PIMA Technical Bulletin #104

# Fire Test Standards for Polyiso Insulation and Roof Assemblies

## About Polyiso Insulation

Polyiso is a rigid foam insulation used in more than 70% of commercial roof construction and offers a continuous insulation solution for commercial and residential wall assemblies. As one of North America's most widely used and readily available building products, Polyiso is a cost-effective insulation option for reducing building energy use and improving the overall service-life of roofs and walls.

The benefits of using Polyiso include:

- High R-value per inch of thickness
- Excellent fire test performance
- Extensive building code approvals
- Cost-effective continuous insulation (ci) solution
- Compatible with most roof and wall systems
- Dimensional stability
- Compressive strength
- Moisture resistance
- Thinner walls and roofs with shorter fasteners
- Long service life
- Preferred insurance ratings
- Virtually no global warming potential
- Zero ozone depletion potential
- Recyclable through reuse
- Recycled content (amount varies by product)
- Regional materials (nationwide production network)

POLYISO

Surround yourself with the best.

Polyisocyanurate (polyiso) has a proven track record of performance in low-slope roofing applications. The performance benefits of polyiso, such as its high R-value and excellent fire test performance, make polyiso an excellent insulation choice for roofing applications to ensure long-term performance over the life of a building.

This technical bulletin discusses fire performance tests and applicability of these tests to polyiso in roofing applications. Further information regarding these tests is available from ASTM International (ASTM), Underwriters Laboratories (UL), Underwriters Laboratories of Canada (ULC), FM Approvals (FM), National Fire Protection Association (NFPA), product manufacturers, building code authorities as well as accredited third-party testing laboratories and certification bodies. For more specific information regarding the fire performance and approved uses of specific polyiso insulation products, please contact the manufacturers.

Important note: Fire performance testing is used to measure and describe how materials and assemblies respond to heat and flame under controlled conditions. Testing does not, by itself, incorporate all factors required for the assessment of fire hazard or fire risk, nor can it purport to address all safety concerns, if any, associated with its use.

## Fire Performance and Associated Requirements in Model Building and Fire Codes

The fire performance of building products and assemblies is an essential component of fire and life safety in the built environment. Model building and fire code requirements regulate fire performance of building materials and assemblies through various tests and performance requirements to establish a minimum level of fire and life safety in buildings. Building and fire codes also regulate fire safety through requirements and limitations related to the use, maintenance, and repair of buildings and structures.

When regulating building materials and assemblies, the model building codes set forth requirements and limitations based on the general design and anticipated use of a building then add specific performance requirements for building materials and assemblies as the actual design takes shape. The code requirements refer to consensus tests and performance standards developed by Standard Development Organizations. In the United States and Canada, the model building codes reference standards from ASTM, ULC, FM, and NFPA when evaluating the fire performance in roof applications. Table 1 identifies the most common fire performance tests referenced in International Building Code (IBC) Chapter 15[A] and Section 2603[B] and International Residential Code (IRC) Chapter 9[C] and Section R316[D] for provisions applicable to polyiso

roof insulation and roof assemblies containing polyiso insulation. Table 2 identifies the most common fire performance tests referenced in National Building Code of Canada (NBCC) Articles 3.1.4[E], 3.1.5[F], 3.1.15[G], and 9.26[H]. Note that the model building codes may require multiple fire performance tests depending on the specific application, condition, and project requirements.

## Material Tests vs. Assembly Tests

**Table 1: Common fire tests required for roofing applications under the IBC and IRC**

| Test[1] | Test Type | Performance Evaluated |
|---|---|---|
| ASTM E84 / UL 723 | Material | Surface burning characteristics |
| ASTM E108 / UL 790[2] | Assembly | Roof assemblies exposed to exterior flame |
| ASTM E119 / UL 263 | Assembly | Fire resistance |
| UL 1256 | Assembly | Flame spread of roof deck constructions from interior fire exposure |
| NFPA 276 | Assembly | Heat release rate of roof assemblies with combustible above-deck roofing components |

Table 1 Notes:

1. See Referenced Standards at the end of this document for the full name of each test method.
2. ASTM E108 and UL 790 each contain three different assembly tests and performance requirements for each Classification (Class A, B, or C).

