Insulation

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Building Regulations for the Conservation of Fuel & Power

WALES – EXISTING DWELLINGS

2014 EDITION

Kingspan®

Low Energy –
Low Carbon Buildings

Contents

Introduction

Approved Documents L

Approved Documents L (ADL), published by the Welsh Government (Llywodraeth Cymru), provide technical guidance on how to meet the energy efficiency requirements of the Building Regulations 2010, as amended, for building work carried out in Wales.

There are four Approved Documents L:

- Approved Document L1A: Conservation of fuel & power in new dwellings (ADL1A);
- Approved Document L1B: Conservation of fuel & power in existing dwellings (ADL1B);
- Approved Document L2A: Conservation of fuel & power in new buildings other than dwellings (ADL2A); and
- Approved Document L2B: Conservation of fuel & power in existing buildings other than dwellings (ADL2B).

Each document sets out what, in ordinary circumstances, may be accepted as reasonable provision for compliance with the energy efficiency requirements of the Building Regulations for the type of building work in question.

About this Document

Kingspan Insulation has produced this document as a simple guide to the 2014 edition of ADL1B for use in Wales, including the salient changes from the 2010 edition, which was for use in both England & Wales. It specifically concentrates on the parts that are relevant to building fabric insulation, whilst showing how compliance can be achieved using Kingspan Insulation products for roofs, walls and floors and, for the purpose of comparison, thermally equivalent solutions using other common insulation materials.

Approved Document L1B – Existing Dwellings

Introduction

ADL1B gives guidance on ways of demonstrating 'reasonable provision' for compliance with the energy efficiency requirements of the Building Regulations, for building work to 'existing dwellings'. A dwelling can be defined as a 'self–contained unit designed to accommodate a single household'. Rooms for residential purposes, such as those in nursing homes or halls of residences containing student accommodation, are not considered dwellings. In such cases the guidance given in ADL2B should instead be followed.

The 2014 edition of ADL1B came into effect on 31st July 2014. The guidance given is applicable to non–exempt building work originating from plans and notices submitted to a building control body (BCB) for approval on or after this date.

Types of Work Covered

ADL1B is applicable to existing dwellings where the building work comprises the extension, conversion or renovation of the dwelling (or parts of), which are subject to the energy efficiency requirements of the building regulations i.e. walled and roofed constructions that use energy to heat or cool the indoor climate. It gives specific guidance for building work involving, amongst other things, windows and doors, fixed buildings services and thermal elements.

Windows and doors are defined as those that separate a conditioned space from the external environment, the ground, and any parts of the building which are not conditioned or, where another part of the building which is not a dwelling, is heated or cooled to a different temperature.

A fixed building service is defined as any part of, or any controls associated with either, or a combination of: fixed internal or external lighting systems (excluding emergency escape or specialist process lighting); or fixed systems for heating, hot water, air–conditioning or mechanical ventilation.

A thermal element is defined as a roof, wall or floor, which separates a heated space from the external environment, the ground and any unheated parts of the dwelling, or where another part of the building that is not considered part of the dwelling (e.g. a garage) is heated to a different temperature.

New or Replacement Thermal Elements

Any new or replacement roofs, walls and floors in extensions, conversions, material changes of use and non–exempt conservatories and porches, should achieve, or better, the maximum U–values shown in Table 1.

Element[1]	Maximum U–value[2] ($W/m^2 \cdot K$)
Roofs	0.15
Walls	0.21
Floors[3]	0.18

1 'Roof and loft' includes the roof and loft parts of dormer windows, and 'wall' includes the walls or cheeks of dormer windows.
2 U–values for thermal elements comprising roofs, walls and floors, should be calculated using the methods and conventions set out in BR 443 (Conventions for U–value Calculations).
3 The U–value of the floor of an extension can be calculated using the exposed perimeter and floor area of the whole enlarged dwelling.

Table 1: Maximum U–values for New or Replacement Thermal Elements

Retained Thermal Elements

Where an existing thermal element is either part of a building that is subject to a material change of use, or is to become part of the thermal envelope where previously it was not e.g. as part of an extension or a conversion where the space is now to be heated, reasonable provision would be to upgrade the element to achieve the maximum U–value for that element type set out in Table 2, provided that it is functionally, technically and economically feasible. A reasonable test of economic feasibility is to achieve a payback for the initial cost of the upgrade measure through energy savings within 15 years.

When making a simple payback calculation the following guidance should be used:

- the cost should be the marginal cost i.e. the additional cost (materials and labour) of the works over and above the works that were intended, not the whole cost of the works;
- the annual energy savings should be estimated using the latest version of the Standard Assessment Procedure (SAP); and
- VAT should be taken into account for both the cost and the saving.

If achievement of the maximum U–value is not functionally, technically or economically feasible, the element should be upgraded to the best standard that is functionally, technically and economically feasible. Generally, this lesser standard should be no worse than the limiting U–value for that element type also set out in Table 2.

Examples of where a lesser provision than the maximum U–value might apply are where the weight of the additional insulation might not be supported by the existing structure, or where the thickness of the additional insulation might reduce the usable floor area of any room by more than five per cent, create difficulties with adjoining floor levels, or create insufficient headroom.

In such cases, the choice of insulant should be based upon the best thermal performance that is practicable to achieve a U–value as close as possible to the limiting U–value for each element type.

Two alternative optional approaches are also allowed, providing greater design flexibility. For details, refer to the 'Design Flexibility' section of this document.

