



SURE-FIRE PERFORMANCE

THE FIRE PERFORMANCE OF
KINGSPAN INSULATION PRODUCTS



Introduction

Fire performance is not a simple science. It has a number of facets that interrelate and are often confused and conflated by the ill informed or those wishing to deliberately mislead.

In the case of insulation products, the three most important aspects of fire performance are 'Reaction to Fire', 'Fire Resistance' and 'Smouldering Combustion (or Pinking)'.

Reaction to Fire

There are a number of systems and standards in different jurisdictions for measuring a construction product's reaction to fire, for example the Euroclass system in the EU and ASTM E 84 in North America. Kingspan Insulation's products achieve good results in a wide range of reaction to fire tests (see Box 1 for details).

Box 1

- Products in the *Kingspan Kooltherm*® range can achieve a Euroclass rating as good as B_{s1,d0}.
- Products in the *Kingspan Kooltherm*® range can achieve a classification as good as Class 0, when tested to BS 476-6: 1989 (Fire tests on building materials and structures. Method of test for fire propagation for products) and BS 476-7: 1997 (Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products).
- Products in the *Kingspan Kooltherm*® range, produced at Kingspan Insulation's Pembridge and Castleblayney manufacturing facilities, can achieve a Flame Spread Index (FSI) of 10 and a Smoke Developed result of 5 when tested to ASTM E 84 - 12c (Standard Method of Test for Surface Burning Characteristics of Building Materials).
- Products in the *Kingspan Kooltherm*® and *Kingspan Therma*™ ranges can achieve a material class B2 when tested to DIN 4102-1: 1998 (Fire behaviour of building materials and elements - Part 1: Classification of building requirements and materials testing).
- Products in the *Kingspan Kooltherm*® and *Kingspan Therma*™ ranges have been tested to AS 1530 Part 3 (Simultaneous determination of ignitability, fire propagation, heat release and smoke release). The products achieved an Ignitability Index, Spread of Flame Index and Heat Evolved Index of 0, as well as a Smoke Developed Index of 0-1.
- For fire performance and test results for the full Kingspan Insulation range please refer to the relevant Kingspan Insulation literature or the Kingspan Insulation Technical Service Department.



Figure 1: *Kingspan Thermaroof*® TR26 LPC/FM being tested 'in application' to the Euroclass system.



Figure 2: *Kingspan Kooltherm*® K5 External Wall Board being tested 'in application' to the Euroclass system.
Picture courtesy of Insuletics.

The Euroclass system for reaction to fire, has two flaws, which render its application to insulation products difficult.

Firstly, the most important component in the testing that lies behind Euroclasses, the Fire Growth Rate Index (FIGRA), is arranged such that it can discriminate against products with thin combustible facings (see Box 2 for details). Although thin facings have an impact on classifications under the Euroclass system, they have little effect on the fire load of a building as their mass is insignificant. An example of a FIGRA for a product with a thin combustible facing can be seen in Figure 3.

Secondly, the system was set up with reference to a test based on wall and ceiling linings only (see Box 3 for details). Euroclass ratings can be given for products 'as placed on the market (naked)' or 'in application'. It is rare for insulation products to be used as an exposed wall or ceiling lining. Normally, insulation products are installed behind another layer e.g. plasterboard. Therefore, for insulation products, Euroclasses for products 'as placed on the market (naked)' could be regarded as being irrelevant. 'In application' results could be regarded as giving a better indication of real-life performance.

Box 2

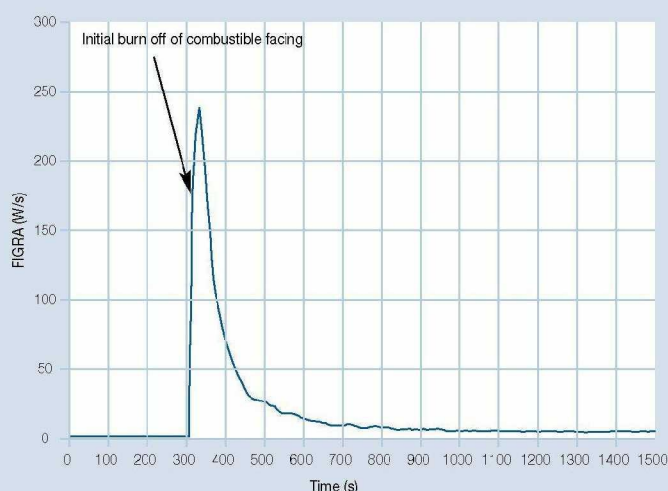


Figure 3: An example of a FIGRA for a product with a thin combustible facing

A high FIGRA can be obtained with quick burn-off of an insubstantial surface layer. Unexpected classifications are in many cases caused by low heat but quick burn-off of this surface layer even though it may not represent any risk and may contribute little to the propagation of a fire or the fire load. Total Heat Release (THR) can lead to a better assessment of risk as it measures the total contribution of a product to a fire.