**Table 2: Common fire tests required for roofing applications under the NBCC**

| Test[1] | Test Type | Performance Evaluated |
|---|---|---|
| CAN/ULC-S102 | Material | Surface burning characteristics |
| CAN/ULC-S127 | Material | Flammability characteristics of non-melting foam plastic building materials |
| CAN/ULC-S101 | Assembly | Fire resistance |
| CAN/ULC-S1072 | Assembly | Roof coverings |
| CAN/ULC-S126 | Assembly | Flame spread of roof deck constructions from interior fire exposure |

Table 2 Notes:

1. See Referenced Standards at the end of this document for the full name of each test method.
2. CAN/ULC-S107 contains three different assembly tests and performance requirements for each Classification (Class A, B, or C).

Since the mid 1970's model building codes in the US and Canada have regulated the use of foam plastic insulations using a two-step approach. The first step establishes a minimum performance baseline for the foam plastic itself. The second step evaluates assemblies containing the foam plastic such as polyiso using larger scale tests that are representative of the intended end use.

A. IBC Chapter 15 – Roof Assemblies and Rooftop Structures
B. IBC Section 2603 – Foam Plastic Insulation
C. IRC Chapter 9 – Roof Assemblies
D. IRC Section R316 – Foam Plastic
E. NBCC Article 3.1.4 – Combustible Construction
F. NBCC Article 3.1.5 – Noncombustible Construction
G. NBCC Article 3.1.15 – Roof Covering
H. NBCC Article 9.26 – Roofing

Under the IBC and IRC in the United States, for installations up to 4 inches in thickness, all foam plastic insulation and foam plastic insulation used in cores of manufactured products is required to have a flame spread index of 75 or less and a smoke developed index of 450 or less when tested in accordance with ASTM E84 or UL 723 at the thickness intended for end use. The IBC and IRC modify this minimum material performance requirement depending on the specific use accompanied by requirements for additional large-scale tests. By comparison, the NBCC uses a similar approach that requires material testing for surface burning characteristics (CAN/ULC-S102) combined with assembly testing (CAN/ULC-S107) for roofing applications.

## Basic Descriptions of Common Fire Performance Tests

### ASTM E84, UL 723, and CAN/ULC-S102

Often referred to as the "tunnel test" (Steiner Tunnel), the test procedure requires a nominal 24-inches wide by 24-feet long test specimen. The test specimen is placed horizontally in the ceiling of the test chamber with the foam plastic facing downward into the chamber. There are some differences between the CAN/ULC-S102 and ASTM E84 / UL 723 in the configuration of the tunnel apparatus' observation windows and fire-brick lining. An air draft of fixed velocity is drawn through the chamber and the test specimen is exposed to a gas flame at approximately 5,000 Btu/min (88-90 kW) for a period of 10 minutes. The distance and rate of flame front progression and the amount of smoke produced are measured and then used to calculate the flame spread index and smoke developed index.

### CAN/ULC-S127

The CAN/ULC-S127 test is a corner wall method that is referenced in CAN/ULC-S102 as additional required testing based on certain performance parameters observed during the tunnel test. The CAN/ULC-S127 uses a test chamber measuring 1300mm × 1300mm × 1300mm (internal dimensions) with the floor, ceiling, and two adjacent walls (i.e., a corner) lined with inorganic cement board.

### ASTM E108, UL 790, and CAN/ULC-S107

These tests evaluate how roof coverings assemblies, including the roof deck, react when exposed to exterior flame and burning debris through a series of three (3) tests:

1. Spread of Flame
2. Intermittent Flame
3. Burning Brand
4. Flying Brand (only required with wood shakes and shingles)

These tests are conducted with the assembly set at an incline and subjected to flame exposure from a gas burner or burning brand. The tests are conducted within a 12-mph (5.3-m/s) air stream. Multiple, replicate tests are required for each of the three tests. The specific tests, number of test replicates, and acceptance criteria are determined by the desired classification (Class A, B, or C). Where a roof covering installation is limited to noncombustible roof decks, only the Spread of Flame test is required.

### ASTM E119, UL 263, and CAN/ULC-S101

These tests evaluate the duration for which construction assemblies are able to contain a fire and retain their structural integrity during a predetermined test exposure (i.e., a standard time vs. temperature curve). Test specimens are constructed with all components and configured as intended to be installed in the building. Test specimens for roof assembly tests are required to be no less than 12-feet long by 12-feet wide.

