July 27, 2020

Submitted via www.regulations.gov

U.S. Environmental Protection Agency
Stratospheric Protection Division
Office of Atmospheric Program
Attn: Christina Thompson
1200 Pennsylvania Ave. NW
Washington, DC 20460


Dear Ms. Christina Thompson,

The Polyisocyanurate Insulation Manufacturers Association\(^1\) (PIMA) is pleased to submit the following public comments in response to the Environmental Protection Agency’s (EPA) Significant New Alternatives Policy (SNAP) Program Proposed Rule 23. The PIMA comments respond to the proposed listing of three blends of HFC-134a as acceptable for the “extruded polystyrene: boardstock and billet” end use category (XPS products).

Specifically, PIMA objects to the conclusions regarding the suitability of substitutes with low global warming potential (GWP) for XPS products. The commercial successes of XPS products with low-GWP formulations globally contradict the conclusions in Proposed Rule 23 and we urge the Agency to reconsider the proposed acceptable status for the HFC-134a blends.

As the Agency considers the arguments presented below, it is important to recognize that the domestic market for foam insulation products is highly competitive with multiple products being suitable alternatives for many applications. This is especially true for the building products sector. In this sector, other closed-cell foam insulation products have converted, or are in the process of converting, to low-GWP blowing agent substitutes. We encourage EPA to consider this landscape as it proposes to list HFC blends as acceptable for one foam insulation end-use when the use of the same blends in other competing end-uses is prohibited.

\(^1\) More information available at: www.polyiso.org.
I. The availability of commercialized XPS products with low-GWP formulations in global markets undermines Proposed Rule 23’s conclusion that low-GWP substitutes are not suitable for use within the United States market.

With respect to Proposed Rule 23, EPA concludes that certain low-GWP substitutes do not satisfy the technical needs and performance requirements for the XPS market. A review of XPS products available globally tells a different story. For example, Owens Corning – a domestic manufacturer of XPS products – has announced that its low-GWP XPS product (Foamular® NGX) will be available in Canada beginning January 1, 2021 in order to satisfy the country’s restrictions on high-GWP substitutes. Canada prohibits the use of blowing agent substitutes with a GWP greater than 150 effective January 1, 2021 for XPS products.

Soprema, a global manufacturer of building products, also announced in June 2020 that it will produce a low-GWP XPS product for the Canadian market beginning January 1, 2021. Importantly, in its announcement, Soprema highlights that its low-GWP formulation will maintain the same physical properties exhibited by the product formulation based on HFC-134a.

DuPont, a domestic producer of XPS products, operates an XPS manufacturing plant in Québec Canada. A press release published by DuPont in December 2019 states that the company plans to manufacture compliant XPS products for the Canadian marketplace effective January 1, 2021. This fact further undermines the claim that low-GWP substitutes are not suitable for XPS products manufactured in the United States market.

In Europe, the European Union’s F-gas Regulation prohibits the use of blowing agent substitutes with a GWP greater than 150 effective January 1, 2020 for XPS products. Producers across Europe continue to manufacture compliant XPS products under the regulation. An

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2 A copy of Owens Corning Canada’s July 6, 2020 announcement is attached to these comments. The announcement indicates that a low-GWP alternative will be available January 1, 2021. The information in the announcement also demonstrates that the new formulation will be launched across the company’s XPS product portfolio and that the new products will meet the needs of the marketplace in terms of performance.

3 A copy of Soprema’s June 18, 2020 announcement regarding its SOPRA-XPS product line is attached to these comments.

4 DuPont Press Release, “Rooted in sustainable technology and innovation, DuPont reaffirms commitment to leading with environmentally compliant products and building solutions that support global sustainability” (December 6, 2019). Available at: https://www.dupont.com/news.dupont-on-track-for-styrofoam-hfc-compliance.html. The press statement indicates that XPS products manufactured by DuPont will be “fully compliant with the . . . Canadian Environmental Protection Act in Canada, as regulations come into effect in 2021.”

example of these success stories includes Kingspan Insulation’s launch of its low-GWP XPS product, Kingspan GreenGuard GG300.⁶

The global presence of commercialized low-GWP formulations for XPS products is evidence of the fact that domestic manufacturers have the technology and capability to produce similar products for the United States market.

II. The XPS manufacturer’s claim that a minimum R-value of R-5.0 is unachievable with low-GWP substitutes is contradicted by the published data for commercialized low-GWP XPS products.

First, as described in Section I of these comments, manufacturers globally have successfully adopted low-GWP substitutes for use with XPS product formulations. A review of the associated product marketing literature demonstrates that manufacturers have been successful in producing products with a minimum R-value of 5.0 per inch. This fact contradicts the statement included in Proposed Rule 23 that low-GWP substitutes “have not been proven to meet density and testing requirements of building codes and standards, such as for thermal efficiency, compressive strength, and flame and smoke generation, necessary for XPS products” (emphasis added).

Second, polystyrene insulation manufacturers have commercialized graphite-infused technology to increase the R-value of products. As a result, technologies are available to manufacturers who desire to maintain, or even increase, the R-value of products in combination with a transition to low-GWP blowing agents.

Third, a minimum R-value of 5.0 per inch is not a requirement for insulation products to be competitive in the United States market. Several insulation products like expanded polystyrene and mineral wool are manufactured with lower R-values per inch as compared to the marketed R-value of XPS products. These products compete regularly with XPS products and are used in many of the same construction applications. Furthermore, the building codes adopted and enforced in the United States do not require insulation products to maintain a minimum R-value of 5.0 per inch. Therefore, EPA should not regard the potential for a change in a product’s R-value as a determinative factor when evaluating the effectiveness of low-GWP substitutes.

III. The XPS manufacturer’s claim that low-GWP substitutes limit its ability to maintain other desired physical characteristics for its products is contradicted by the published data for other commercialized low-GWP XPS products.

The building codes adopted by jurisdictions in the United States establish minimum performance requirements for building products like insulation. While the applicable test standards and pass/fail criteria can be unique to the domestic market, global manufacturers of

insulation products also must comply with minimum performance requirements. In many instances, these requirements are comparable if not identical to those in the United States. Therefore, the global presence of XPS products with low-GWP formulations, as described above, undermines the assertions of manufacturing impossibility within the United States as outlined in Proposed Rule 23.

Proposed Rule 23 asserts that low-GWP substitutes do not permit the XPS product manufacturer in the United States to maintain desired physical characteristics for properties like density and fire performance. However, the Canadian and European markets also impose minimum density and fire performance requirements. With respect to Canada specifically, attempts are made to harmonize requirements with the United States so products manufactured in one country can be sold and used in the other country. Therefore, it stands to reason that low-GWP XPS products that are acceptable to the Canadian market would also be accepted in the United States. However, Proposed Rule 23 and the supporting docket fail to explain how the requirements applicable to XPS products manufactured in the United States present unique challenges to formulating with low-GWP substitutes. Furthermore, as it relates to fire, it is unclear how the introduction of low-GWP blowing agents like CO₂ can negatively impact a product’s performance given these substances are non-flammable.

Unfortunately, the documentation provided to support the XPS manufacturer’s claims regarding the non-functionality of low-GWP substitutes includes broad conclusions and ignores important details. For example, the claim that low-GWP formulations do not meet fire performance requirements lacks sufficient detail for a thorough understanding of the issue and leaves important questions unanswered. Specifically, which fire performance test is the low-GWP formulation unable to satisfy? How is this performance test related to the XPS manufacturer’s ability to bring a product to market? How many applications or what percentage of the manufacturer’s market is negatively impacted by this limitation? These questions are critical for assessing the manufacturer’s assertions regarding low-GWP substitutes. This assessment is important because the cited fire performance test could be required for only niche applications of XPS products. Therefore, the majority of XPS products manufactured and sold for the domestic market could be unaffected by this single technical challenge, yet EPA’s proposal would grant a pass for all products. Similar detail is required for the other physical characteristics (i.e., density) referenced in Proposed Rule 23 because not all test requirements or performance criteria are required minimums for each (or the majority of) intended applications of XPS products.

IV. The polyisocyanurate industry was subjected to a much higher bar for converting to more environmentally-friendly blowing agent substitutes as compared to the threshold for the XPS manufacturer as outlined in Proposed Rule 23.

For more than twenty years, the polyisocyanurate industry has been a leader in the manufacture of insulation with low-GWP, non-ozone depleting blowing agent substitutes. However, the regulatory world did not wait for a drop-in substitute to be developed before
requiring our industry to adopt next generation technology. In order to facilitate the transition to
the substances used today, the polyisocyanurate industry made significant investments in
research and development (including partnerships with industry stakeholders and Oak Ridge
National Laboratory) as well as capital investments to retrofit existing manufacturing facilities to
facilitate the safe-use of new substitutes. Polyisocyanurate manufacturers were also forced to
overcome and formulate around challenges that negatively impacted product performance.

While the circumstances around the phase-out of ozone depleting substances were
different than those surrounding current efforts to reduce the use of high-GWP substances like
HFC-134a, Proposed Rule 23 applies a much lower threshold for evaluating the suitability of
low-GWP alternatives for XPS products compared to the high bar set for the polyisocyanurate
industry. Furthermore, other industries will be impacted by EPA’s decision to finalize Rule 23 as
proposed because XPS products compete in the marketplace with a wide-variety of insulation
alternatives. Some of these alternatives are currently undergoing the transition to low-GWP
alternatives as well (e.g., spray polyurethane foam). EPA’s decision to grant authority to the XPS
manufacturer for the continued use of HFC-134a blends could create unfair advantages; an
outcome that should be avoided given the proven viability of low-GWP alternatives for XPS
products.

V. Conclusion

In light of the SNAP Program’s history of protecting the environment together with the
examples highlighted above that demonstrate the viability of low-GWP substances at
commercial scale for XPS products, PIMA strongly urges EPA to reconsider its proposed listing
of the three blends of HFC-134a as acceptable for XPS products.

PIMA appreciates the opportunity to submit these public comments regarding Proposed
Rule 23. Please contact me (jkoscher@pima.org; (703) 224-2289) should additional information
be helpful to the regulatory process.