Element[1]	Maximum U–value[2] (W/m²·K)	Limiting U–value[2] (W/m²·K)
Lofts	0.16	0.35
Other roofs	0.18	0.35
Walls – cavity insulation[3]	0.55	0.70
Walls – external or internal insulation	0.30	0.70
Floors[4]	0.25	0.70

[1] 'Roof and loft' includes the roof and loft parts of dormer windows, and 'wall' includes the walls or cheeks of dormer windows.
[2] U–values for thermal elements comprising roofs, walls and floors, should be calculated using the methods and conventions set out in BR 443 (Conventions for U–value Calculations).
[3] If a wall has a cavity but it is not suitable for filling with cavity insulation, it should be treated as 'wall – external or internal insulation'.
[4] The U–value of the floor of an extension can be calculated using the exposed perimeter and floor area of the whole enlarged dwelling.

Table 2: Maximum U–values for Retained or Renovated Thermal Elements

Renovated Thermal Elements

The renovation of a thermal element through the provision of a new layer means either:

- cladding or rendering its external surface; or
- dry–lining its internal surface.

The renovation of a thermal element through the replacement of an existing layer means either:

- stripping it down to its basic structural components (masonry, timber frame, steel frame etc) and then rebuilding it; or
- replacing the waterproof membrane of a flat roof.

Where a thermal element is subject to renovation, the performance of the whole element should be improved to achieve, or better, the maximum U–value for that element type shown in Table 2, provided the area to be renovated is greater than 50% of the surface of the individual element, or 25% of the surface of the total building envelope.

When assessing this percentage, the area of the element should be taken as that of the individual element and not all the elements of that type in the dwelling. The area of the element should also be interpreted in the context of whether the element is being renovated from the inside or outside. For example: if removing all the plaster finish from the inside of a solid brick wall, the area of the element is the area of external wall in the room; if removing external render, it is the area of the elevation in which that wall sits; if all the roofing on the flat roof of an extension is being stripped down, the area of the element is the roof area of the extension and not the total roof area of the dwelling.

As with retained thermal elements, if achievement of the maximum U–value is not functionally, technically or economically feasible, the element should be upgraded to the best standard that is functionally, technically and economically feasible. Generally, this lesser standard should be no worse than the limiting U–value for that element type also set out in Table 2.

Examples of where a lesser provision than the maximum U–value might apply are where the weight of the additional insulation might not be supported by the existing structure, or where the thickness of the additional insulation might reduce the usable floor area of any room by more than five per cent, create difficulties with adjoining floor levels or create insufficient headroom.

In such cases, the choice of insulant should be based upon the best thermal performance that is practicable to achieve a U–value as close as possible to the limiting U–value for each element type.

Two alternative optional approaches are also allowed, providing greater design flexibility. For details, refer to the 'Design Flexibility' section of this document.

For guidance on payback calculations see the 'Retained Thermal Elements' section of this document.

Thermal Elements in Extensions

Where an extension involves the provision of new or replacement roofs, walls or floors, the work should comply with the requirements for new or replacement thermal elements, as detailed above.

Where the work involves the incorporation of a part of the existing building structure not previously subject to the energy efficiency requirements e.g. a garage, any retained roofs, walls or floors should comply with the requirements for retained thermal elements, as detailed above.

The area of windows, roof windows and doors in extensions should not exceed the sum of 25% of the floor area of the extension plus the area of any windows or doors which, as a result of the extension works, are no longer in existence or are no longer exposed.

Two alternative optional approaches are also allowed, providing greater design flexibility. For details, refer to the 'Design Flexibility' section of this document.

Thermal Elements in Conversions, Material Change of Use & Change of Energy Status

Where a building is subject to a conversion, a change of use e.g. from commercial to domestic use, or to a change to its energy status e.g. any change which results in the building becoming subject to the energy efficiency requirements of the Building Regulations, where previously it was not, then ADL1B requires the thermal performance of the roof, walls and floors to achieve a minimum standard of performance. This standard of performance varies depending on the nature of the works taking place.

Where the work involves the provision of new or replacement roofs, walls or floors, the work should comply with the requirements for new or replacement thermal elements, as detailed above.

Where the work involves retained roofs, walls or floors, the work should comply with the requirements for retained thermal elements, as detailed above.

Two alternative optional approaches are also allowed, providing greater design flexibility. For details, refer to the 'Design Flexibility' section of this document.

Windows & Doors

ADL1B gives specific guidance for building work comprising the installation of replacement, the enlargement of existing and the creation of new windows and doors. It also however, gives separate guidance, which includes elemental requirements for window, door, roof window and rooflight U–values, for extensions, conversions, material changes of use and conservatories and porches.

In all cases, insulated cavity closers should be installed around new windows and doors, where appropriate.

Fixed Building Services

ADL1B refers directly to the Domestic Building Services Compliance Guide for the minimum standards of energy efficiency for work involving the provision, extension, alteration or replacement of a fixed building service.

Conservatories & Porches

Conservatories and porches are exempt from the Building Regulations if they: are built at ground level; have a floor area no greater than 30 m^2; are thermally separated from the heated space of the dwelling; and do not contain an independent fixed heating appliance or do not use the heating system of the dwelling whereby the system is extended into the conservatory or porch.

Non–exempt conservatories and porches should be thermally separated from the heated space of the dwelling and their opaque roof, wall and floor elements should achieve U–values no worse than those given in Table 1.

If the proposed addition is not thermally separated from the dwelling, it should be treated as an extension.

