# LTTR CONTROVERSY CONTINUES

CAN/ULC-S770, Standard Test Method for Determination of Long-Term Thermal Resistance (LTTR) of Closed-Cell Thermal Insulating Foams, was developed to predict the R-values of rigid closed cell plastic foam insulations. It is widely accepted that the thermal resistivity of closed cell insulations that rely on captive blowing agents decreases over time before it stabilizes. The test method in S770 is used to predict the magnitude of this change in the R-value.

The method is not without controversy. The article that follows, "R-value concerns," appeared in the May 2010 issue of *Professional Roofing* and discusses NRCA's testing related to the effects of ambient environmental conditions on R-values.

In response to industry concerns raised from the NRCA testing, Dr. M. Drouin, Dr. P. Mukhopadhyaya and Cliff Shirtliffe, members of ULC's Standards Committee on Thermal Insulation Materials and Systems, have also provided their article discussing the benefits and limitations of the LTTR test method. Their piece, titled here "Insight into LTTR," follows on page 10.

*Peter Kalinger, Technical Director, Canadian Roofing Contractors' Association*

## R-value concerns

### R-values are found to be below LTTR

*By Mark S. Graham*

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

### NRCA testing

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

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

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

A graph of mean tested R-values is provided in the figure on page 10.

### Comparing R-values

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

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

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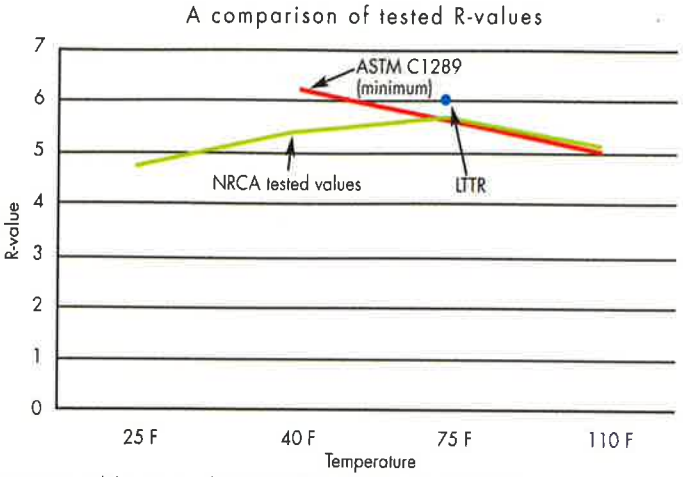

NRCA's tested data, LTTR and ASTM C1289's minimum required R-values

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

### What to do?

NRCA maintains its longstanding recommendation that designers determine polyisocyanurate board insulation's total in-service thermal resistance on the basis of an R-value of 5.6 per inch. However, based on NRCA's testing, it may be prudent for designers to use an even lower R-value when designing for cold conditions, such as in northern climates or cold-storage applications.

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*CRCA wishes to thank NRCA for allowing us to reprint this article.*

# Insight into LTTR

## What we know about long-term thermal resistance of closed-cell insulating foam: a response to concerns raised by NRCA testing

*By Dr. Michel Drouin, Dr. Phalguni Mukhopadhyaya & Cliff Shirtliffe*

The current version of CAN/ULC-S770, "Standard Test Method for Determination of Long-Term Thermal Resistance (LTTR) of Closed-Cell Thermal Insulating Foams," is the third edition published in 2009. The first edition was published in 2000 (Note that ASTM C1303, "Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation," and CAN/ULC-S770 use the same basic principle of closed-cell foam aging). LTTR is defined as the thermal resistance value of a product measured after storage for five years under prescribed laboratory conditions (i.e., 23 ± 5 °C and 50 ± 20 % RH).

The LTTR method is used for determining R-values of rigid closed-cell foam insulations and applies to all cellular plastic insulations that rely on a captive blowing agent (or gas), other than air, for increased thermal resistance values. It is indicative of the predicted R-values after extended service, where the R-value is known to decrease with time. In the LTTR method described in the Standard, the foam insulation is thin-sliced to reduce the diffusion path length for the gas and hence accelerate the aging process to allow a relatively rapid prediction of the long-term R-value. The resulting temporal acceleration is proportional to the square of the ratio of the full product thickness to the slice thickness. For example, a sample of 12.7mm (0.5-in.) thick insulation material ages 16 times as fast as a 50.8mm (2-in.) sample.

### Background

At the time of manufacture, the cells of the foam contain their highest percentage of blowing agent and the lowest percentage of atmospheric gases (air). As time passes, the relative concentrations of these gases change due to inward diffusion of air components ($O_2$, $N_2$, $CO_2$, $H_2O$, etc.) and outward diffusion of the cell gasses. This phenomenon is typically referred to as foam aging and results in a general reduction of the thermal resistance of the foam due to a reduction in the thermal resistance of the resultant cell gas mixture.

This test procedure is included in the Canadian material standards for extruded polystyrene foam (XPS), spray polyurethane foam (SPF) and polyisocyanurate foam (PIR). These foam plastic insulations rely on the captive blowing agents (hydrofluorocarbons, HFC, or hydrocarbon, HC) for thermal performance.

The LTTR procedure predicts the thermal resistance of the foam at an age of five years under prescribed laboratory conditions. This corresponds closely to the average thermal resistance of the full thickness products (25 to 100mm) over a 15-year service life under equivalent conditions. The LTTR test method is very prescriptive as it specifies a series of procedures. It provides information regarding changes in the thermal resistance of these materials as a function of time, but in a "shorter" test period of time. This allows the producer to make crucial decisions regarding formulations and production of closed-cell foam, and allows the user to gauge the relative long-term performance of the material.

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