Sincerely,

Justin Koscher
President

Enclosures (4)
July 6, 2020

Dear Owens Corning® FOAMULAR® Customer,

We are excited to introduce Foamular® NGX (Next Generation Extruded), our new extruded polystyrene (XPS) product line produced with a foam blowing agent solution specifically designed to meet and exceed the requirements of upcoming regulatory changes in Canada.

Foamular® NGX will be available January 1, 2021 to ensure our customers' ability to comply with the regulated timing requirements that take effect on that date.

The new product line will retain the signature Owens Corning® Pink® color, while including visible differentiation from our current line to help customers easily distinguish between the two. These products deliver the same great quality, performance and variety you expect from the Foamular® brand. Foamular® NGX will deliver best-in-class performance, including:

- Excellent energy efficiency in the form of a high R-5 per inch
- Extremely low water absorption potential, delivering superior R-value retention in the presence of water
- A wide range of compressive strengths – up to 100 psi – to handle heavy loads
- The only XPS with a limited lifetime warranty that guarantees a minimum 90% of R-value for the life of the product
- Zero ozone depletion potential
- Updated CCMC listings to ensure all necessary compliance

In addition, Foamular® NGX will be produced with a formulation specifically designed to meet and exceed the stricter regulatory standards going into effect January 1, 2021, throughout Canada. This is yet another step forward in Owens Corning’s market-leading commitment to sustainability.

Customers will receive the same best-in-class service and support with Foamular® NGX. All Owens Corning Foamular® plants serving the Canadian market will be equipped to produce the new product well ahead of the regulatory enactment dates, ensuring the product you need will be available when you need it.
Thank you for continuing to be a valued Owens Corning customer. We look forward to our ongoing partnership and mutual growth with Foamular® NGX.

Please reach out to your local Area Sales Manager with any questions. We will send further details on the product launch – with a preview of the new look – soon.

Sincerely,

Jose Manuel Canovas
General Manager North America
XPS Foam (Foamular®)

NOTE: These enhancements and new name will affect the following products:

<table>
<thead>
<tr>
<th>OLD Name</th>
<th>NEW Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOAMULAR® Half Inch</td>
<td>FOAMULAR® NGX Half Inch</td>
</tr>
<tr>
<td>FOAMULAR® C-200</td>
<td>FOAMULAR® NGX C-200</td>
</tr>
<tr>
<td>FOAMULAR® CodeBord 200®</td>
<td>FOAMULAR® NGX CodeBord® 200</td>
</tr>
<tr>
<td>FOAMULAR® C-300</td>
<td>FOAMULAR® NGX C-300</td>
</tr>
<tr>
<td>FOAMULAR® 350</td>
<td>FOAMULAR® NGX 350</td>
</tr>
<tr>
<td>FOAMULAR® 400</td>
<td>FOAMULAR® NGX 400</td>
</tr>
<tr>
<td>FOAMULAR® 600</td>
<td>FOAMULAR® NGX 600</td>
</tr>
<tr>
<td>FOAMULAR® 1000</td>
<td>FOAMULAR® NGX 1000</td>
</tr>
<tr>
<td>FOAMULAR® Cel-Lok® 200</td>
<td>FOAMULAR® NGX Cel-Lok® 200</td>
</tr>
</tbody>
</table>
June 18, 2020

Subject: Changes to SOPRA-XPS

Dear Partner,

In January 2021, a new Environment Canada regulation governing the use of halocarbons with a global warming potential of more than 150 will be implemented in Canada. Therefore, all insulation materials made of extruded polystyrene (XPS) made in Canada will no longer contain the HFC-134a blowing agent.

SOPREMA will abide by this new regulation for its SOPRA-XPS panels and will offer a product that complies with the new standard by the end of 2020.

In order to prepare for the new regulation, we have already started to optimize the product recipe. The only visible change will be its colour, which will go from orange to grey at the end of June 2020. You may therefore receive grey panels rather than orange ones in your next order, but be assured that it is the same quality product.

Indeed, although SOPRA-XPS will be grey at the end of June 2020, and manufactured without HFC-134a at the end of the year 2020, all of its properties—including its R-value of 5 per inch, low water absorption, and high compression resistance—will remain the same. Product names and codes, our broad product line, and our current certifications and approvals will also remain unaffected.

Further communications regarding SOPRA-XPS will be sent to you in the fall. If you have any questions or concerns, please contact customer service.

Regards,

Daniel Nadeau, National Vice-President of Sales
SOPREMA Canada
Kingspan GreenGuard Basements

Insulation for Basements

- High performance rigid extruded polystyrene insulation - thermal conductivities as low as 0.034 W/mK
- High compressive stress
- Resistant to ground moisture penetration
- Unaffected by air infiltration
- Easy to handle and install
- Ideal for new build and refurbishment
- Non-deleterious material
- Manufactured with a blowing agent that has zero ODP and low GWP
Typical Constructions and U-values

Assumptions

The U-values in the tables that follow have been calculated, under a management system certified to the BBA Scheme for Assessing the Competency of Persons to Undertake U-value and Condensation Risk Calculations, using the method detailed in BS EN ISO 13370: 2017 / I.S. 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). They are valid for the constructions shown in the details immediately above each table. These examples assume that the basement walls are 300 mm thick and the height of the basement walls are 2.5 m.

Unlike roofs, walls and intermediate floors, U-value calculations for basement floors cannot be calculated with reference to the construction detail alone. Heat loss from basement floors depends upon the ratio of exposed floor perimeter to the total floor area, the thickness of the basement wall and depth of the basement.

Floor dimensions should be measured between the finished internal surfaces of the external walls. Non - usable heated space such as ducts and stairwells should be included when determining the area of the floor. Unheated spaces outside of the insulated fabric, such as attached garages or porches, should be excluded when determining the area of the floor, but the length of the wall between the heated building and the unheated space should be included when determining the perimeter. The floor dimensions of semi-detached, terraced or other joined premises / dwellings can be taken either as those of the premises / dwelling itself or those of the whole building. Where extensions to existing buildings are under consideration, the floor dimensions should be taken as those of the extension.

If the P/A ratio lies between two of the numbers shown in the tables to follow, for a safe estimate, please use the P/A ratio shown that is the next highest i.e. for 0.57 use 0.6.

U-value Table Key

Where an X is shown, the U-value is higher than the worst of the maximum new build area weighted average U-values allowed by the:

- 2013 editions of Approved Documents L to the Building Regulations for England;
- 2014 editions of Approved Documents L to the Building Regulations for Wales;
- 2015 editions of Technical Handbooks Section 6 to the Building Standards for Scotland;
- 2012 editions of Technical Booklets F1 & F2 to the Building Regulations for Northern Ireland; and

NB The figures quoted are for guidance only. A detailed U-value calculation should be completed for each project.

NB For the purposes of these calculations, using the method as detailed in BS EN ISO 13370: 2017 / I.S. EN ISO 13370: 2007, the soil has been assumed to be sand or gravel, the wall insulation is assumed to overlap the floor insulation by minimum 150 / 225* mm, and the standard of workmanship has been assumed good, and therefore the correction factor for air gaps has been ignored.

NB If your construction is different from those specified, and / or to gain a comprehensive U-value calculation for your project, please consult the Kingspan Insulation Technical Service Department for assistance (see rear cover).

* 150 mm applies to the UK and 225 mm to the Republic of Ireland.
Typical Constructions and U-values

Basement Floors

Basement Insulated with Kingspan GreenGuard® GG300

Damp proof membrane
Geotextile membrane
Triangular piece of Kingspan GreenGuard® GG300
Kingspan Kooltherm® K116 or K118 Cavity Board
Separation layer
65 mm floor screed
Damp proof membrane lapped minimum 300 mm under the tanking membrane
Damp proof membrane either above or below Kingspan GreenGuard® GG300
Kingspan GreenGuard® GG300

Figure 1

U-values (W/m²K) for Various Thicknesses of Kingspan GreenGuard® GG300* and Floor Perimeter / Area Ratios

<table>
<thead>
<tr>
<th>Insulant Thickness (mm)</th>
<th>Perimeter / Area (m⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>✓</td>
</tr>
<tr>
<td>50</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
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<tr>
<td>60</td>
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<tr>
<td>80</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>90 (40 + 50)</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>100</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>110 (50+60)</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
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<td>190 (150 + 40)</td>
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<td>200 (100 + 100)</td>
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<td>280 (140 + 140)</td>
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<tr>
<td>340 (100 + 120 + 120)</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>360 (120 + 120 + 120)</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
</tbody>
</table>

* The above table contains figures for Kingspan GreenGuard® GG300 only. Please consult the Kingspan Insulation Technical Service Department (see rear cover) for calculations for other products in the range.

NB Where multiple layers of insulation of different thicknesses are used, the thickest layer should be installed as the outermost layer in the construction.

NB Refer to local distributor or Kingspan Insulation price list for current stock and non-stock sizes.

Basement Walls

Calculations for basement walls are based on the height of the basement, the P/A ratio of the basement floor and the thermal performance of the basement floor. Once all three variables have been obtained, please contact the Kingspan Insulation Technical Service Department (see rear cover) for the U-values to be calculated.
Design Considerations

Heat Loss and Linear Thermal Bridging

Basic Principles

Linear thermal bridging describes the heat loss or gain that occurs at junctions between elements e.g. where a basement wall meets the floor, or at junctions around openings in the building fabric where the thermal insulation layer is discontinuous e.g. sills, jambs and lintels.

Interruptions within the insulation layer by materials with poorer insulating properties can result in a thermal bridge, which in turn can lead to problems of condensation and mould growth, especially if there is a drop in surface temperature.

The heat flow at these junctions and opening locations, over and above that through the adjoining plane elements, is the linear thermal transmittance of the thermal bridge: measured in W/mK; referred to as a ‘psi-value’, and expressed as a ‘ψ-value’.

The lower the ψ-value, the better the performance. ψ-values are taken into account in the calculation methodologies e.g. the Standard Assessment Procedure (SAP) that are used to assess the operational CO₂ emissions and, where applicable, the fabric energy efficiency of buildings.