Removing, and not replacing, any or all of the thermal separation between, the dwelling and an existing exempt conservatory or porch, or extending the dwelling's heating system into the conservatory or porch, means the conservatory or porch ceases to be exempt. This constitutes a change to the dwelling's energy status. In such situations, the conservatory or porch should be treated as a conversion and reasonable provision would be to demonstrate that it meets the requirements for conversions.

Two alternative optional approaches are also allowed, providing greater design flexibility. For details, refer to the 'Design Flexibility' section of this document.

Approved Document L1B – Existing Dwellings

Indoor Swimming Pools

Both the walls and floors comprising the basin of new indoor swimming pools should achieve a U–value no worse than 0.25 $W/m^2 \cdot K$. In addition, design consideration should be given to: compressive creep, insulation boards not being fully supported; and the effects of point loading. Furthermore, particular care should be given to the avoidance of thermal bridging – especially around basin wall and floor junctions with foundations.

Two alternative optional approaches are also allowed, providing greater design flexibility. For details, refer to the 'Design Flexibility' section of this document.

Consequential Improvements

Where an existing dwelling is extended such that its habitable volume is increased (e.g. a non–exempt conservatory), or converted such that there is a requirement for the provision or extension of a fixed heating appliance in a previously unheated space (e.g. a loft), consequential improvements to the existing dwelling are required, regardless of the size increase in floor area of the habitable space. Consequential improvements are subject to technical, functional and economical feasibility.

Design Flexibility

In order to allow greater design flexibility, some elements of the design may be relaxed if compensated for elsewhere. For example, where the required area of windows and doors exceeds the limit for extensions set out in ADL1B, improved wall and floor U–values may balance the shortfall associated with the increase in heat gains / losses through the glazing.

There are two alternative optional approaches to the standards based approach set out in the relevant sections of ADL1B. These are:

- the U–value trade off approach, which requires the calculation of an area–weighted average U–value; and
- the equivalent carbon target approach, which requires a SAP 2012 energy rating assessment, carried out by an On Construction Domestic Energy Assessor (OCDEA), to calculate the CO_2 emissions for both the notional and actual proposals.

Both approaches require two calculations. One is based upon a notional building that complies with the requirements set out in the relevant sections of ADL1B to form the benchmark proposal. The other is based upon the actual dwelling, which if required, can trade–off better performance against poorer performing elements, so long as it complies with the benchmark.

Although U–value requirements maybe relaxed, the U–value of any individual thermal element should be no worse than the limiting U–value for that element type set out in Table 2, for both the U–value trade–off and equivalent carbon target approaches.

U-Value Calculations

All U–values should be calculated using the methods and conventions set out in BR 443 (Conventions for U–value calculations) and should include allowances for any repeating thermal bridges.

Design & Installation Standards

The new or replacement building fabric should be carefully designed, detailed and constructed to: avoid gaps in the insulation; minimise air–leakage; and limit reasonably avoidable thermal bridges. Particular attention should be paid around window and door openings, to junctions between building elements, such as between the walls and roof, and at changes of geometry, for example a corner in a wall or hip in a roof. For new building fabric, this requirement can be achieved by adopting the Accredited Construction Details (ACDs) for Part L.

Kingspan Insulation Solutions

Constructions & U-Values

Set out in the following pages, are constructions, using Kingspan Insulation products, which are designed to meet the U–values shown in Tables 1 and 2. These U–values are valid for the constructions shown in the details immediately above. Also shown, is a range of alternative solutions that other insulation manufacturers might offer.

The constructions shown do not comprise an exhaustive list of Kingspan Insulation solutions. Please contact the Kingspan Insulation Technical Service Department, if you require similar calculations for other constructions.

U–values have been calculated using the methods detailed in:

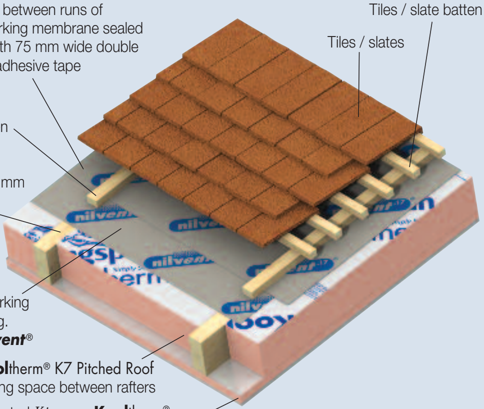
- BS EN ISO 6946: 2007 (Building components & building elements. Thermal resistance & thermal transmittance. Calculation method);
- BS EN ISO 13370: 2007 (Thermal performance of buildings. Heat transfer via the ground. Calculation methods); and
- using the conventions set out in BR 443 (Conventions for U–value calculations).

For the purposes of these calculations, the standard of workmanship has been assumed good and, therefore, the correction factor for air gaps has been ignored.

The figures quoted are for guidance only. A detailed U–value calculation and a condensation risk analysis should be completed for each project. Please contact the Kingspan Insulation Technical Service Department.

