

Thermal Bridging and Junction Design in Building Envelopes



System Solution Providers





Independently reviewed by The Retrofit Academy

The Retrofit Academy has reviewed this guide and considers it a useful resource for retrofit professionals looking to understand thermal bridging, its implications and approaches to mitigating its effects. View the full review [here](#).



Introduction

As the performance requirements of buildings continue to tighten, thermal bridging becomes an increasingly critical consideration, in today's highly optimised building envelope.

Thermal bridging is one of the most critical yet often underestimated aspects of building performance. While modern construction places significant emphasis on insulation, airtightness, and energy efficiency, even small discontinuities in the thermal envelope can undermine these efforts. Understanding thermal bridging is therefore essential for architects, engineers, and construction professionals who aim to deliver high-performing buildings.

What Exactly is Thermal Bridging?

At its most basic, thermal bridging occurs when a material with higher thermal conductivity than the surrounding materials allows heat to bypass insulation. In other words, it creates a path of least resistance for heat flow. Instead of being evenly resisted by insulation, heat “short-circuits” through these more conductive elements, leading to localised heat loss or gain.

There are several common locations where thermal bridges typically occur. One of the most frequent is at junctions—places where different building elements meet. For example, the junction between a wall and a floor; or a roof and a wall, often creates conditions where insulation continuity is disrupted.

Openings in the building envelope also present a significant risk. Around windows and doors, insulation is often thinner or interrupted entirely, creating weak points in the thermal layer.

Thermal bridges are not isolated anomalies, they are a fundamental part of the geometry and structure of buildings, regardless of the construction methods used. Whether in new build or refurbishment projects, recognizing where they occur is the first step towards assessing and reducing their impact.

Effects and Implication

The consequences of thermal bridging extend far beyond simple heat loss. It can affect energy efficiency, occupant comfort, moisture behaviour, and even regulatory compliance. Let's take a look at some of these effects in more detail.

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NBS

Energy and Comfort

From an energy perspective, thermal bridges reduce the overall thermal performance of the building envelope. Even if walls, roofs, and floors meet insulation standards individually, the presence of thermal bridges can significantly increase the total heat transfer for the heated envelope.

Thermal bridges also affect thermal comfort. Localised cold spots can develop on internal surfaces, particularly near junctions or around windows. Occupants may feel draughts or local temperature differences, even if the overall air temperature is within a comfortable range, which can lead to increased use of heating systems if it “feels” colder than it is.

Reducing thermal bridging links closely to the “fabric first” principle, which emphasises improving the building envelope before relying on mechanical systems. If thermal bridging is not addressed, the effectiveness of this approach is compromised.

Moisture and Durability

When heat escapes through a thermal bridge, the internal surface temperature at that location drops. If this temperature falls below the dew point of the indoor air, condensation can occur.

This is particularly problematic in areas with high humidity, such as kitchens, bathrooms, or poorly ventilated spaces. Persistent condensation can lead to mould growth, which poses health risks and negatively impacts indoor air quality.

Over time, moisture accumulation can also degrade building materials. Timber elements may rot, metal components may corrode, and finishes may deteriorate. This reduces the durability and lifespan of the building.

In severe cases, thermal bridging can contribute to structural issues if moisture-related damage is left unaddressed.

Regulatory and Certification Impacts

Thermal bridging is also a key factor in the UK building regulations and certification schemes such as Passive House.

In the past, calculation methods such as SAP allowed the use of standardised Accredited Construction Details, but since 2022 these are no longer considered sufficient and bespoke calculations, or reference to “reputable non-governmental detail libraries” are required.

While there are default values included in heat loss calculations, these are very high, and relying on these can make it significantly harder to demonstrate compliance in most circumstances.

Thermal Bridging and Condensation Risks

In addition to heat flow, temperature factors, often referred to as f-factors, are used to assess condensation risk as specific points in the building. An f-factor below 0.75 typically indicates a higher likelihood of surface condensation, highlighting areas that may require additional insulation.

Design Stage

The most effective time to tackle thermal bridging is during the design stage. A key principle is ensuring continuity of insulation across the entire building envelope. This means avoiding gaps or interruptions, particularly at junctions.

Another important consideration is preserving usable internal space, so while adding insulation can improve performance, ideally it should not excessively reduce floor area. This often leads to the strategy of placing insulation externally, where possible. Again, if designed in early, this is often relatively simple to achieve.

External insulation systems allow the structural elements and services to remain within the thermal envelope, and hence fully warm. This reduces the risk of thermal bridging most efficiently while maintaining internal dimensions.

Refurbishment Projects

While all these options can be very effective at reducing the heat losses associated with thermal bridging, if the building already exists then a different approach is required.

In refurbishment projects, such extensive optimisation of the building envelope may not be achievable, but there are still important steps that can be taken to reduce the effect of thermal bridges.

A key principle here is ensuring that some level of insulation is provided as continuously as possible, so even if there is limited depth available, even the bare minimum can make a difference.

A good example of this is window reveals.