ψ-values can comprise either, or a combination of, approved, calculated or assumed values.

Approved details, such as the Accredited Construction Details (England & Wales / Scotland / Northern Ireland) and Acceptable Construction Details (Republic of Ireland), collectively referred to here as ACDs, can uplift performance to provide a clear starting point towards achieving compliance, but they are limited in scope and applicability. The greatest opportunity for mitigating the impact of linear thermal bridges can come from following accurately ‘modelled’ details that take into account the following design considerations.

Reducing Linear Thermal Bridging

Detailing at junctions to minimise the effects of thermal bridging and the associated risk of condensation or mould growth is important and there are some simple design considerations that can be adopted to help mitigate the risks and to reduce heat losses.

- Care is required to ensure continuation of insulation wherever possible between the basement wall and floor and also at the junction between the external wall, ground floor and basement wall for best thermal performance. Where this is not possible, the insulation should be overlapped and ideally, insulation material introduced between.

- The best approach to minimise cold bridging is to take insulation externally of the construction and junction and to overlap this such that the wall insulation extends past the level of the floor insulation.

- In order to minimise cold bridging at the edge of the floor, the distance between the top surface of the floor insulation or perimeter insulation upstand, and the bottom of the wall insulation must be a minimum of 150 / 225* mm. The further down the wall insulation extends past the floor insulation, the better the thermal performance of the junction between the wall and the floor.

* 150 mm applies to the UK and 225 mm to the Republic of Ireland.

- Perimeter upstand insulation can also help to reduce heat losses from the junction between the floor and walls. The upstand insulation further increases the distance that the heat has to travel in order to escape through the junction, which therefore helps to reduce heat loss. Omitting this, or using a poorer performing insulation, can increase these losses.

- Using better thermally performing blockwork for the basement and above ground wall constructions, particularly in adjacency to the junction with the floor, can assist with reducing heat losses from the junctions.

- An internal lining of insulation on the warm side of the construction can also help to reduce heat losses through the junction. The internal lining, such as Kingspan Kooltherm® K118, could be used over the whole wall area, or a thin insulation layer could be used behind the wall lining adjacent to the junction to help reduce losses. A combination of external and internal insulation layers can be particularly effective to reduce cold bridging.

For further advice on details to reduce linear thermal bridging please contact the Kingspan Insulation Technical Service Department (see rear cover for details).
Design Considerations

Responsible Sourcing

Kingspan GreenGuard® GG300 produced at Kingspan Insulation’s Selby, North Yorkshire manufacturing facility is manufactured under a management system certified to BS EN ISO 14001: 2015.

NB The above information is correct at the time of writing. Please confirm at the point of need by contacting Kingspan Insulation’s Technical Service Department (see rear cover), from which copies of Kingspan Insulation’s certificates can be obtained.

Sustainability & Responsibility

Kingspan Insulation has a long-term commitment to sustainability and responsibility: as a manufacturer and supplier of insulation products; as an employer; as a substantial landholder; and as a key member of its neighbouring communities.

A report covering the sustainability and responsibility of Kingspan Insulation Ltd’s British operations at its Pembridge, Herefordshire and Selby, North Yorkshire manufacturing facilities is available at www.kingspaninsulation.co.uk/sustainabilityandresponsibility.

Specification Clause

Kingspan GreenGuard® should be described in specification as:-

The basement wall / floor insulation shall be Kingspan GreenGuard® GG300 / GG500 / GG700 (delete as appropriate) _____ mm thick: comprising high performance rigid extruded polystyrene insulation. The product shall be manufactured, with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP); under a management system certified to ISO 9001:2015; and installed in accordance with the instructions issued by Kingspan Insulation Limited.

NBS Specifications

Details also available in NBS Plus.
NBS users should refer to clause(s):
J30 330 (Standard and Intermediate)
J40 380 (Minor Works)

Product Selection

The high compressive stress of Kingspan GreenGuard® makes it particularly suitable for use where floor loads are to be severe.

Consideration must be given to which Kingspan GreenGuard® product is most appropriate for the required application. A table of the key distinguishing features is shown below.

<table>
<thead>
<tr>
<th>Product</th>
<th>Thermal Conductivity (W/mK)</th>
<th>Density (kg/m³)</th>
<th>Compressive Stress (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingspan GreenGuard®</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GG300</td>
<td>0.034 W/mK (30 - 150 mm)</td>
<td>30</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>0.036 W/mK (&gt; 150 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kingspan GreenGuard®</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GG500</td>
<td>0.034 W/mK (40 - 60 mm)</td>
<td>35</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>0.036 W/mK (&gt; 60 mm)</td>
<td></td>
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<tr>
<td>Kingspan GreenGuard®</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GG700</td>
<td>0.034 W/mK (40 - 60 mm)</td>
<td>45</td>
<td>700</td>
</tr>
<tr>
<td></td>
<td>0.036 W/mK (&gt; 60 mm)</td>
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<td></td>
</tr>
</tbody>
</table>

Design Standards

Consideration should be given to the recommendations of BS 8102: 2009 (Code of practice for protection of structures against water from the ground), BS 8215: 1991 (Code of practice for design and installation of damp proof courses in masonry construction) and the information given in Building Research Establishment Digest 104 (Floor Screeds).

Waterproofing

BS 8102: 2009 (Code of practice for protection of structures against water from the ground) provides guidance on protection of basements against ground water. The level of protection needed by a new basement in housing, offices, restaurants, leisure centres etc. is Grade 3 (refer to BS 8102 for a full list). Grade 3 protection consists of one of the following waterproofing options.

Tanking System - A continuous waterproofing membrane surrounding the exterior of the basement structure, preventing ground water from penetrating the basement construction. Available in mastic asphalt tanking, cementitious renders, self-adhesive membranes and liquid applied membranes (see Figure 1).

Waterproofed Concrete - A continuous waterproofed concrete, mixed in accordance with BS EN 1992-3:2006 (Eurocode 2. Design of concrete structures. Liquid retaining and containing structures). The waterproofed concrete is used as the exterior of the construction to prevent water penetration.

Drained Cavity & DPM - An effective drainage system where moisture that seeps through a monolithic wall, into the cavity is collected and channelled away under the floor. Using a DPM in conjunction with the drained cavity prevents any water penetrating the structure.
Sitework

General
- Kingspan Insulation recommends that suitable professional advice is sought when designing basements.

Drainage
- Water collecting at the base of Kingspan GreenGuard® must be drained away by filter drains located around the perimeter of the basement.
- To construct a filter drain, a perforated / porous drainage pipe should be positioned 200 mm below the floor level of the basement and should be surrounded by a free draining aggregate e.g. course gravel.
- A geotextile membrane must be placed around the gravel to prevent fines blocking the drain.
- Depending upon ground conditions, drains may be connected to surface drainage systems or soakaways.

Basement Floors

Installation Below a Floor Slab
- The site should be prepared and foundations, where appropriate, built to damp proof course (DPC) level.
- A thin sand blinding may be used to achieve a continuous level surface free from projections over rolled hardcore.
- The damp proof membrane (minimum 300 micron / 1200 gauge polythene) can be laid with joints well lapped and folded, to prevent the passage of ground water, either directly over the well compacted hardcore prior to laying the insulation boards, or over the insulation boards.
- The membrane should be laid under the basement wall, and under the triangular shaped piece of insulation placed between the concrete slab and the exterior of the basement wall, and lapped by 300 mm under the basement wall tanking membrane.
- Insulation boards should always be loose-laid break-bonded, with the joints lightly butted.
- If two layers of insulation are required, they should be horizontally offset relative to each other so that, as far as possible, the board joints in the two adjacent layers do not coincide with each other (see Figure 2).

Figure 2 - Offseting of Multiple Insulation Layers

A strip of rigid insulation board (minimum 20 mm thick) should be placed vertically around the perimeter of the floor slab in order to prevent cold bridging. The top of the strip of insulation board should be level with the top of the floor screed and the bottom should be level with the bottom of the horizontal floor insulation, and closely butted up to it.
- If the damp proof membrane is laid directly onto the hardcore below the insulation boards, the boards should be overlaid with a polythene sheet (not less than 125 micron / 500 gauge), to prevent the wet concrete penetrating the joints between the boards, and to act as a vapour control layer. Ensure the polythene sheet has 150 mm overlaps and is taped at the joints.
- The subsequent installation of the concrete slab and screed or other flooring material is carried out in a manner similar to that for an uninsulated floor.
- The concrete slab and screed should be allowed to dry out prior to the installation of the floor finish.

Installation Below a Floor Screed
- Concrete slabs should be allowed to dry out fully prior to the installation of the insulation boards (average 1 day per mm of slab thickness).
- The surface of the slab should be smooth, flat and free from projections. Rough cast slabs should be levelled using a thin sand blinding to ensure boards are continuously supported.
- The damp proof membrane (minimum 300 micron / 1200 gauge polythene) should be laid with joints well lapped and folded, to prevent the passage of ground water, either directly over the floor slab prior to laying the insulation boards, or over the insulation boards.
- The membrane should be laid under the basement wall, and over the triangular shaped piece of insulation placed between the concrete slab and the exterior of the basement wall, and lapped by 300 mm under the basement wall tanking membrane.
Sitework

- Insulation boards should always be loose-laid break-bonded, with the joints lightly butted.
- If two layers of insulation are required, they should be horizontally offset relative to each other so that, as far as possible, the board joints in the two adjacent layers do not coincide with each other (see Figure 2).
- A strip of rigid insulation board (minimum 20 mm thick) should be placed vertically around the perimeter of the floor slab in order to prevent cold bridging. The top of the strip of insulation board should be level with the top of the floor screed and the bottom should be level with the bottom of the horizontal floor insulation, and closely butted up to it.
- Insulation boards should be overlaid with a polythene sheet (not less than 125 micron / 500 gauge), to prevent the wet screed penetrating the joints between the boards, and to act as a vapour control layer. Ensure the polythene sheet has 150 mm overlaps and is taped at the joints.
- Use sand and cement screed laid to a minimum thickness of 65 mm for domestic construction and 75 mm elsewhere.