Kingspan Insulation Solutions – New Thermal Elements

Pitched Roof – Insulation Between & Under Rafters

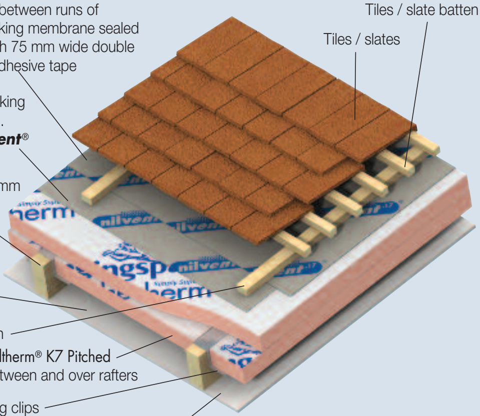


Insulation Thicknesses to Achieve a U–value of 0.15 W/m²·K					
Insulation Material	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Under Rafter Insulated Plasterboard Thickness (mm)***	Overall Thickness (mm)	
Kingspan **Kool**therm®	100	100	62.5	162.5	THINNER
Glass Fibre* (Between)	125	125	132.5	257.5	THICKER
& XPS** (Under)	100	100	162.5	262.5	

*Assuming thermal conductivity 0.037 W/m·K.
**Assuming thermal conductivity 0.036 W/m·K.
***All insulated plasterboard thicknesses include 12.5 mm plasterboard.
NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations assume that insulated plasterboard is fixed using carbon steel fixings with a cross–sectional area of 4.00 mm², with 16.7 fixings per m². The effect of fixings for *Kingspan* **Kool**therm® insulated plasterboard is insignificant as the insulation layer penetrated is not the main insulation layer.

Using *Kingspan* **Kool**therm® can result in a thinner overall construction, regardless of rafter depth, and is less likely to have a prohibitive effect on headroom. There may be practicality issues with fixing a 132.5 mm and a 162.5 mm insulated plasterboard product.

Pitched Roof – Insulation Between & Over Rafters



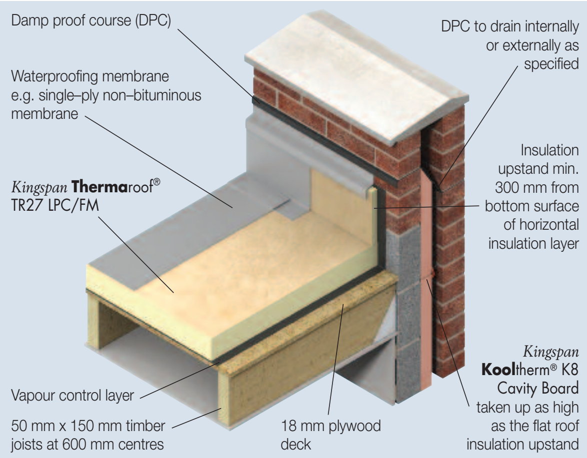
Insulation Thicknesses to Achieve a U–value of 0.15 W/m²·K					
Insulation Material	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Over Rafter Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan **Kool**therm®	100	60	70	170	THINNER
Rock Fibre*	100	100	140	240	THICKER
XPS**	100	100	140	240	

**Assuming thermal conductivity 0.038 W/m·K for between & 0.036 W/m·K for over.*
***Assuming thermal conductivity 0.036 W/m·K.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations assume that the layers of insulation over the rafters are fixed using stainless steel fixings with a cross–sectional area of 7.45 mm², with 8.3 fixings per m² (insulant thickness 61–80 mm), and 10.0 fixings per m² (insulant thickness > 80 mm).

Using *Kingspan* **Kool**therm® can result in a thinner overall construction, regardless of rafter depth, and is less likely to have a prohibitive aesthetic effect on bargeboard / fascia board depth. There may be cost issues with the rafter depth required for some solutions.

Kingspan Insulation Solutions – New Thermal Elements

Flat Roof – Timber Deck

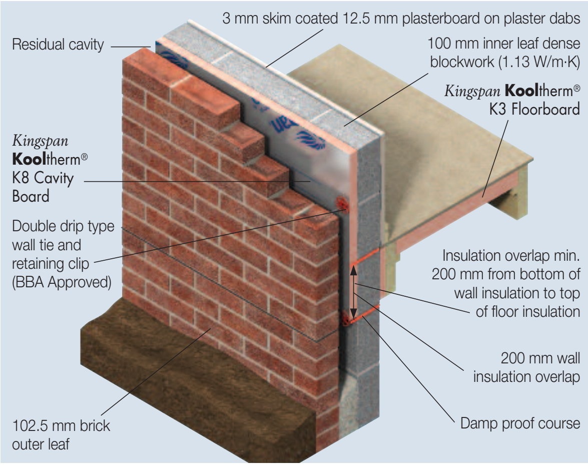


Insulation Thicknesses to Achieve a U–value of 0.15 W/m²·K			
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan **OPTIM-R**™ Roofing System* & *Kingspan* **Therma**roof® TR27 LPC/FM (Overlay)	45 + 25	70	THINNEST
Kingspan **Therma**roof® TR27 LPC/FM	145	145	THINNER
Rock Fibre**	80 + 145	225	THICKER

** The bridging effect of the Kingspan OPTIM-R™ flex component of the System is taken as 10%.*
***Assuming thermal conductivity 0.038 W/m·K.*
NB Where multiple layers of insulation of different thicknesses are shown, the second thickness is the overlay board.
These calculations assume that the insulation boards are fully bonded to the vapour control layer.

It can be seen from the tables above that the *Kingspan* **OPTIM-R™ Roofing System** insulation thickness can be significantly less than that for rock mineral fibre – less than one third of the thickness, which may allow lower parapets. Furthermore, the weight of the insulation in the rock mineral fibre solution, shown above, will be over 7 times that in the *Kingspan* **Therma**roof® solution. The manual handling and roof loading implications of this weight should be carefully considered.

