EXTRUDED POLYSTYRENE FOAM ASSOCIATION

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# XPSA BULLETIN – RSI DESIGN VALUES

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**FAQs: In-Service Factors that Potentially Affect Insulation Design RSI-values in Canada**

**1) All construction materials (wood, steel, concrete, foam, etc.) are impacted by their exposure to the in-service environment. What specific service conditions can potentially impact rigid foam insulation RSI-values?**

Rigid foam insulation RSI-values are primarily impacted by temperature, bulk moisture, long-term aging and air/vapor-permeability.

- As temperature decreases ↓, insulation RSI-values increase ↑
- As moisture increases ↑, insulation RSI-values decrease ↓
  - The rigid cellular structure of XPS gives it a unique advantage to resist moisture absorption and minimize air/vapor permeability.
- As aging increases ↑, insulation RSI-values decrease ↓
  - XPS products are manufactured with non-air blowing agents that are slowly released over time from the cellular structure.
  - The skins of XPS rigid foam insulation reduce the speed at which bulk moisture, blowing agents, and natural air/vapor move through the insulation board.
- As air/vapor permeability increases ↑, insulation RSI-values decrease ↓ (especially with loosely-packed, non-foam insulation)
- Below-grade foundations, above-grade walls and roof assemblies each have their own unique in-service conditions for a given climate zone.

**2) How are these service conditions accounted for in the XPS/EPS product standard?**

Service conditions can vary significantly from climate to climate and there are no test methods that can account for every application. XPS/EPS product standards use standardized test procedures under laboratory conditions that ensure XPS/EPS products are qualified to:

- Minimum RSI thermal resistance, and LTTR (aging) thermal resistance
- Maximum water vapor permeance
- Maximum water absorption
- Other properties such as dimensional stability, flexural strength, compressive strength, etc.

The certification reports provided by the insulation manufacturers list these properties and allow for comparisons between rigid foam products. Standardized test procedures for product properties are not intended to correlate to every possible in-service condition; standardized test procedures provide a repeatable method to demonstrate product performance under a single service condition.

3) **How are XPS/EPS RSI-values reported?**

XPS/EPS RSI values are reported per CAN/ULC S701-05, CAN/ULC S701-11, or CAN/ULC S701.1-17, typically through a CCMC or a recognized third-party evaluation agency report or listing.

4) **Do other application-based standards adjust foam insulation RSI-values according to service conditions?**

Yes, application standards such as ASCE 32 for Frost Protected Shallow Foundations, and the International Code Council (ICC) International Residential Code (IRC) recognize the differences in moisture performance and aging of XPS and EPS rigid foam insulation.

For frost protected shallow foundations, the thermal resistance value is adjusted in horizontal applications to a design R-value of 80% for XPS and a design R-value of 65% for EPS. In vertical applications, XPS's design R-value is adjusted to 90% and the design R-value is adjusted to 80% for EPS. ***This recognizes that in below-grade applications, EPS absorbs more moisture and moisture absorption in EPS has a far greater negative effect than the XPS long-term aging and moisture absorption, based on in-service measurements.***

5) **Why is aging in-service included in the CAN/ULC S701 and CAN/ULC S701.1 standards, when other in-service factors such as moisture, temperature, etc., are not included?**

The roofing industry back in the 1980's initiated studies to determine the aging performance of rigid foam insulation. There was a significant effort to establish a laboratory test method (CAN/ULC S770) that predicted a long-term aging performance of rigid foam insulation in a roofing application. This laboratory technique, known as "Slicing and Scaling," is the basis of the long-term thermal resistance (LTTR) value. LTTR takes into account the effect of gas diffusion on the thermal performance of the foam insulation.

The long-term thermal resistance (LTTR) of a thermal insulating foam product is defined as its thermal resistance measured under standard laboratory conditions (23 ± 2 °C and 50 ± 10 % RH) after 5-year storage in a room (23 ± 5 °C and 50 ± 20 % RH). The LTTR is a design thermal resistance property, introduced for comparing different foam products to one another.

LTTR is defined as the time weighted average of thermal resistance over 15 years at a given thickness. ***XPS thermal resistance at an age of 5 laboratory years corresponds to the average thermal resistance over a 15-year in-service life***

The CAN/ULC S701 and CAN/ULC S701.1 standards do not address other in-service conditions as these are not an application-based standards.

6) **Where do I find information about compliance of XPS to the LTTR values?**

See the ***XPSA Bulletin – LTTR Compliance*** for additional information about labeling and code compliance requirements for XPS rigid foam insulation.