Box 3

ISO 9705 is a test method for measurement of the burning behaviour of construction products. The method was specifically designed to measure the behaviour of surface products.

'The International Standard specifies a test method that simulates a fire that under well ventilated conditions starts in a corner of a small room with a single open doorway. The method is intended to evaluate the contribution of fire growth provided by a surface product using a specified ignition source', where the surface product is defined as 'any part of a building that constitutes an exposed surface on the interior walls and/or the ceiling such as panels, tiles, boards, wall papers, sprayed or brushed coatings' (ISO 9705).

ISO 9705 is used as a reference scenario for the definition of class limits in the Euroclass system. Therefore the Euroclass system is based on a test method specifically created to test the reaction to fire of wall and ceiling linings only.

When tested to EN 13823: 2010 (Reaction to fire tests for building products. Building products excluding floorings exposed to the thermal attack by a single burning item), products in the **Kingspan Kooltherm®** range, in roof and wall constructions, can achieve an 'in application' Euroclass rating of as good as B_{s1d0}. Products in the **Kingspan Therma™** range, in roof and wall constructions, can achieve an 'in application' Euroclass rating as good as B_{s2d0}.

Notwithstanding this, small scale tests, such as those carried out to EN 13823: 2002, are only a substitute for large scale fire

tests and are an approximation, rather than an accurate reflection of performance in large scale tests, which are complex. Extrapolating from small scale tests may yield unexpected and surprising results.

Wherever possible, data from large scale tests such as LPS 1181: 2003 (Requirements and tests for LPCB approval of wall and ceiling lining products and composite cladding products) should be relied upon rather than small scale proxies. Box 4 outlines the fire performance of Kingspan Insulation products when tested to large scale test methods.

Box 4

Kingspan Thermaroof® TR26 LPC/FM, Kingspan Thermaroof® TR27 LPC/FM and their tapered equivalents have been successfully tested to LPS 1181: 2003. LPS 1181: 2003 is an insurer approval test that uses a burning wooden crib with a peak heat output of 1 Megawatt. A pass requires that there be:

- no flashover at the ceiling;
- no sustained surface flaming;
- no external flame spread;
- no concealed burning;
- no fall of burning brands from the ceiling; and
- no part of the insulation core completely destroyed.

LPS 1181: 2003 therefore combines assessments of both reaction to fire and fire resistance of a complete construction in the same system.

The LPCB also carry out post-test quality checks ensuring that insulation material being manufactured is of the same high-quality as the material used in the construction that passed the test.

Apart from its severity, what makes this test such a good indicator of the real fire performance of any product is its scale, which is far greater and far more comprehensive than the tests used for Euroclass ratings. Furthermore, it gives a credible indication of how an actual structure is likely to behave under the stresses of fire, since interfaces such as joints are also examined during the test.

BS 8414-1: 2002 (Fire performance of external cladding systems. Test methods for non-loadbearing external cladding systems applied to the face of a building) is a full scale test method for non-load bearing external cladding systems, and can be regarded as the only genuine test of the suitability of an insulation product for external wall cladding applications.

Kingspan Kooltherm® K15 Rainscreen Board and **Kingspan Kooltherm® K5 External Wall Board** have been tested to BS 8414-1: 2002 and, when assessed in accordance with BR 135, it is acceptable for use above 18 metres in accordance with the English / Welsh, Scottish and Irish Building Regulations. Successful testing to BS 8414-1: 2002 means that the insulation product can be used in areas normally limited to non-combustible and limited combustibility products.



Figure 4: **Kingspan Kooltherm® K5 External Wall Board** being tested to BS 8414: 2002. Picture courtesy of Insuletics.

Fire Resistance

Reaction to fire under the Euroclass System is mostly determined by the innermost layer of a construction, which, in real buildings, is generally not an insulation product. The fire performance of insulation products is of more importance in the context of the fire resistance of an element of construction.