Cavity Wall – Cavity Insulation Only

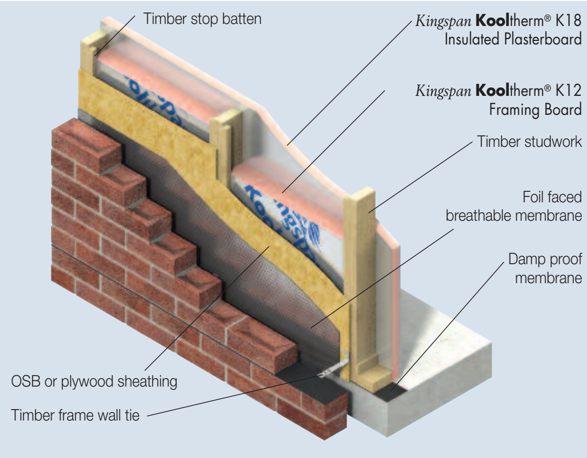


Insulation Thicknesses to Achieve a U–value of 0.21 W/m²·K			
Insulation Material	Insulation Thickness (mm)	Overall Cavity Width (mm)	
Kingspan **Kool**therm® (Partial Fill)	70	120	THINNER
Glass Fibre* (Full Fill)	160**	160	THICKER

**Assuming thermal conductivity 0.037 W/m·K.*
***The insulation fully, rather than partially, fills the cavity and, so, the wall tie specification will differ and no retaining clips will be present.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of wall tie used may change the thickness of insulation required.
These calculations assume the following:
- *for 120 mm cavity widths, a stainless steel flexible tie with 2.5 ties per m² and a cross–sectional area of 12.50 mm²; and*
- *for 160 mm full fill cavity widths, a stainless steel flexible tie with 3.0 ties per m² and a cross–sectional area of 60.80 mm².*

A standard cavity of just 120 mm can be used with the *Kingspan* **Kool**therm® K8 Cavity Board solution, reducing total wall width by 40 mm, compared with the glass mineral fibre full fill alternative shown above.

Timber Frame Wall – Insulation Between Timber Studs with Insulated Dry-Lining

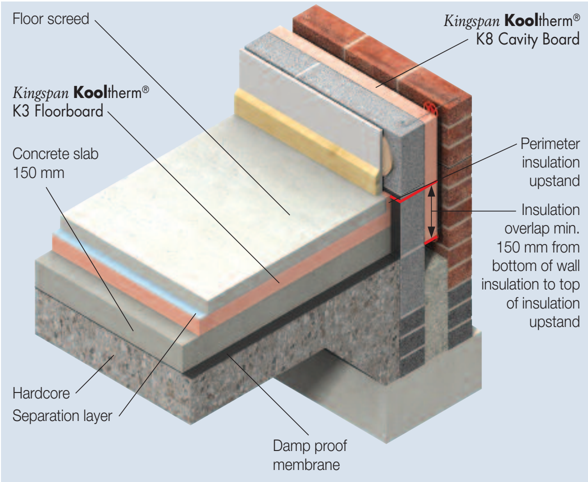


Insulation Thicknesses to Achieve a U–value of 0.21 W/m²·K					
Insulation Material	Stud Depth (mm)	Between Stud Insulation Thickness (mm)	Inside Stud Insulated Plasterboard Thickness** (mm)	Overall Thickness (mm)	
Kingspan **Kool**therm®	89	70	32.5	121.5	THINNER
Glass Fibre* (Between) & *Kingspan* **Kool**therm® (Inside)	140	140	32.5	172.5	THICKER

**Assuming thermal conductivity 0.035 W/m·K.*
***All insulated plasterboard thicknesses include 12.5 mm plasterboard.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. The effect of fixings for the insulated plasterboard is insignificant as the insulation layer penetrated is not the main insulation layer. A 15% bridging factor has been assumed for the timber stud. The thermal conductivity of the timber has been assumed to be 0.12 W/m·K. Calculations assume that a foil faced breather membrane yields an airspace thermal resistance of 0.54 m²·K/W.

Using *Kingspan* **Kool**therm® can result in a thinner overall construction. The glass mineral fibre solution shown above requires considerably deeper studwork to accommodate the required thickness of insulation. This may have a cost implication.

Ground Floor – Solid Concrete



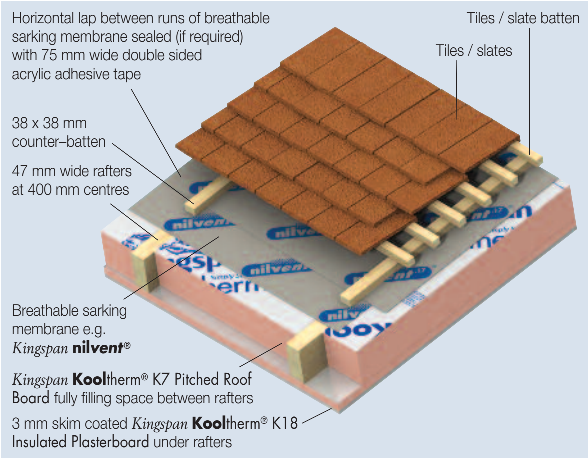
Insulation Thicknesses to Achieve a U–value of 0.18 W/m²·K			
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan OPTIM-R™ Flooring System*	35	35	THINNEST
Kingspan **Kool**therm®	75	75	THINNER
EPS**	140	140	THICKER

**The bridging effect of the Kingspan OPTIM-R™ flex component of the System is taken as 15%.*
***Assuming thermal conductivity 0.038 W/m·K.*
NB For the purposes of these calculations, using the method as detailed in BS EN ISO 13370: 1998, the soil has been assumed to be clay or silt, and the wall insulation is assumed to overlap the floor insulation by minimum 150 mm. The P/A ratio is taken as 0.5.