The tests determine the passage of heat and flame across the assembly from exposed face to the unexposed face as measured and recorded by temperature-rise on the nonexposed face for the rating period (i.e., 1-hr, 2-hr, etc.). The tests also determine the ability of the test specimen to resist a superimposed load for the rating period. Test results may be extended to assemblies similar to the one tested through careful analysis of test data (See ASTM E2032 Standard Practice for Extension of data from Fire Resistance Tests Conducted in Accordance with ASTM E119).

### UL 1256 and CAN/ULC-S126

The UL 1256 test contains two options, "large-scale" test and "small-scale" test. Due to its size and cost, the large-scale test is rarely performed today – the test specimen is 100-feet long by 20-feet wide. The small-scale test, by comparison, uses the same test apparatus and test specimen size as ASTM E84 and UL 723, therefore, it is the preferred approach. The IBC and IRC permit the installation of foam plastic insulation in roof covering assemblies without the use of code-prescribed thermal barrier on the basis of successful testing in accordance with UL 1256.

The test specimen of UL 1256 small-scale test is composed of the roof assembly (deck type and roof covering) installed on top of a metal roof deck. The test assembly is placed in the test chamber such that the under-side of the roof deck is exposed to the same gas burner and flame as the ASTM E84 / UL 723 test. The test duration of the small-scale test is 30-minutes and measures the observed flame front progression at 10-minutes and 30-minutes. Acceptance criteria for these tests include limits on flame front progression and a post-test damage assessment that requires fire damage of the test specimen to decrease at distances farther away from the gas burner.

The CAN/ULC-S126 test is very similar to the UL 1256 small-scale test. It uses the Steiner Tunnel apparatus (configured in accordance with CAN/ULC-S102), exposes the underside of a simulated roof assembly to the same 5,000 Btu/min (88-90 kW) gas flame for 30-minutes, and uses the same acceptance criteria. In contrast to UL 1256, the CAN/ULC-S126 standard has two testing substrate options: a wood roof-deck assembly and a metal roof-deck assembly.

### NFPA 276 and FM 4450

The NFPA 276 test is the same methodology as the Combustibility test of the FM 4450 approval standard. In this method, a test specimen approximately 4.5-feet long by 5-feet wide is placed on top of the test furnace apparatus. The test measures the fuel contribution from a roof assembly exposed to a 26,400 Btu/min (464 kW) under-deck fire over a 30-minute test duration. Acceptance criteria for the test limits the heat release rate at several time intervals during the test and does not permit dropping of flaming particles into the furnace or uncontrolled flaming on the exterior surface of the test specimen.

## Takeaways

Polyiso roof insulations and assemblies are subject to multiple fire performance tests to ensure predictable performance in the event of interior or exterior fires. From individual building materials to assemblies representing actual designs, fire performance testing and compliance with applicable building and fire code requirements are critical to fire and life safety in the built environment. PIMA supports wholistic approaches to fire and life safety and adoption of the most current model building codes, performance standards, and consensus principles of fire safety.

## For More Information

For more specific information regarding the fire performance, approved uses, and code compliance information of specific polyiso insulation products, please contact the manufacturers.

## ABOUT PIMA

Since 1987, PIMA has served as the voice of the North American rigid polyiso insulation industry. PIMA is a leading advocate for safe, cost-effective, sustainable, and energy-efficient construction. The Association is comprised of polyiso manufacturers and industry suppliers, and represents the public policy interests of its membership at the local, national, and international levels to advance high-performance building practices.

PIMA produces technical bulletins to address key topics related to polyiso insulation. These publications inform architects, specifiers, and contractors about the performance characteristics of polyiso insulation. Always consult individual manufacturers for product specific information, including product data sheets and installation instructions.

For more information on polyisocyanurate insulation, visit www.polyiso.org

PIMA
POLYISOCYANURATE INSULATION MANUFACTURERS ASSOCIATION

ATLAS · CARLISLE CONSTRUCTION MATERIALS · GAF · HOLCIM · IKO · JM Johns Manville · MAX · SOPREMA