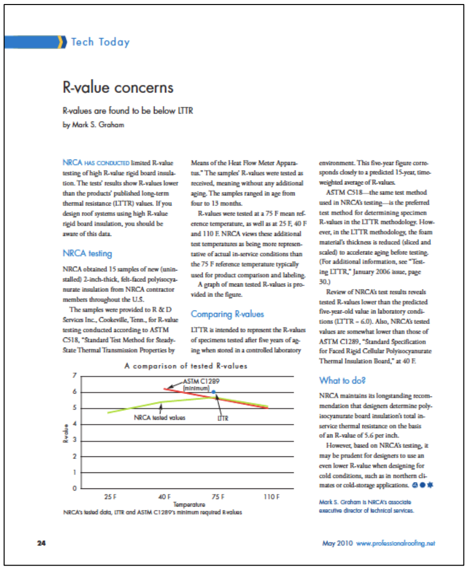

"Tech today," *Professional Roofing*, May 2010

NRCA 2009 R-value testing:

- 15 samples of new 2-inch polyiso. were testing according to ASTM C518
- Tested R-values at 75 F were lower than LTTR
- R-value of polyiso. is temperature sensitive
- R-values at 25 F, 40 F and 110 F are lower than R-value at laboratory conditions

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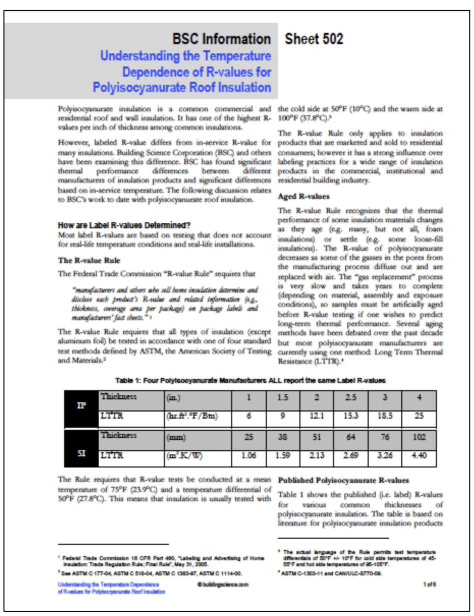

BCS Info. Sheet 502:

- Replicated NRCA's 2009 R-value testing
- Similar results
- Suggests a "climate-based" R-value approach
- Suggests use of a hybrid insulation approach

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INDUSTRY ISSUE UPDATE

NRCA Member Benefit

Polyiso's R-value

NRCA recommends polyisocyanurate insulation be specified by its desired thickness

Jan. 1, 2014

This month, U.S. polyisocyanurate insulation manufacturers will begin reporting long-term thermal resistance (LTTR) values based on updated and revised test methods. As a result, LTTR values will be less than values previously used.

Theory of foam aging

The R-value of closed-cell, polyisocyanurate insulation is affected by the amount of gas in the foam's cells. Because the R-value of most blowing agents (gases) is greater than that of air, polyisocyanurate insulation's R-value is greatest when there is more blowing agent and less air in the foam's cells.

During polyisocyanurate insulation's service life, air diffuses into the foam's cells and the blowing agent diffuses out or partially dissolves into the cell's polymer matrix. Each of these processes occurs at rates dependent upon temperature, pressure and the foam's polymer type, gas type and cell structure. Generally, the inward diffusion of air occurs at a much faster rate than the outward diffusion of the captive blowing agent. Diffusion rates also are affected by the foam's thickness and type of facer sheets.

Because of this phenomenon, the R-value of polyisocyanurate insulation is not constant. Its R-value is highest soon after manufacturing and decreases at a relatively significant rate during the earliest portion of its service life. As polyisocyanurate insulation ages further, its R-value decreases at a slower rate until the gas concentration in the foam's cells equals the gas concentration in air, at which point its R-value no longer changes with time.

R-value testing

The R-value of most insulation products used in the roofing industry is tested using ASTM C518, "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus," originally published in 1963.

When urethane foam and later polyisocyanurate insulation boards were introduced to the U.S. roofing industry, their R-values typically were reported using ASTM C518 testing conducted immediately after manufacturing and before the cell gas had diffused from the foam's cells and been replaced with air. As a result, R-values of 7.2 or higher per inch thickness were reported.

Beginning in the 1980s, the Roof Insulation Committee of the Thermal Insulation Manufacturers Association's (RIC/TIMA's) conditioning procedure (RIC/TIMA 281-1) and later the Polyisocyanurate Insulation Manufacturers Association's (PIMA's) conditioning procedure (PIMA 101) called for preconditioning foam samples at room conditions (75 F) for 180 days before R-value testing. This preconditioning was an early attempt at addressing polyisocyanurate insulation's R-value loss over time. Using RIC/TIMA 281-1 or PIMA 101 conditioning, R-values of about 6.6 per inch thickness were reported.

In 1987, based on extensive testing of in-service R-values, NRCA and the Midwest Roofing Contractors Association issued a joint technical bulletin regarding the in-service R-values of polyisocyanurate and polyurethane insulation. The bulletin recommended using an in-service R-value of 5.6 per inch of foam thickness. This in-service R-value was intended to account for polyisocyanurate insulation's R-value losses over time and provides a more realistic design R-value for polyisocyanurate insulation during a roof system's entire design life.

LTTR

During the early 1990s, Oak Ridge National Laboratory (ORNL), Oak Ridge, Tenn., in cooperation with NRCA, PIMA and The Society of the Plastics Industry, conducted research that led to the development of a new methodology for assessing aged R-values for closed-cell plastic foam insulation. This methodology involves thin slicing and accelerated aging of polyisocyanurate insulation specimens and testing their R-values using ACTM C518—a process called LTTR.

In 1995, ASTM International published an LTTR test method, ASTM C1303, "Standard Test Method for Estimating the Long-Term Change in the Thermal Resistance of Unfaced Rigid Closed-Cell Plastic Foams by Slicing and Scaling Under Controlled Laboratory Conditions," based upon this new methodology.

In 1998, the Standards Council of Canada and Underwriters Laboratories of Canada published CAN/ULC-S770, "Standard Test Method for Determination of Long Term Thermal Resistance of Closed-Cell Thermal Insulation Foams." CAN/ULC-S770 is based on ORNL's research and ASTM C1303 and provides R-value data based on a 15-year time-weighted average, corresponding to a product's R-value five years after manufacturing.

Beginning in 2003, U.S. polyisocyanurate insulation manufacturers began reporting LTTR values using a third-party certification program, referred to as PIMA's QualityMark℠ program. This program used the 2003 edition of CAN/ULC-S770 for LTTR

Moisture-related problems with lightweight structural concrete roof decks

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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

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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

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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

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NRCA considers the decision of when it is appropriate to cover newly placed concrete substrates with roofing materials to be beyond roof contractors' control....

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NRCA's recommendations

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

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NRCA's 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

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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.

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.

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

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 compounds*. 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

Development of the 2015 I-codes

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2015 I-codes

- IBC 2015 (Chapter 15):
  - Some reformatting
  - Secondary drain exception in reroofing
  - Additional language on rooftop PV
- IRC 2015 (Chapter 9):
  - Rooftop PV scoped with roofing chapter

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2015 I-codes – cont.

- IECC 2015:
  - Reroofing applicability clarified
  - Min. R-values increased (+R=5)
  - Air barrier exception in reroofing
- IgCC 2015:
  - 2014 code development cycle

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2015 I-codes (except IgCC) will be published in June 2014

Illinois adoption????

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