Basement Walls

- A triangular shaped piece of Kingspan GreenGuard® should be placed between the concrete slab and the exterior of the basement wall to create a slope (see Figure 1) and a platform for the basement wall insulation.
- The damp proof membrane should be laid under the basement wall and the triangular shaped piece of insulation, and connect with the basement wall tanking membrane in accordance with the tanking membrane manufacturer’s recommendations.
- A tanking membrane is applied to the external face of the basement wall, to prevent water entering the basement structure.
- The insulation board should be installed outside of the tanking membrane.
- A cavity drainage membrane or layer of washed no fines gravel should be installed outside of the insulation boards.
- This relieves hydrostatic pressure and channels water to the foundation drain.
- The membrane or gravel should be covered with a geotextile layer to prevent fines from blocking the drainage material.
- The ground around the structure must slope away from the basement wall to ensure rainwater drains away from the building.

Waterstops

- When using reinforced concrete as the main structure of the basement, waterstops must be installed at the junctions where day joints have been made in the structure to prevent water leakage.

Refer to:

- Movement Joints (UK) Ltd
  +44 (0) 1354 60 79 60
  www.mjuk.co.uk
- Fosroc Ltd
  +44 (0) 1827 262 222
  www.fosroc.com
- Beton Construction Materials Ltd
  +44 (0) 1256 353 146
  www.betonconmat.co.uk

Wheeled / Foot Traffic

- Ensure boards are protected during installation from wheeled / foot traffic by using scaffold planks or other protective measures.

General

Cutting

- Cutting should be carried out either by using a fine toothed saw, a hot wire system or by scoring with a sharp knife and snapping the board over a straight edge.
- Ensure accurate trimming to achieve close-buttting joints and continuity of insulation.

Availability

- Kingspan GreenGuard® is available through specialist insulation distributors and selected builders’ merchants throughout the UK, and Ireland.

Packaging and Storage

- Kingspan GreenGuard® may be delivered in packaging bearing alternative product branding.
- The polyethylene packaging of Kingspan Insulation products, which is recyclable, should not be considered adequate for outside protection.
- Ideally, boards should be stored inside a well ventilated building. If, however, outside storage cannot be avoided, then the boards should be stacked clear of the ground and covered with a pale pigmented polythene sheet or weatherproof tarpaulin.
- Kingspan GreenGuard® should not be left in the sun covered by either a transparent or a dark plastic sheet, since in both cases, board temperatures can build up to a level hot enough to appreciably alter board dimensions or cause warping.

Health and Safety

- Kingspan Insulation products are chemically inert and safe to use.
- A Safety Information Data Sheet for this product is available from the Kingspan Insulation website
  www.kingspaninsulation.co.uk/safety or
  www.kingspaninsulation.ie/safety.

Warning – do not stand on or otherwise support your weight on this product unless it is fully supported by a load-bearing surface.
Product Details

Composition
Kingspan GreenGuard® GG300, GG500 and GG700 are high performance rigid extruded polystyrene insulants with a fibre-free core. They are manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP) and has a smooth, dense skin on both faces.

Standards and Approvals

NB The above information is correct at the time of writing. Please confirm at the point of need by contacting Kingspan Insulation’s Technical Service Department (see rear cover), from which copies of Kingspan Insulation’s certificates can be obtained.

Water Vapour Resistivity
The products typically achieve a resistivity greater than 400 MNs/gm, when tested in accordance with BS EN 12086: 2013 (Thermal insulating products for building applications. Determination of water vapour transmission properties).

Absorption of Moisture
Kingspan GreenGuard® is highly resistant to water absorption and the effects of freeze-thaw cycling.

Durability
If correctly installed, Kingspan GreenGuard® can have an indefinite life. Its durability depends on the supporting structure and the conditions of its use.

Resistance to Solvents, Fungi & Rodents
Kingspan GreenGuard® is resistant to most commonly occurring construction materials such as lime, cement, plaster, anhydrous gypsum, solvent-free bituminous compounds, water-based wood preservatives, as well as alcohols, acids and alkalis. Certain organic materials such as solvent-based wood preservatives, coal tar and derivatives (creosote), paint thinners and common solvents (e.g. acetone, ethyl acetate, petrol, toluene and white spirit), will attack Kingspan GreenGuard®, resulting in softening, shrinkage and possible dissolution, with a consequent loss of performance.

Kingspan GreenGuard® does not provide any food value to vermin and is not normally attractive to them.

Fire Performance
Kingspan GreenGuard® achieves European Classification (Euroclass) E when classified to EN 13501-1:2018 (Fire classification of construction products and building elements. Classification using data from reaction to fire tests).

Further details on the fire performance of Kingspan Insulation products may be obtained from the Kingspan Insulation Technical Service Department (see rear cover).

Maximum Service Temperature
Kingspan GreenGuard® should not be brought into direct contact with high temperature heat sources. The maximum service temperature of Kingspan GreenGuard® is 75°C.

Standard Dimensions
All products in the Kingspan GreenGuard® range are available in the following standard size:

<table>
<thead>
<tr>
<th>Nominal Dimension</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (m)</td>
<td>2.50</td>
</tr>
<tr>
<td>Width (m)</td>
<td>0.6</td>
</tr>
<tr>
<td>Insulant Thickness (mm)</td>
<td>Refer to local distributor or Kingspan Insulation price list for current stock and non-stock sizes.</td>
</tr>
<tr>
<td>Edge Profile</td>
<td>Straight</td>
</tr>
</tbody>
</table>

Compressive Stress
The compressive stress of Kingspan GreenGuard® is as follows:
Kingspan GreenGuard® GG300 – 300 kPa;
Kingspan GreenGuard® GG500 – 500 kPa; and
Kingspan GreenGuard® GG700 – 700 kPa,
when tested to EN 826: 2013 (Thermal insulating products for building applications. Determination of compression behaviour).

Water Vapour Resistivity
The products typically achieve a resistivity greater than 400 MNs/gm, when tested in accordance with BS EN 12086: 2013 (Thermal insulating products for building applications. Determination of water vapour transmission properties).

Absorption of Moisture
Kingspan GreenGuard® is highly resistant to water absorption and the effects of freeze-thaw cycling.

Durability
If correctly installed, Kingspan GreenGuard® can have an indefinite life. Its durability depends on the supporting structure and the conditions of its use.

Resistance to Solvents, Fungi & Rodents
Kingspan GreenGuard® is resistant to most commonly occurring construction materials such as lime, cement, plaster, anhydrous gypsum, solvent-free bituminous compounds, water-based wood preservatives, as well as alcohols, acids and alkalis. Certain organic materials such as solvent-based wood preservatives, coal tar and derivatives (creosote), paint thinners and common solvents (e.g. acetone, ethyl acetate, petrol, toluene and white spirit), will attack Kingspan GreenGuard®, resulting in softening, shrinkage and possible dissolution, with a consequent loss of performance.

Kingspan GreenGuard® does not provide any food value to vermin and is not normally attractive to them.

Fire Performance
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Maximum Service Temperature
Kingspan GreenGuard® should not be brought into direct contact with high temperature heat sources. The maximum service temperature of Kingspan GreenGuard® is 75°C.
Product Details

Thermal Properties


Thermal Conductivity

The boards achieve a thermal conductivity (λu-value) of Kingspan GreenGuard® GG300 is:
0.034 W/mK (insulant thickness 30 - 150 mm); and
0.036 W/mK (insulant thickness > 150 mm).

Kingspan GreenGuard® GG500 is:
0.034 W/mK (insulant thickness 40 - 60 mm); and
0.036 W/mK (insulant thickness > 60 mm).

Kingspan GreenGuard® GG700 is:
0.034 W/mK (insulant thickness 40 - 60 mm); and
0.036 W/mK (insulant thickness > 60 mm).

Thermal Resistance

Thermal resistance (R-value) varies with thickness and is calculated by dividing the thickness of the board (expressed in metres) by its thermal conductivity. The resulting number is rounded down to the nearest 0.05 (m²K/W).

<table>
<thead>
<tr>
<th>Insulant Thickness (mm)</th>
<th>GG300 Thermal Resistance (m²K/W)</th>
<th>GG500</th>
<th>GG700</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.85</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>40</td>
<td>1.15</td>
<td>1.15</td>
<td>1.15</td>
</tr>
<tr>
<td>50</td>
<td>1.45</td>
<td>1.45</td>
<td>1.45</td>
</tr>
<tr>
<td>60</td>
<td>1.75</td>
<td>1.75</td>
<td>1.75</td>
</tr>
<tr>
<td>70</td>
<td>2.05</td>
<td>1.90</td>
<td>1.90</td>
</tr>
<tr>
<td>80</td>
<td>2.35</td>
<td>2.20</td>
<td>2.20</td>
</tr>
<tr>
<td>100</td>
<td>2.90</td>
<td>2.75</td>
<td>2.75</td>
</tr>
<tr>
<td>120</td>
<td>3.50</td>
<td>3.30</td>
<td>3.30</td>
</tr>
<tr>
<td>140</td>
<td>4.10</td>
<td>3.85</td>
<td>3.85</td>
</tr>
<tr>
<td>150</td>
<td>4.40</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

NB Multiple layers of insulation are required for higher thermal resistances.
NB Refer to local distributor or Kingspan Insulation price list for current stock and non-stock sizes.
NB Where a hyphen is shown the thickness is not available.
Kingspan Insulation

Company Details
Kingspan Insulation Ltd is part of the Kingspan Group plc., one of Europe’s leading construction product manufacturers. The Kingspan Group was formed in the late 1960s and is a publicly quoted group of companies headquartered in Kingscourt, County Cavan, Ireland.

Kingspan Insulation Ltd is a market leading manufacturer of premium and high performance rigid insulation products and insulated systems for building fabric and building services applications.

Insulation Product Benefits
Kingspan OPTIM-R® Vacuum Insulation Panel (VIP) Products
- With a declared value thermal conductivity of 0.007 W/mK, these products provide an insulating performance that is up to five times better than commonly used insulation materials.
- Provides high levels of thermal efficiency with minimal thickness.
- Over 90% (by weight) recyclable.