Using the *Kingspan* **Kool**therm® or the *Kingspan* OPTIM-R™ **Flooring System** rather than the expanded polystyrene solution, in the floor shown above, can result in having to dig out, and dispose of, less soil to make the space to accommodate the insulation.

Kingspan Insulation Solutions – Retained or Renovated Thermal Elements

Pitched Roof – Re-roof with Insulation Between & Under Rafters

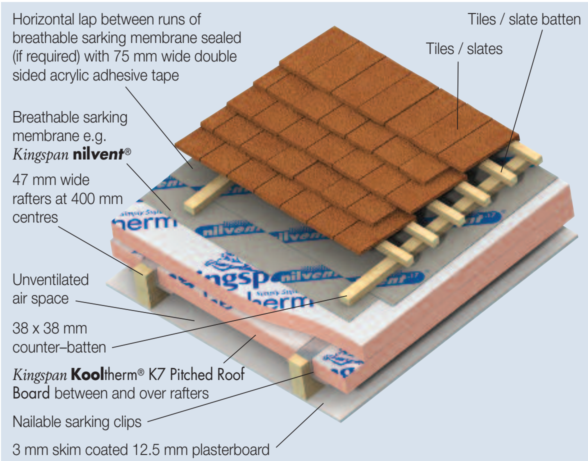


Insulation Thicknesses to Achieve a U–value of 0.18 W/m²·K					
Insulation Material	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Under Rafter Insulated Plasterboard Thickness (mm)***	Overall Thickness (mm)	
Kingspan **Kool**therm®	100	100	52.5	152.5	THINNER
Glass Fibre* (Between)	125	125	102.5	227.5	THICKER
& XPS** (Under)	100	100	132.5	232.5	

**Assuming thermal conductivity 0.037 W/m·K.*
***Assuming thermal conductivity 0.036 W/m·K.*
****All insulated plasterboard thicknesses include 12.5 mm plasterboard.*
*NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations assume that insulated plasterboard is fixed using carbon steel fixings with a cross–sectional area of 4.00 mm², with 16.7 fixings per m². The effect of fixings for Kingspan **Kool**therm® and the 102.5 mm XPS insulated plasterboard is insignificant as the insulation layer penetrated is not the main insulation layer.*

Using *Kingspan* **Kool**therm® can result in a thinner overall construction, regardless of rafter depth, and is less likely to have a prohibitive effect on headroom. There may be practicality issues with fixing a 132.5 mm insulated plasterboard product.

Pitched Roof – Re-roof with Insulation Between & Over Rafters



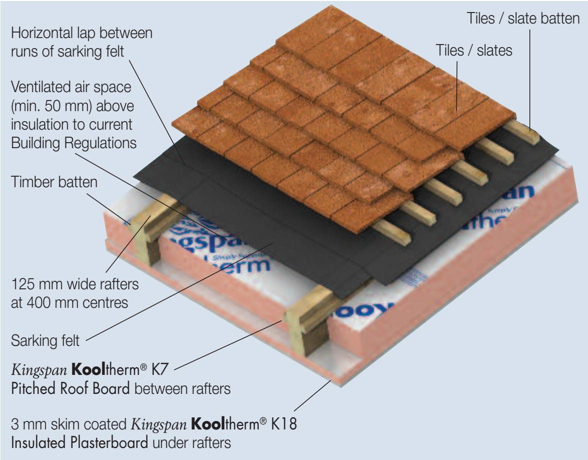
Insulation Thicknesses to Achieve a U–value of 0.18 W/m²·K					
Insulation Material	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Over Rafter Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan **Kool**therm®	100	55	55	155	THINNER
Rock Fibre*	140	140	80	220	THICKER
XPS**	100	80	120	220	

**Assuming thermal conductivity 0.038 W/m·K for between & 0.036 W/m·K for over.*
***Assuming thermal conductivity 0.036 W/m·K.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations assume that the layers of insulation over the rafters are fixed using stainless steel fixings with a cross–sectional area of 7.45 mm^2, with 6.2 fixings per m^2 (insulant thickness 41–60 mm), 8.3 fixings per m^2 (insulant thickness 61–80 mm), and 10.0 fixings per m^2 (insulant thickness > 80 mm).

Using *Kingspan* **Kool**therm® can result in a thinner overall construction, regardless of rafter depth, and is less likely to have a prohibitive aesthetic effect on bargeboard / fascia board depth. There may be cost issues with the rafter depth required for some solutions.