There are a number of systems and standards for measuring the fire resistance of a construction, e.g. BS 476-21: 1987 (Fire tests on building materials and structures. Methods for determination of the fire resistance of loadbearing elements of construction) and EN 1365-2: 2000 (Fire resistance tests for loadbearing elements. Floors and roofs).

A timber frame wall construction insulated with 75 mm thick **Kingspan Kooltherm® K12 Framing Board** has been successfully tested to BS 476-21: 1987. The test is designed to assess the length of time a construction can maintain integrity, insulation and resistance under load. The construction, which was lined with 12.5mm plasterboard, achieved a fire resistance of over 50 minutes, approaching double the minimum requirement for this type of construction.

When tested to EN 1365-2: 2001, a construction, insulated with **Kingspan Thermo roof® TR26 LPC/FM**, **Kingspan Thermo roof® TR27 LPC/FM** and their tapered equivalents, has achieved a fire resistance of 31 minutes (REI30).

The build-up consisted of a 0.75 mm trapezoidal steel sheet, a vapour barrier, two layers of 55 mm **Kingspan Thermo roof®** and a single-ply membrane of 1.2 mm.

Indeed the types of insulation manufactured by Kingspan Insulation perform extremely well in fire resistance tests, and can perform better than some equivalent man made mineral fibre products. For a comparison between constructions insulated with PIR and glass mineral fibre please see Box 5.

Kingspan Insulation's products tend to form an intumescent-type char which protects the insulation behind from the flames. This char will break down slowly and allow the flames to char another layer of insulation, but it takes a significant amount of time. Lightweight mineral fibre and polystyrene products will melt away from flames, offering little or no resistance to fire penetration.

Smouldering Combustion (Punking)

Punking is not a phenomenon which is practically associated with Kingspan Insulation products. This is, however, a phenomenon associated with mineral fibre and cellulose fibre insulation products. Numerous fires have been reported, globally, that are related to this phenomenon in mineral fibre and cellulose fibre insulation products.

Box 5

Tests carried out by Exova Warrington Fire for PU Europe to EN 1365-1: 1999 (Fire resistance tests for load-bearing elements. Walls) have compared the fire resistance of equivalent timber frame wall constructions insulated with PIR and glass mineral fibre. The results were as follows:

	Construction Insulated with PIR	Construction Insulated with Glass Mineral Fibre
Load-bearing Capacity	39 minutes	32 minutes
Integrity Performance	38 minutes	31 minutes
Insulation Performance	38 minutes	31 minutes

The results show that not only can the construction insulated with PIR meet the minimum legal requirement of 30 minutes fire resistance (REI30) for this type of construction in the UK, but also that, for this specific build-up, the fire resistance of the construction insulated with PIR is better than that of the construction insulated with glass mineral fibre.

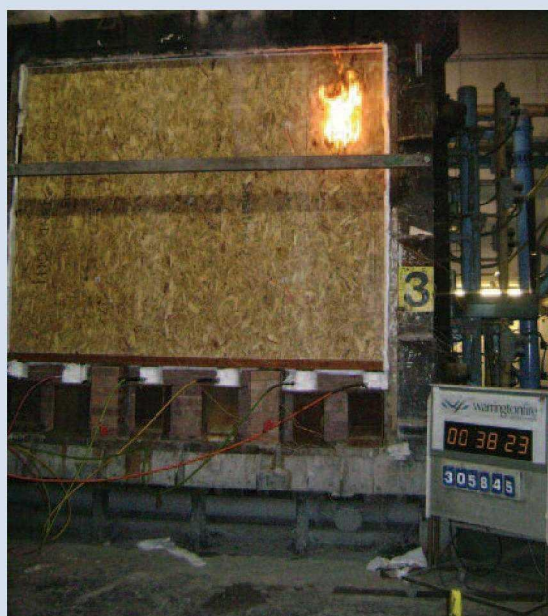


Figure 5: A timber frame wall construction insulated with PIR being tested to EN 1365-1: 1999

Construction Site Management

Some insulation manufacturers like to draw attention to the supposed risk associated with insulation products stored on site or exposed during construction.