Kingspan Kooltherm® and Kooltherm® 100 Products
- With a thermal conductivity of 0.018–0.023 W/mK these are the most thermally efficient insulation products commonly used.
- The thinnest commonly used insulation products for any specific U-value.
- Manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP).

Kingspan QuadCore®
- With a thermal conductivity of 0.021 W/mK this is amongst one of the more thermally efficient insulation products commonly used.
- Offering excellent thermal and fire performance, enhanced environmental credentials and backed by an extended warranty.
- Manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP).

Kingspan Therma™ Products
- With a thermal conductivity of 0.022-0.028 W/mK these are amongst the more thermally efficient insulation products commonly used.
- Manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP).

Kingspan GreenGuard® Products
- Rigid extruded polystyrene insulation (XPS) has the necessary compressive stress to make it the product of choice for specialist applications such as heavy duty flooring, car park decks and inverted roofing.
- Manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP).

All Products
- Unaffected by air infiltration - a problem that can be experienced with mineral fibre and which can reduce thermal performance.
- Safe and easy to install.
- If installed correctly, can provide reliable long term thermal performance over the lifetime of the building.
- Each product achieves the required fire performance for its intended application.

Products & Applications
Kingspan Insulation Ltd has a vast product range. Kingspan Insulation Ltd products are suitable for both new build and refurbishment in a variety of applications within both domestic and non-domestic buildings. The available insulation solutions are listed below.
- Pitched Roofs
- Flat Roofs
- Green Roofs
- Cavity Walls
- Solid Walls
- Timber and Steel Framing
- Insulated Cladding Systems
- Insulated Render Systems
- Floors
- Soffits
- Ductwork

Further Solutions:
- Insulated Dry-Lining
- Tapered Roofing Systems
- Cavity Closers
- The Kingspan KoolDuct® System
- Kingspan nilvent®
- Kingspan TEK® Building System
Kingspan **GreenGuard®**

Inverted Roofs

Insulation for Protected Membrane Flat Roofs and Green Roofs

- High performance rigid extruded polystyrene insulation - thermal conductivities as low as 0.034 W/mK
- Protects waterproofing membrane
- Minimal water absorption
- High compressive stress
- Withstands freeze / thaw cycling
- Compatible with green roof systems
- Resistant to the passage of water vapour
- Easy to handle and install
- Ideal for new build and refurbishment
- Non-deleterious material
- Manufactured with a blowing agent that has zero ODP and low GWP
Typical Constructions and U-values

Assumptions

The U-values in the tables that follow have been calculated, under a management system certified
to the BBA Scheme for Assessing the Competency of Persons to Undertake U-value and Condensation Risk
Calculations, using the method detailed in BS EN ISO 6946: 2017 / I.S. EN ISO 6946: 2007 (Building
components and building elements. Thermal resistance and
thermal transmittance. Calculation methods), and using
the conventions set out in BR 443 (Conventions for U-value calculations). The method detailed in part F.4.2 of BS EN ISO
6946: 2017 and D.4.2 of I.S. EN ISO 6946: 2007 has been used
taken account of the effect of the Kingspan AQUAZONE®
(high performance, non-woven polyethylene membrane)
over the insulation, and an (fx) factor of 0.0012 for a paving
slab ballast application or 0.0010 for a green roof or gravel
ballast application, has been assumed. They are valid for the
constructions shown in the details immediately above each table.

They assume a nominal selection of post-codes, selected to
represent the influence of geographical variations in rainfall
on thermal performance.

The ceiling, where applicable, is taken to be a 3 mm skim
coated 12.5 mm plasterboard with a cavity between it and the
underside of the deck.

NB 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.

NB The figures quoted are for guidance only. A detailed U-value calculation together with
condensation risk analysis should be completed for each project.

NB If your construction is different from those specified, and / or to gain a
comprehensive U-value calculation along with a condensation risk analysis for your
project, please consult the Kingspan Insulation Technical Service Department (see rear
cover).

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comprehensive U-value calculation along with a condensation risk analysis should be completed for each project.

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comprehensive U-value calculation along with a condensation risk analysis for your
project, please consult the Kingspan Insulation Technical Service Department (see rear
cover).

U-value Table Key

Where an ✗ is shown, the U-value is higher than the worst
of the maximum new build area weighted average U-values
allowed by the:

■ 2013 editions of Approved Documents L to the Building
Regulations for England;
■ 2014 editions of Approved Documents L to the Building
Regulations for Wales;
■ 2015 editions of Technical Handbooks Section 6 to the
Building Standards for Scotland;
■ 2012 editions of Technical Booklets F1 & F2 to the Building
Regulations for Northern Ireland; and
Document L (Buildings other than Dwellings) to the
Building Regulations for the Republic of Ireland.

Concrete Deck with Paving Slab Ballast

Dense Concrete Deck with Suspended Ceiling

<table>
<thead>
<tr>
<th>Insulant Thickness (mm)</th>
<th>London NW1</th>
<th>Birm’ham B1</th>
<th>Glasgow G1</th>
<th>Cardiff CF10</th>
<th>Ireland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingspan GreenGuard® GG300*</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>130 (80 + 50)</td>
<td>0.24</td>
<td>0.24</td>
<td>0.24</td>
<td>0.25</td>
<td>0.24</td>
</tr>
<tr>
<td>140</td>
<td>0.22</td>
<td>0.22</td>
<td>0.22</td>
<td>0.23</td>
<td>0.22</td>
</tr>
<tr>
<td>150</td>
<td>0.21</td>
<td>0.21</td>
<td>0.21</td>
<td>0.22</td>
<td>0.21</td>
</tr>
<tr>
<td>160 (80 + 80)</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.21</td>
<td>0.20</td>
</tr>
<tr>
<td>170 (120 + 50)</td>
<td>0.19</td>
<td>0.19</td>
<td>0.19</td>
<td>0.20</td>
<td>0.19</td>
</tr>
<tr>
<td>180 (100 + 80)</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.19</td>
<td>0.18</td>
</tr>
<tr>
<td>190 (150 + 40)</td>
<td>0.17</td>
<td>0.17</td>
<td>0.17</td>
<td>0.18</td>
<td>0.17</td>
</tr>
<tr>
<td>200 (100 + 100)</td>
<td>0.16</td>
<td>0.16</td>
<td>0.16</td>
<td>0.17</td>
<td>0.16</td>
</tr>
<tr>
<td>210 (150 + 60)</td>
<td>0.16</td>
<td>0.16</td>
<td>0.16</td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td>220 (120 + 100)</td>
<td>0.15</td>
<td>0.15</td>
<td>0.16</td>
<td>0.16</td>
<td>0.15</td>
</tr>
<tr>
<td>230 (150 + 50)</td>
<td>0.14</td>
<td>0.14</td>
<td>0.15</td>
<td>0.15</td>
<td>0.14</td>
</tr>
<tr>
<td>240 (120 + 120)</td>
<td>0.14</td>
<td>0.14</td>
<td>0.14</td>
<td>0.15</td>
<td>0.14</td>
</tr>
<tr>
<td>250 (150 + 100)</td>
<td>0.13</td>
<td>0.13</td>
<td>0.14</td>
<td>0.14</td>
<td>0.13</td>
</tr>
<tr>
<td>260 (140 + 100)</td>
<td>0.13</td>
<td>0.13</td>
<td>0.13</td>
<td>0.14</td>
<td>0.13</td>
</tr>
<tr>
<td>270 (150 + 120)</td>
<td>0.12</td>
<td>0.12</td>
<td>0.13</td>
<td>0.15</td>
<td>0.12</td>
</tr>
<tr>
<td>280 (140 + 140)</td>
<td>0.12</td>
<td>0.12</td>
<td>0.13</td>
<td>0.15</td>
<td>0.12</td>
</tr>
<tr>
<td>290 (150 + 140)</td>
<td>0.12</td>
<td>0.12</td>
<td>0.12</td>
<td>0.12</td>
<td>0.12</td>
</tr>
<tr>
<td>300 (150 + 150)</td>
<td>0.11</td>
<td>0.11</td>
<td>0.12</td>
<td>0.12</td>
<td>0.11</td>
</tr>
<tr>
<td>320 (100 + 100 + 120)</td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
</tr>
<tr>
<td>340 (100 + 120 + 120)</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.11</td>
<td>0.10</td>
</tr>
<tr>
<td>360 (120 + 120 + 120)</td>
<td>0.09</td>
<td>0.09</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
</tr>
</tbody>
</table>

* The above table contains figures for Kingspan GreenGuard® GG300 only.
Please consult the Kingspan Insulation Technical Service Department (see rear
cover) for calculations for other products in the range.

NB Where there are multiple layers of insulation of different thicknesses the thickest
insulation board is installed first.

NB Refer to local distributor or Kingspan Insulation price list for current stock and
non-stock sizes.
Typical Constructions and U-values

Concrete Deck with Gravel Ballast

Dense Concrete Deck with Suspended Ceiling
- Kingspan Kooltherm® K106 or K108 taken up as high as the flat roof insulation upstand
- Damp proof course (DPC) to drain internally or externally as specified
- Gravel ballast
- Kingspan Aquazone®
- Non-woven polyester fleece layer (if required)
- Kingspan GreenGuard®
- 50 mm screw to falls
- 150 mm concrete deck
- 12.5 mm plasterboard fixed to 25 x 50 mm timber battens at 600 mm centres

Dense Concrete Deck with no Ceiling
- Kingspan Kooltherm® K106 or K108 taken up as high as the flat roof insulation upstand
- Damp proof course (DPC) to drain internally or externally as specified
- Gravel ballast
- Kingspan Aquazone®
- Non-woven polyester fleece layer (if required)
- Kingspan GreenGuard®
- 50 mm screw to falls
- 150 mm concrete deck
- 150 mm concrete deck
- 50 mm screed to falls
- Kingspan GreenGuard® GG301 upstand min. 300 mm from bottom surface of horizontal insulation layer

Figure 2

U-values (W/m²K) for a Nominal Selection of Post-Codes

<table>
<thead>
<tr>
<th>Insulant Thickness (mm)</th>
<th>London NW1</th>
<th>Birm’ham</th>
<th>Glasgow</th>
<th>Cardiff CF10</th>
<th>Ireland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingspan GreenGuard® GG300+</td>
<td></td>
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</tr>
<tr>
<td>120</td>
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</tr>
<tr>
<td>130 (80 + 50)</td>
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<tr>
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</tr>
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<tr>
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<tr>
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** NB Where there are multiple layers of insulation of different thicknesses the thickest insulation board is installed first.