Kingspan Insulation Solutions – Retained or Renovated Thermal Elements

Pitched Roof – Loft Conversion with Insulation Between & Under Rafters

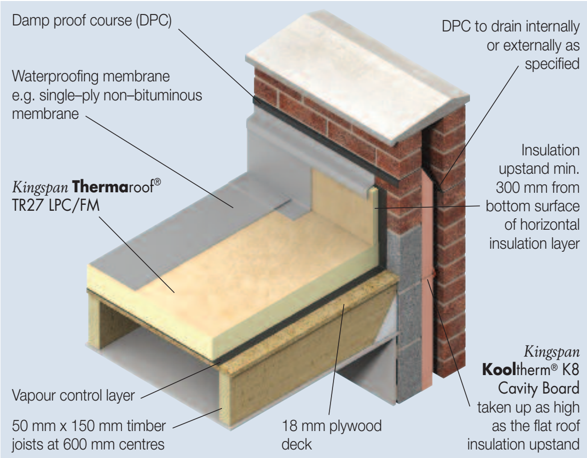


Insulation Thicknesses to Achieve a U–value of 0.18 W/m²·K					
Insulation Material	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Under Rafter Insulated Plasterboard Thickness (mm)***	Overall Thickness (mm)	
Kingspan **Kool**therm®	125	75	62.5	187.5	THINNER
Glass Fibre* (Between) & XPS** (Under)	125	75	147.5	272.5	THICKER

**Assuming thermal conductivity 0.037 W/m·K.*
***Assuming thermal conductivity 0.036 W/m·K.*
****All insulated plasterboard thicknesses include 12.5 mm plasterboard.*
*NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations assume that insulated plasterboard is fixed using carbon steel fixings with a cross–sectional area of 4.00 mm², with 16.7 fixing per m². The effect of fixings for Kingspan **Kool**therm® insulated plasterboard is insignificant as the insulation layer penetrated is not the main insulation layer.*

Using *Kingspan* **Kool**therm® can result in a thinner overall construction, regardless of rafter depth, and is less likely to have a prohibitive effect on headroom. There may be severe practicality issues with fixing a 147.5 mm insulated plasterboard product.

Flat Roof – Timber Deck



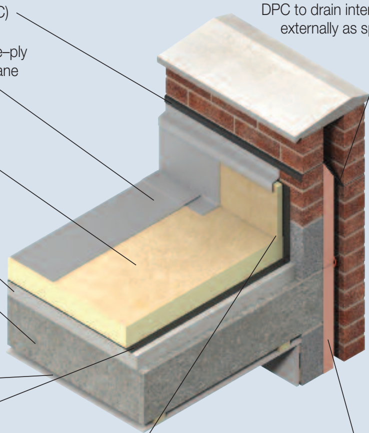
Insulation Thicknesses to Achieve a U–value of 0.18 W/m²·K			
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan OPTIM-R™ Roofing System* & *Kingspan* **Therma**roof® TR27 LPC/FM (Overlay)	35 + 25	60	THINNEST
Kingspan **Therma**roof® TR27 LPC/FM	120	120	THINNER
Rock Fibre**	95 + 95	190	THICKER

** The bridging effect of the Kingspan OPTIM-R™ flex component of the System is taken as 10%.*
***Assuming thermal conductivity 0.038 W/m·K.*
NB Where multiple layers of insulation of different thicknesses are shown, the second thickness is the overlay board.
These calculations assume that the insulation boards are fully bonded to the vapour control layer.

It can be seen from the tables above that the *Kingspan* **OPTIM-R™ Roofing System** insulation thickness can be significantly less than that for rock mineral fibre – one third of the thickness, which may allow lower parapets. Furthermore, the weight of the insulation in the rock mineral fibre solution, shown above, will be over 7 times that in the *Kingspan* **Therma**roof® solution. The manual handling and roof loading implications of this weight should be carefully considered.

Kingspan Insulation Solutions – Retained or Renovated Thermal Elements

Flat Roof – Concrete Deck

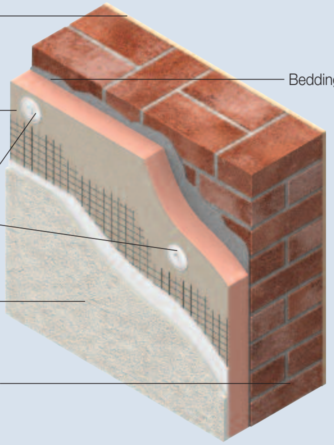


Insulation Thicknesses to Achieve a U–value of 0.18 W/m²·K			
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan OPTIM-R™ Roofing System* & *Kingspan* **Therma**roof® TR27 LPC/FM (Overlay)	35 + 25	60	THINNEST
Kingspan **Therma**roof® TR27 LPC/FM	120	120	THINNER
Rock Fibre**	95 + 95	190	THICKER

**The bridging effect of the Kingspan OPTIM-R™ flex component of the System is taken as 10%.*
***Assuming thermal conductivity 0.038 W/m·K.*
NB Where multiple layers of insulation of different thicknesses are shown, the second thickness is the overlay board.
These calculations assume that the insulation boards are fully bonded to the vapour control layer.

It can be seen from the tables above that the *Kingspan* OPTIM-R™ **Roofing System** insulation thickness can be significantly less than that for rock mineral fibre – one third of the thickness, which may allow lower parapets. Furthermore, the weight of the insulation in the rock mineral fibre solution, shown above, will be over 7 times that in the *Kingspan* **Therma**roof® solution. The manual handling and roof loading implications of this weight should be carefully considered.