The UK Timber Frame Association (UKTFA) has developed pioneering new test methods that identify which construction products can help reduce the risks of fire during construction. The method consists of two tests: one ignition test which assesses reaction to fire, spread and burn through, and the other, a room scale test measuring radiant heat and temperature at a distance from the fire. Three resulting categories are used to help construction planning decisions and risk assessment on site. Both *Kingspan Thermawall*® TW55 and *Kingspan Kooltherm*® K12 Framing Board in open panel treated timber frame constructions fall into category B of the UKTFA classification system, demonstrating that their use in open panel timber frame

construction does not compromise the construction's fire performance, even when the open panel timber frame construction is at its most vulnerable (i.e. before the finishing layers of plasterboard and brickwork have been applied).

Moreover, there are, stored on most construction sites, building materials and other substances that are very combustible compared with the types of insulation manufactured by Kingspan Insulation. And yet fires on construction sites are remarkably rare. Where they do occur, they are often found to have been deliberately started and initially fuelled by something other than insulation products. The risk of fire on construction sites may be more affected by the standard of security, housekeeping and health and safety management, than it is by the insulation products that are being used or stored.

Box 6



Figure 6: A timber frame building during construction

Insurer Approval

Arguably the best measure of the fire performance of an insulation product is how the insurance industry perceives its use in buildings. Insulation products manufactured by Kingspan Insulation are approved for use by the world's leading insurance testing and certification labs, e.g. UL, FM and LPCB. If they are comfortable with the use of products manufactured by Kingspan Insulation, so should you. Box 7 details the various insurer approvals that apply to Kingspan Insulation products.

Box 7

- Metal deck roofing constructions incorporating *Kingspan Thermaroof®* TR26 LPC/FM, *Kingspan Thermaroof®* TR27 LPC/FM and their tapered equivalents, produced at Kingspan Insulation's British manufacturing facilities have been successfully tested to LPS 1181: Part 1: 2003 (Requirements and Tests for Built-up Cladding and Sandwich Panel Systems for use as the External Envelope of Buildings) and achieve a grade of EXT-B.
- *Kingspan Thermaroof®* TR26 LPC/FM, *Kingspan Thermaroof®* TR27 LPC/FM and their tapered equivalents, produced at Kingspan Insulation's British and Irish sites, and *Kingspan Thermaroof®* TR26 FM, *Kingspan Thermaroof®* TR27 FM, and their tapered equivalents, produced at Kingspan Insulation's Dutch sites, are certified as achieving Class 1 Insulated Steel Deck Pass to Factory Mutual Research Standards 4450: 1989 (Approval Standard for Class 1 Insulated Steel Deck Pass) and 4470: 2010 (Approval Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 Non-combustible Roof Deck Construction), subject to the conditions of approval as a roof insulation product for use in Class 1 roof constructions as described in the current edition of the Factory Mutual Research Approval Guide.
- *Kingspan Kooltherm®* K10 FM Soffit Board (thicknesses up to, and including, 120 mm), produced at Kingspan Insulation's Pembroke and Castleblayney manufacturing facilities, is certified as achieving Class 1 Fire Rating to Factory Mutual Class Number 4880: 2005 (Insulated Wall or Wall and Roof / Ceiling Panels, Interior Finish Materials or Coatings, and Exterior Wall Systems).
- *Kingspan Kooltherm®* FM Duct Insulation, produced at Kingspan Insulation's Pembroke manufacturing facility, is certified, by FM Approvals, to Factory Mutual Research Approval Standard – Pipe Insulation Class Number 4924 – March 1973, when manufactured and installed in accordance with the conditions defined by the approval.
- Ductwork fabricated from the *Kingspan KoolDuct®* System, produced at Kingspan Insulation's Pembroke and Castleblayney manufacturing facilities, is the only premium performance pre-insulated ductwork in the world to be UL Listed as a Class 1 Air Duct, to Standard for Safety UL 181 (Underwriters Laboratories: Factory Made Air Ducts & Air Connectors). To meet UL Class 1 Air Duct requirements, ductwork fabricated from the *Kingspan KoolDuct®* System, and / or the individual components from which it is fabricated, must withstand the stringent conditions to which they are subjected in a series of rigorous physical tests, including: surface burning characteristics; burning and flame penetration.
- For further details of the LPCB, FM and UL Approval Listings for Kingspan Insulation products please refer to the relevant Kingspan Insulation literature.

Contact Details

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Kingspan Insulation produces a comprehensive range of technical literature for specifiers, contractors, stockists and end users. The literature contains clear 'user friendly' advice on typical design; design considerations; thermal properties; sitework and product data.

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