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Figure 3

U-values (W/m²K) for a Nominal Selection of Post-Codes

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<td>130 (80 + 50)</td>
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Typical Constructions and U-values

Green Roofs

Semi-intensive Green Roof Covering with no Ceiling

- Substrate to depth required
- Filtration layer
- Kingspan Aquazone®
- Kingspan GreenGuard®
- Root barrier / protection layer(s)
- 2 layer mastic asphalt waterproofing on an underlay of Type 4A sheathing felt to BS EN 13707: 2013
- 50 mm screed to falls
- 150 mm concrete deck

Intensive Green Roof Covering with no Ceiling

- Substrate to depth required
- Filtration layer
- Kingspan Aquazone®
- Kingspan GreenGuard®
- Root barrier / protection layer(s)
- 2 layer mastic asphalt waterproofing on an underlay of Type 4A sheathing felt to BS EN 13707: 2013
- 50 mm screed to falls
- 150 mm concrete deck

U-values (W/m²K) for a Nominal Selection of Post-Codes

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</tbody>
</table>

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U-values (W/m²K) for a Nominal Selection of Post-Codes

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Design Considerations

Linear Thermal Bridging

Basic Principles

Linear thermal bridging describes the heat loss / gain that occurs at junctions between elements e.g. where an external wall meets the roof, or at junctions around openings in the building fabric where the thermal insulation layer is discontinuous e.g. sills, jambs and lintels.

Interruptions within the insulation layer by materials with poorer insulating properties can result in a thermal bridge, which in turn can lead to problems of condensation and mould growth, especially if there is a drop in surface temperature.

The heat flow at these junctions and opening locations, over and above that through the adjoining plane elements, is the linear thermal transmittance of the thermal bridge: measured in W/mK; referred to as a ‘psi-value’, and expressed as a ‘ψ-value’.

The lower the ψ-value, the better the performance. ψ-values are taken into account in the calculation methodologies e.g. the Standard Assessment Procedure (SAP), that are used to assess the operational CO₂ emissions and, where applicable, the fabric energy efficiency of buildings.

ψ-values can comprise either, or a combination of, approved, calculated or assumed values.

Reducing Linear Thermal Bridging

Detailing at junctions to minimise the effects of thermal bridging and the associated risk of condensation or mould growth is important and there are some simple design considerations that can be adopted to help mitigate the risks and to reduce heat losses.

- Care is required to ensure continuation of insulation wherever possible between the wall and roof for best thermal performance. Where this is not possible, the roof and wall insulation should be overlapped and ideally, insulation material introduced between.

- Parapet detailing can represent a good, low heat loss approach, with insulation continuity maintained using an insulated upstand to reduce cold bridging. A Kingspan GreenGuard® GG301 upstand should be used around the perimeter of the roof on the internal façade of parapets. The upstand should extend a minimum of 150 mm above the roof insulation and achieve a minimum distance of 300 mm between the top of the insulation upstand and the bottom of the horizontal roof insulation. Wall insulation should be carried up into parapets at least as high as the flat roof insulation upstand.

- For best thermal performance, roof-lights and ventilator kerbs should be insulated with the same thickness of Kingspan GreenGuard® GG301, with a separate backing layer of Kingspan GreenGuard®, as the general roof area (see Figure 6).

- Where a parapet construction is not used, to achieve best performance, the roof insulation should overlap the wall to extend the thermal bridge path, if necessary by adding thermal insulation to edge beams to achieve continuity with external insulation (see Figure 7).

- Insulate internal rainwater downpipes and other pipes that penetrate the roof if they pass through spaces with a high humidity and if any condensate will damage the structure or internal finishes. Use Kingspan GreenGuard® around the pipe outlet and wrap joints with vapour resistant tape to restrict water vapour from reaching the pipe (see Figure 8).

- Where guttering is incorporated within a flat roof construction, this should be accounted for within the overall thermal design of the roof via an area-weighted calculation for the whole roof. The risk of localised interstitial condensation from reduced insulation provision at the gutter should be considered.

- Where an internal gutter is formed, vertical insulation should be used to reduce thermal bridging, using Kingspan GreenGuard® GG301 with a separate backing layer of Kingspan GreenGuard® (see Figure 9). A similar approach can also reduce losses where a change in levels is required (see Figure 11).

- Lightweight aggregate blockwork to the inner leaf of wall constructions can help to improve thermal performance at junctions generally and where used for the inner leaf of parapet walls it can help to reduce losses (see Figure 10).

Responsible Sourcing

Kingspan GreenGuard® GG300 produced at Kingspan Insulation’s Selby, North Yorkshire manufacturing facility is manufactured under a management system certified to ISO 14001: 2015.

NB The above information is correct at the time of writing. Please confirm at the point of need by contacting Kingspan Insulation’s Technical Service Department (see rear cover), from which copies of Kingspan Insulation’s certificates can be obtained.
Design Considerations

Sustainability & Responsibility

Kingspan Insulation has a long-term commitment to sustainability and responsibility: as a manufacturer and supplier of insulation products; as an employer; as a substantial landholder; and as a key member of its neighbouring communities.

A report covering the sustainability and responsibility of Kingspan Insulation Ltd’s British operations at its Pembridge, Herefordshire and Selby, North Yorkshire manufacturing facilities is available at www.kingspaninsulation.co.uk/sustainabilityandresponsibility.

Insulation can be lifted to allow inspection of the waterproofing system.

Additional insulation can be added at a later date.

The installation of the insulation is not weather dependant.

Rigid extruded polystyrene insulation has minimal water absorption, due to its closed cell structure, and is one of only a few materials suitable and approved for this application, where it will be subject to wetting / drying and freeze / thaw cycles.

Product Selection

Consideration must be given to which Kingspan GreenGuard® product is most appropriate for the required application. A table of the key distinguishing features is shown below.

<table>
<thead>
<tr>
<th>Product</th>
<th>Thermal Conductivity (W/mK)</th>
<th>Density (kg/m³)</th>
<th>Compressive Stress (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingspan GreenGuard® GG300</td>
<td>0.034 W/mK (30 - 150 mm) 0.036 W/mK (&gt; 150 mm)</td>
<td>30</td>
<td>300</td>
</tr>
<tr>
<td>Kingspan GreenGuard® GG500</td>
<td>0.034 W/mK (40 - 60 mm) 0.036 W/mK (&gt; 60 mm)</td>
<td>35</td>
<td>500</td>
</tr>
<tr>
<td>Kingspan GreenGuard® GG700</td>
<td>0.034 W/mK (40 - 60 mm) 0.036 W/mK (&gt; 60 mm)</td>
<td>45</td>
<td>700</td>
</tr>
</tbody>
</table>

NBS Specifications

Details also available in NBS PLUS. NBS users should refer to clause(s): J21 440, J31 340, J41 440 (Standard and Intermediate)

Protected Membrane Roofs

This literature describes the use of Kingspan GreenGuard® as a component of protected membrane roofing systems using either a gravel or paving slab finish, and as a component of green roof systems.

Protected membrane roofing systems place the insulation above the waterproofing, and offer several advantages over traditional warm flat roofs.

- The waterproofing system can be expected to have a life in excess of that obtained in an exposed situation, as it is protected from mechanical damage, UV degradation from solar radiation and temperature extremes (both daily and seasonal).
- The roof is safe from condensation risk.
- The roof achieves the national requirements for external fire exposure when covered with an inorganic material i.e. 50mm gravel or 40mm paving slabs.

<table>
<thead>
<tr>
<th>Ballast Layer</th>
<th>Dead Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 mm thick paving slabs</td>
<td>125 kg/m²</td>
</tr>
<tr>
<td>Gravel (16-32 mm diameter)</td>
<td>16 kg/m² per 10 mm depth</td>
</tr>
<tr>
<td>Soil (intensive green roof)</td>
<td>180 - 500 kg/m²</td>
</tr>
<tr>
<td>Soil (semi-intensive green roof)</td>
<td>120 - 200 kg/m²</td>
</tr>
<tr>
<td>Soil (extensive green roof)</td>
<td>60 - 150 kg/m²</td>
</tr>
</tbody>
</table>

The ballast layer resists wind uplift, prevents flotation of the boards after heavy rain and prevents UV degradation of the boards.

Design Loads & Roof Structure

The suitability of the structure under consideration to accept design loads, including the increased dead load from ballast, snow and roof traffic, should be verified in accordance with BS EN 1991-1-3: 2003 + A1: 2015 (Eurocode 1. Actions on structures. General actions. Snow loads).

The additional load from ballast can be considerable.
Design Considerations

Wind Loads


For constructions located in sheltered exposure zones, or on buildings of up to 10 storeys, the self weight of a minimum 50 mm gravel ballast layer (minimum 80 kg/m²), installed over a non-woven polyethylene membrane, is generally sufficient to ensure that both the insulation boards and waterproofing system remain stable under the full design load.

For constructions located in moderate exposure zones, or on buildings of up to 10 to 15 storeys, this gravel ballast specification is generally sufficient, but the perimeter should be loaded with 50 mm thick paving slabs.

For severe exposure zones or tall buildings over 15 storeys, specialist advice should be sought. BRE Digest 311 (Wind scour of gravel ballast on roofs) should be used when a calculation is required for a specific building project.

Falloffs

The fall on a flat roof, constructed using Kingspan GreenGuard®, is normally provided by the supporting structure being directed towards the rainwater outlets. The fall should be smooth and steep enough to prevent the formation of rainwater ponds. In order to ensure adequate drainage, BS 6229: 2003 (Flat roofs with continuously supported coverings. Code of practice) recommends uniform gradients of not less than 1 in 80. However, because of building settlement, it is advisable to design in even greater falls.