Solid Walls – External Wall Insulation



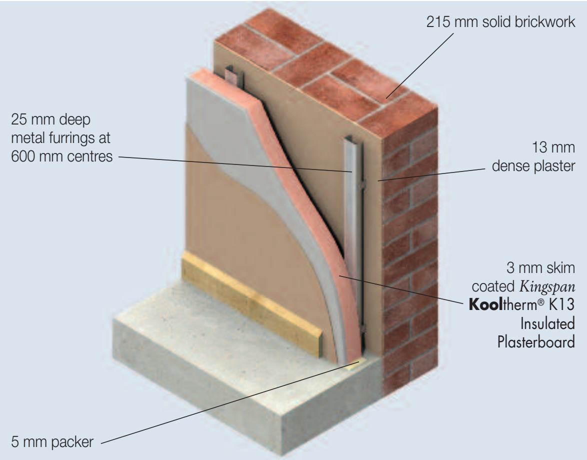
Insulation Thicknesses to Achieve a U–value of 0.30 W/m²·K			
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan OPTIM-R™ **External Wall System***	35 (+ 12 mm carrier board)	47	THINNEST
Kingspan **Kool**therm®	55	55	THINNER
Rock Fibre**	105	105	THICKER
EPS**	105	105	

The Kingspan OPTIM-R™* **External Wall System *is overlaid with a magnesium silicate render carrier board. This is mechanically fixed through the appropriate horizontal or vertical Kingspan OPTIM-R™ fix panels using carbon steel fasteners with a cross–sectional area of 7.44 mm², with 2.88 fasteners per m². The bridging effect of the Kingspan OPTIM-R™ flex & Kingspan OPTIM-R™ fix components of the System is taken as 30%.*
***Assuming thermal conductivity 0.038 W/m·K.*
NB These calculations assume that the Kingspan OPTIM-R™ component of the Kingspan OPTIM-R™ **External Wall System** *is adhesive fixed to the substrate, and that all other insulation boards are mechanically fixed. When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations also assume thermally broken fasteners with a thermal conductivity 1.00 W/m·K or less, the effect of which is insignificant.*

Kingspan **Kool**therm® or the *Kingspan* OPTIM-R™ **External Wall System** can dramatically reduce the thickness of insulation compared with the alternatives shown above. In refurbishment projects, where space under the eaves may be constrained, this could be critical. LABC guidance makes it clear that the required U-value of 0.30 W/m²·K can not be relaxed on the grounds that poorly performing insulation materials can not meet the required U-value in the space available.

Kingspan Insulation Solutions – Retained or Renovated Thermal Elements

Solid Wall – Internal Wall Insulation

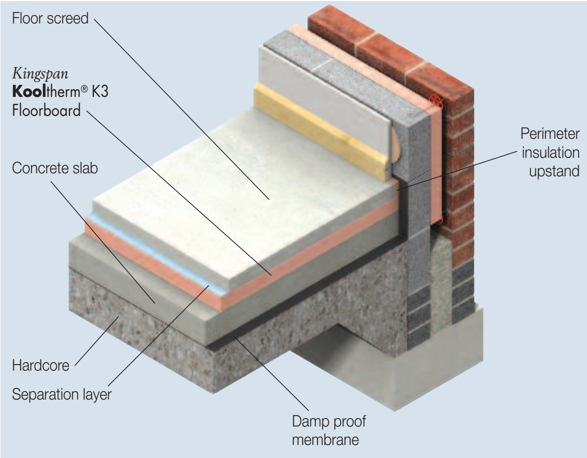


Insulation Thicknesses to Achieve a U–value of 0.30 W/m²·K				
Insulation Material	Between Stud Insulation Thickness (mm)	Insulated Plasterboard Thickness (mm)***	Overall Thickness (mm)	
Kingspan **Kool**therm® Lower Lambda	–	59.5	59.5	THINNEST
Kingspan **Kool**therm®	–	67.5	67.5	THINNER
XPS**	–	112.5	112.5	THICKER
Rock Fibre***	150****	37.5	187.5	

All insulated plasterboard thicknesses include 12.5 mm plasterboard except that for Kingspan **Kooltherm® Lower Lambda, which includes 9.5 mm plasterboard.*
***Assuming thermal conductivity 0.036 W/m·K.*
****Assuming thermal conductivity 0.035 W/m·K for between stud insulation & 0.36 W/m·K for plasterboard bonded insulation.*
***** Assuming construction illustrated above, but with an independent metal framing system with 150 mm studs fully filled with rock fibre, and a 25 mm gap between the studs and the wall.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations assume that insulated plasterboard is fixed with carbon steel fasteners with a cross–sectional area of 4.00 mm², with 16.7 fasteners per m². A 0.3% bridging factor has been assumed for the metal studwork. The thermal conductivity of the metal has been assumed to be 0.50 W/m·K.

Using *Kingspan* **Kool**therm® can result in a thinner overall construction, compared with the alternatives shown above. In refurbishment projects, where floor space may be constrained, this could be critical. LABC guidance makes it clear that the required U-value of 0.30 W/m²·K can not be relaxed on the grounds that poorly performing insulation materials can not meet the required U-value in the space available.

Ground Floor – Solid Concrete



Insulation Thicknesses to Achieve a U–value of 0.25 W/m²·K			
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan OPTIM-R™ Flooring System*	25	25	THINNEST
Kingspan **Kool**therm®	50	50	THINNER
EPS**	90	90	THICKER

**The bridging effect of the Kingspan OPTIM-R™ flex component of the System is taken as 15%.*
***Assuming thermal conductivity 0.038 W/m·K.*
NB For the purposes of these calculations, using the method as detailed in BS EN ISO 13370: 1998, the soil has been assumed to be clay or silt, and the wall insulation is assumed to overlap the floor insulation by minimum 150 mm. The P/A ratio is taken as 0.5.

Using the *Kingspan* **Kool**therm® or the *Kingspan* OPTIM-R™ **Flooring System** rather than the expanded polystyrene solution, in the floor shown above, can result in having to dig out, and dispose of, less soil to make the space to accommodate the insulation.

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