Protected membrane roofing systems incorporating Kingspan GreenGuard® can be laid on roofs with a finished fall of less than 1:80, but the waterproofing system must be of a tanking specification.

Flotation

The ballast specifications detailed in the ‘Wind Loads’ section (above) will be sufficient to prevent flotation of the insulation boards after heavy rain.

Design Details

Paving Slab Ballasted Protected Membrane Roof Details

Figure 6 - Eave / Kerb Detail

- Mastic asphalt waterproofing
- Kingspan AQUAZONE®
- Kingspan GreenGuard® GG301
- 80 mm min.
- Gravel
- Non-woven polyester fleece layer (if required)
- Concrete deck

Figure 7 - Eave / Gutter Detail

- Mastic asphalt waterproofing
- Non-woven polyester fleece layer (if required)
- Kingspan GreenGuard® GG301
- Insulation*
- Concrete deck

Figure 8 - Two Level Drainage

- Kingspan GreenGuard®
- Gravel
- Non-woven polyester fleece layer (if required)
- Screed to falls
- Outlet
- Mastic asphalt waterproofing
- Concrete deck

* The insulation specification will depend on the full build up and facade finish.
Design Considerations

Rainfall Factors

The requirements of part F.4.2 of BS EN ISO 6946:2017 and D.4.2 of I.S. EN ISO 6946:2007 dictate that inverted roof constructions are subject to a geographical rainfall analysis. The cooling effect of rainwater flowing between and beneath the insulation boards, can mean that greater thicknesses of insulation are required to meet desired U-values, particularly in locations that receive high levels of rainfall.

The use of Kingspan Aquazone® over the insulation (see Figures 6-11), can dramatically minimise heat loss by reducing the amount of rainwater that flows between and beneath the insulation boards.

This reduction in rainwater flow is represented by the infiltration (fx) factor of the membrane. The fx factor of a membrane is fall (gradient) specific, and an fx factor measured on a fall can not be used to represent the performance of a membrane if installed horizontally.

Drainage

The number and type of rainwater outlets should be assessed in accordance with BS EN 12056-3:2000 (Gravity drainage systems inside buildings. Roof drainage, layout and calculation). The rainwater outlets should be double entry type, to allow rainwater to be drained from the roof surface at both the membrane level and the upper surface level. When using paving slabs as ballast, on a roof with a finished fall of less than 1:80, they must be laid on supports, in order to aid drainage.

The drainage of green roofs should be carefully considered, especially in the case of intensive systems, which may require a moisture retention layer to ensure adequate moisture levels for the system but still allow the rapid drainage of excess rainwater. Dam type rainwater outlets that hold water in the system are not recommended, as the depth of water may create a moisture vapour impermeable layer above the insulation.
Design Considerations

Roof Waterproofing
Kingspan GreenGuard® is suitable for use over some fully adhered single-ply waterproofing membranes.

Kingspan GreenGuard® is also suitable for use over mastic asphalt waterproofing systems. Mastic asphalt waterproofing should be laid, where applicable, in accordance with BS 8216: 1998 (Code of practice for mastic asphalt roofing). Mastic asphalt should always be laid over an isolating layer of loose-laid Type 4A sheathing felt to BS EN 13707: 2013 (Flexible sheets for waterproofing. Reinforced bitumen sheets for roof waterproofing. Definitions and characteristics).

Kingspan GreenGuard® is also suitable for use over some hot and cold liquid applied waterproofing systems.

Mastic asphalt, some single-ply and some hot liquid applied waterproofing systems require a separation layer (non-woven polyester fleece layer, 130 - 140 g/m², with an overlap of 250 - 300 mm) positioned between the membrane and the insulation.

Waterproofing systems containing solvents should be allowed to fully cure before installing Kingspan GreenGuard® insulation.

Water Vapour Control
Protected membrane roofs are inherently safe in respect of condensation risk. The roof design can be assessed for the risk of interstitial condensation using BS 5250: 2011 + A1: 2016 (Code of practice for control of condensation in buildings) or BS 6229: 2003 (Flat roofs with continuously supported coverings. Code of practice).

Green Roofs
Benefits
Green roofs, are an alternative to the standard protected membrane roof that offer many advantages but require precise design and detailing.

Specifically they can:
- reduce dust levels;
- provide a habitat for wildlife;
- create usable areas for recreational activities;
- retain rainfall thus prevent water surges into the drainage system;
- improve sound insulation; and
- provide a visually more attractive finish than protected membrane roofs with gravel or paving slab ballast.

Types of Green Roof
Green roof systems can be divided into three main categories.

Extensive green roofs comprise a relatively shallow growing medium and low maintenance vegetation such as grass. They are lightweight, simple to design, construct and maintain, but should not be considered suitable for regular traffic or recreational activities. Extensive systems are especially useful in creating green areas for both ecological and aesthetic reasons.

Semi-intensive green roofs comprise a deeper growing medium and vegetation such as grass, perennials and shrubs. They are designed to be more garden-like and to accommodate limited access for maintenance and recreation.

Intensive green roofs have a much deeper growing medium and a wider variety of flora, including grass, shrubs and smaller trees. They are comparable with normal gardens in respect of maintenance, and can be used for recreation activities. The self weight of the system can be very high, due to the increased soil depth.

Careful design and detailing of all roof types is important and includes the following elements.

Growing Medium
In its simplest form this is normal soil. Specialist mixtures are available, incorporating expanded clay and lava rock, which form the growing medium and have filtration, drainage and moisture retention functions.

Drainage Layer
The drainage layer normally consists of either: a layer of washed gravel 8/16; expanded clay; or a specialist ‘egg carton’ or castellated plastic (HDPE) sheeting; all overlaid with a filtration membrane. The drainage layer allows the rapid removal of excess rainwater from the roof, thus avoiding saturation of the soil and the associated increase in weight.

Moisture Retention Layer
The limited depth of soil, especially in the extensive type of roof, may require the use of a moisture retention layer to ensure sufficient water is available for the vegetation.

Root Barrier
The roots of growing plants can seriously damage waterproof membranes, by growing into any small cracks, lap joints or other discontinuities. A root barrier may be formed by a separate cap sheet of polythene, or bitumen felt incorporating a thin copper film. The cap sheet is either adhered or loose-laid onto the waterproof membrane, with all joints sealed by bonding or welding, and must be continued up vertical faces of upstands.
Waterproofing

- Prior to installing the insulation, it is essential to ensure that the waterproofing system has been installed correctly and that the roof is watertight and clean.
- Single-ply membranes, in particular, need careful attention to ensure that there has been no damage from following trades, and that puncturing from below the membrane (from nail heads or debris) cannot occur.
- If a single-ply membrane or mastic asphalt waterproofing system has been installed, a non-woven polyester fleece separation layer, with 250 - 300 mm overlaps, should be laid on top of the membrane prior to the installation of the insulation.

Insulation Boards

- Start laying the Kingspan GreenGuard® insulation boards from the point of access to the roof.
- Insulation boards should always be loose-laid break-bonded, either with their long edges at right angles to the edge of, or diagonally across the roof, and with joints lightly butted. There should be no gaps at abutments.
- If two or more layers of insulation are required, they should be horizontally offset relative to each other so that, as far as possible, the board joints in any two adjacent layers do not coincide with each other (see Figure 12).

Roof-light or ventilator kerbs, gutter etc. should always be insulated (Kingspan GreenGuard® GG301 with a separate backing layer of Kingspan GreenGuard®) to meet the same U-value as the general roof area.

A Kingspan GreenGuard® GG301 upstand should be used around the perimeter of the roof on the internal façade of parapets.

A minimum distance of 300 mm should be maintained between the top of the insulation upstand and the bottom of the horizontal roof insulation.

Boards can be laid in any weather but, due to the boards being lightweight, care must be taken in windy conditions.

Kingspan Aquazone®

- Kingspan Aquazone®, a high performance, non-woven polyethylene membrane, should be laid over the insulation boards.
- Where one run of the membrane laps another, there should be a minimum 300 mm side and end overlaps.
- The membrane should be turned up at the edge of the roof insulation and sealed under the flashing.

Gravel Ballast

- Install the ballast layer as soon as possible, to ensure that Kingspan Aquazone® is always protected and excessive heat build up or high winds do not damage the insulation boards.
- Gravel ballast should be washed, rounded, nominal 20 - 40 mm diameter, and of minimum depth 50 mm.
- The diameter of the gravel is important as this size has been found to be the most resistant to wind scour, BRE Digest 311 gives advice.

Paving Slab Ballast

- Min. 50 mm thick paving slabs should be laid, over Kingspan Aquazone®, on proprietary paving slab supports of minimum diameter 175 mm (or equivalent base area), in order to maintain drainage below the slabs, and to ensure that moisture vapour can escape.
- Install paving slabs and supports as soon as possible, to ensure that Kingspan Aquazone® is always protected and excessive heat build up or high winds do not damage the insulation boards.
- Gaps between the paving slabs and upstands should be filled with washed, rounded gravel, nominal 20 – 40 mm diameter.
Sitework

Roof Gardens
- Having chosen the type of planting system and correctly detailed the various filter layers, moisture retention layers and growing medium, the installation, especially of extensive systems, is quick and simple.
- A root barrier (unless provided by the waterproofing layer) should be loose-laid on or bonded to the waterproofing membrane with all the laps sealed.
- The root barrier should be turned up at the edge of the roof insulation and sealed under the flashing.
- Kingspan GreenGuard® should be installed as described previously.
- Boards should be overlaid with Kingspan Aquazone®, which should be installed as described previously.
- A filtration layer or combined filtration layer / drainage mat is then installed, per its manufacturer’s instructions.
- The growing medium, generally 50 - 200 mm deep is then installed. Specialist spray systems are available, which allow the application of growing medium and grass / plant seed to be applied in one operation.

Mechanical Fixings (Kingspan GreenGuard® GG301 only)
- Cutting Kingspan GreenGuard® GG301 should be carried out by using a TCT saw. Ensure correct FFP2 or 3 grade PPE is used to protect against inhalation of dust during cutting.
- A minimum of 3 fixings, with a minimum head diameter of 25 mm, are required to secure 1200 mm long boards of Kingspan GreenGuard® GG301 Upstand Board to the parapet.
- Mechanical fixings must be arranged in an even pattern.
- Fixings for Kingspan GreenGuard® GG301 should be positioned across the top edge of the board and at a maximum of 600 mm centres.
- Fixings at insulation board edges must be located > 50 mm and < 200 mm from edges and corners of the board and not overlap board joints.
- Each fixing should incorporate a square or circular plate washer (minimum 25 x 25 mm or 25 mm diameter).
- Fixings should be driven straight.
- Care should be taken not to overdrive fixings.
- The bottom of the board should be supported and held in place by the Kingspan GreenGuard® and ballast / paving slabs on supports.
- Additional fixings should be used if the Kingspan GreenGuard® GG301 is not supported, following the same specification as detailed in the previous bullet point.
- For details on fixings refer to:
  - Ejot UK Limited
    - www.mejot.co.uk
    - +44 (0) 1977 687 040
  - Fixfast
    - www.fixfast.com
    - +44 (0) 1732 882 387
  - MAK Fasteners
    - www.makfasteners.com
    - +353 (0) 1 451 9004
  - SFS Intec
    - www.sfsintec.biz/uk
    - +44 (0) 1132 085 500

General
Cutting
- Cutting should be carried out either by using a fine toothed saw, a hot wire system or by scoring with a sharp knife and snapping the board over a straight edge.
- Ensure accurate trimming to achieve close-butting joints and continuity of insulation.

Availability
- Kingspan GreenGuard® is available through specialist insulation distributors and selected roofing merchants throughout the UK and Ireland.

Packaging and Storage
- Kingspan GreenGuard® may be delivered in packaging bearing alternative product branding.
- The polyethylene packaging of Kingspan Insulation products, which is recyclable, should not be considered adequate for outside protection.
- Ideally, boards should be stored inside a well ventilated building. If, however, outside storage cannot be avoided, then the boards should be stacked clear of the ground and covered with a pale pigmented polythene sheet or weatherproof tarpaulin.
- Kingspan GreenGuard® should not be left in the sun covered by either a transparent or a dark plastic sheet, since in both cases, board temperatures can build up to a level hot enough to appreciably alter their dimensions or warp them.

Health and Safety
- Kingspan Insulation products are chemically inert and safe to use.
- A Safety Information Data Sheet for this product is available from the Kingspan Insulation website www.kingspaninsulation.co.uk/safety or www.kingspaninsulation.ie/safety.

Warning - do not stand on or otherwise support your weight on this product unless it is fully supported by a load-bearing surface.
Product Details

Composition

Kingspan GreenGuard® GG300, GG500 and GG700 are high performance rigid extruded polystyrene insulators with a fibre-free core. They are manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP) and has a smooth, dense skin on both faces.

Standards and Approvals


Water Vapour Resistivity

The products typically achieve a resistivity greater than 400 MNs/gm, when tested in accordance with BS EN 12086: 2013 (Thermal insulating products for building applications. Determination of water vapour transmission properties).

Absorption of Moisture

Kingspan GreenGuard® is highly resistant to water absorption and the effects of freeze-thaw cycling.

Durability

If correctly installed, Kingspan GreenGuard® can have an indefinite life. Its durability depends on the supporting structure and the conditions of its use.

Resistance to Solvents, Fungi & Rodents

Kingspan GreenGuard® is resistant to most commonly occurring construction materials such as lime, cement, plaster, anhydrous gypsum, solvent-free bituminous compounds, water-based wood preservatives, as well as alcohols, acids and alkalis. Certain organic materials such as solvent-based wood preservatives, coal tar and derivatives (creosote), paint thinners and common solvents (e.g. acetone, ethyl acetate, petrol, toluene and white spirit) will attack Kingspan GreenGuard®, resulting in softening, shrinkage and possible dissolution, with a consequent loss of performance.

Kingspan GreenGuard® does not provide any food value to vermin and is not normally attractive to them.

Fire Performance

Kingspan GreenGuard® GG300, GG500 and GG700 achieve European Classification (Euroclass) E when classified to EN 13501-1:2018 (Fire classification of construction products and building elements. Classification using data from reaction to fire tests).

Kingspan GreenGuard®, when used within an inverted roof system meets the National requirements for external fire exposure when covered with an inorganic material i.e. 50 mm gravel or 40 mm paving slabs. For specifications without the gravel ballast or paving slabs please consult the manufacturer of the specific external weatherproofing / ballast for their fire classification details.

Further details on the fire performance of Kingspan Insulation products may be obtained from the Kingspan Insulation Technical Service Department (see rear cover).

Maximum Service Temperature

Kingspan GreenGuard® should not be brought into direct contact with high temperature heat sources. The maximum service temperature of Kingspan GreenGuard® is 75°C.
Product Details

Thermal Properties

The $\lambda u$-values and R-values detailed below are quoted in accordance with BS / I.S. EN 13164: 2012; + AI: 2015 (Thermal insulation products for buildings. Factory made extruded polystyrene foam (XPS) products. Specification).

Declared Thermal Conductivity

The boards achieve a declared thermal conductivity ($\lambda u$-value) of Kingspan GreenGuard® GG300 is:

- 0.034 W/mK (insulant thickness 30 - 150 mm); and
- 0.036 W/mK (insulant thickness > 150 mm).

Kingspan GreenGuard® GG500 is:

- 0.034 W/mK (insulant thickness 40 - 60 mm); and
- 0.036 W/mK (insulant thickness > 60 mm).

Kingspan GreenGuard® GG700 is:

- 0.034 W/mK (insulant thickness 40 - 60 mm); and
- 0.036 W/mK (insulant thickness > 60 mm).

Thermal Resistance

Thermal resistance (R-value) varies with thickness and is calculated by dividing the thickness of the board (expressed in metres) by its thermal conductivity. The resulting number is rounded down to the nearest 0.05 (m²K/W).

<table>
<thead>
<tr>
<th>Insulant Thickness (mm)</th>
<th>GG300</th>
<th>GG500</th>
<th>GG700</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.85</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>40</td>
<td>1.15</td>
<td>1.15</td>
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</tr>
<tr>
<td>150</td>
<td>4.40</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

NB Multiple layers of insulation are required for higher thermal resistances.

NB Refer to local distributor or Kingspan Insulation price list for current stock and non-stock sizes.

NB Where a hyphen is shown the thickness is not available.
Company Details

Kingspan Insulation Ltd is part of the Kingspan Group plc., one of Europe’s leading construction product manufacturers. The Kingspan Group was formed in the late 1960s and is a publicly quoted group of companies headquartered in Kingscourt, County Cavan, Ireland.

Kingspan Insulation Ltd is a market leading manufacturer of premium and high performance rigid insulation products and insulated systems for building fabric and building services applications.

Insulation Product Benefits

Kingspan OPTIM-R® Vacuum Insulation Panel (VIP) Products

- With a declared value thermal conductivity of 0.007 W/mK, these products provide an insulating performance that is up to five times better than commonly used insulation materials.
- Provides high levels of thermal efficiency with minimal thickness.
- Over 90% (by weight) recyclable.

Kingspan Kooltherm® and Kooltherm® 100 Products

- With a thermal conductivity of 0.018–0.023 W/mK these are the most thermally efficient insulation products commonly used.
- The thinnest commonly used insulation products for any specific U-value.
- Manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP).

Kingspan QuadCore®

- With a thermal conductivity of 0.021 W/mK this is amongst one of the more thermally efficient insulation products commonly used.
- Offering excellent thermal and fire performance, enhanced environmental credentials and backed by an extended warranty.
- Manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP).

Kingspan Therma™ Products

- With a thermal conductivity of 0.022-0.028 W/mK these are amongst the more thermally efficient insulation products commonly used.
- Manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP).

Kingspan GreenGuard® Products

- Rigid extruded polystyrene insulation (XPS) has the necessary compressive stress to make it the product of choice for specialist applications such as heavy duty flooring, car park decks and inverted roofing.
- Manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP).

All Products

- Unaffected by air infiltration - a problem that can be experienced with mineral fibre and which can reduce thermal performance.
- Safe and easy to install.
- If installed correctly, can provide reliable long term thermal performance over the lifetime of the building.
- Each product achieves the required fire performance for its intended application.

Products & Applications

Kingspan Insulation Ltd has a vast product range. Kingspan Insulation Ltd products are suitable for both new build and refurbishment in a variety of applications within both domestic and non-domestic buildings. The available insulation solutions are listed below.

- Pitched Roofs
- Flat Roofs
- Green Roofs
- Cavity Walls
- Solid Walls
- Timber and Steel Framing
- Insulated Cladding Systems
- Insulated Render Systems
- Floors
- Soffits
- Ductwork

Further Solutions:

- Insulated Dry-Lining
- Tapered Roofing Systems
- Cavity Closers
- The Kingspan KoolDuct® System
- Kingspan nilvent®
- Kingspan TEK® Building System
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www.kingspaninsulation.co.uk
For individual department contact details please visit
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T: +353 (0) 42 979 5000
E: info@kingspaninsulation.ie
www.kingspaninsulation.ie
For individual department contact details please visit
www.kingspaninsulation.ie/contact

Kingspan Insulation Ltd. reserves the right to amend product specifications without prior notice.
Product thicknesses shown in this document should not be taken as being available ex-stock
and reference should be made to the current Kingspan Insulation price-list or advice sought
from Kingspan Insulation’s Customer Service Department. The information, technical details and
fixing instructions etc. included in this literature are given in good faith and apply to uses described.
Recommendations for use should be verified for suitability and compliance with actual requirements,
specifications and any applicable laws and regulations. For other applications or conditions of use,
Kingspan Insulation offers a Technical Advisory Service, the advice of which should be sought for uses of
Kingspan Insulation products that are not specifically described herein. Please check that your copy of
this literature is current by contacting the Kingspan Insulation Marketing Department.

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Registered in Ireland, No. 54621. Registered Office: Bree Industrial Estate, Castleblayney,
Co. Monaghan, Ireland. VAT IE45755691.