As is always the case when considering the best approach to managing the multiple considerations in any project, whether new build or refurb, taking a well-considered and holistic view of the building fabric will bring huge benefits.

Material and Technology Solutions

Advancements in materials and construction technology have made it easier to address thermal bridging with thinner, higher performing products such as our range of Spacetherm Aerogel products offering adaptable solutions to many common detailing challenges.

In window reveals and on solid walls, the vapour permeable and hydrophobic nature of Spacetherm allows it to be used almost anywhere it is needed in order to maintain continuity of insulation.

Similarly, its thin profile, flexible composition and high level of thermal insulation per mm means even as little as 10 or

20mm can make a meaningful difference to heat loss.

The Role of Insulation in Junction Design

Advanced insulation solutions such as Spacetherm A1 enable designers to achieve high thermal resistance in minimal thickness and maintain continuity of the thermal layer in constrained areas.

Unlike conventional insulation, Spacetherm A1 is particularly suited to tight reveals and abutments, interfaces with existing structures and retrofit scenarios where build-ups must be minimised and traditional thicker insulation cannot be used.

This allows junctions to be designed based on performance requirements, rather than being limited by geometry.

The following pages show some indicative details as to the use of Spacetherm A1 with their associated PSi Calculations.

Application Across Critical Junctions

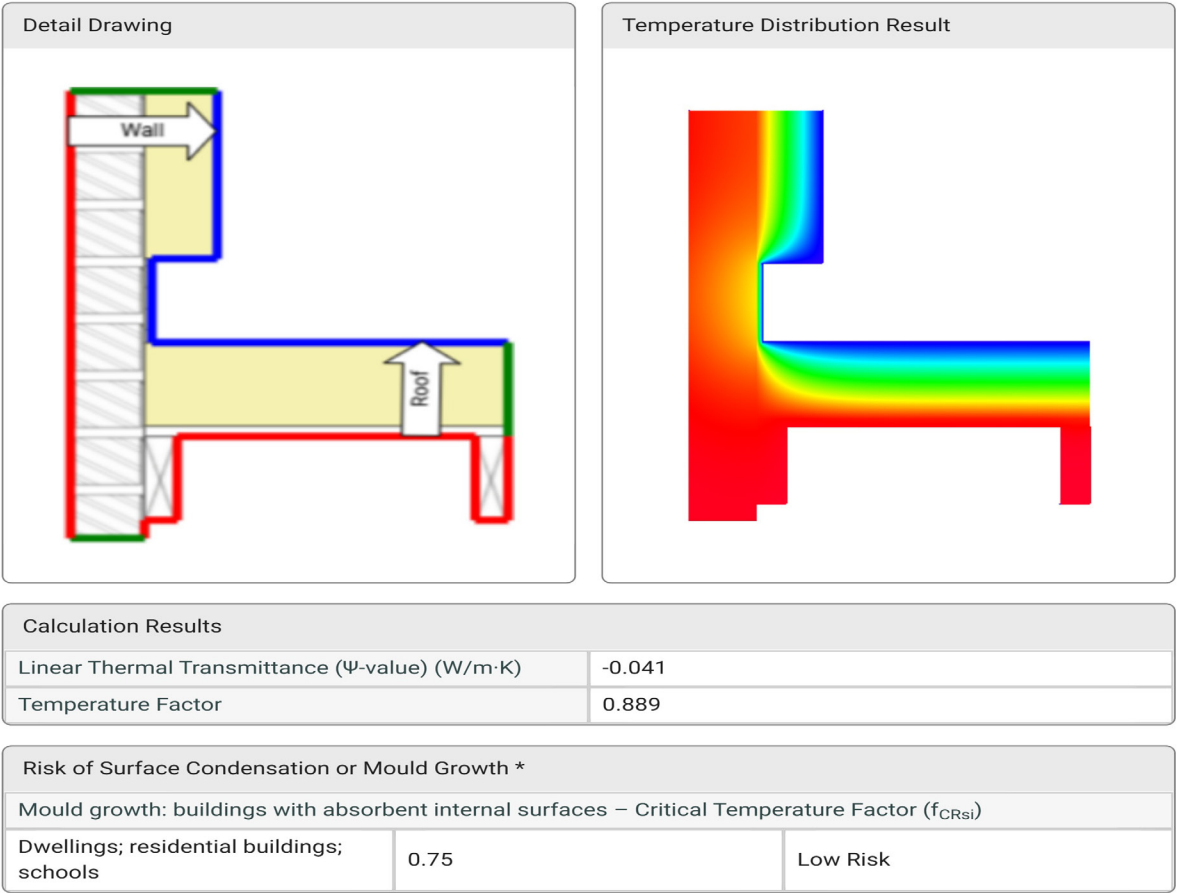
I. Roof Abutments (Flat & Pitched)

At roof-to-wall interfaces, thermal bridging is commonly introduced where:

- Insulation is reduced in thickness
- Continuity between wall and roof insulation is interrupted
- Flashing and weathering elements dominate the build-up

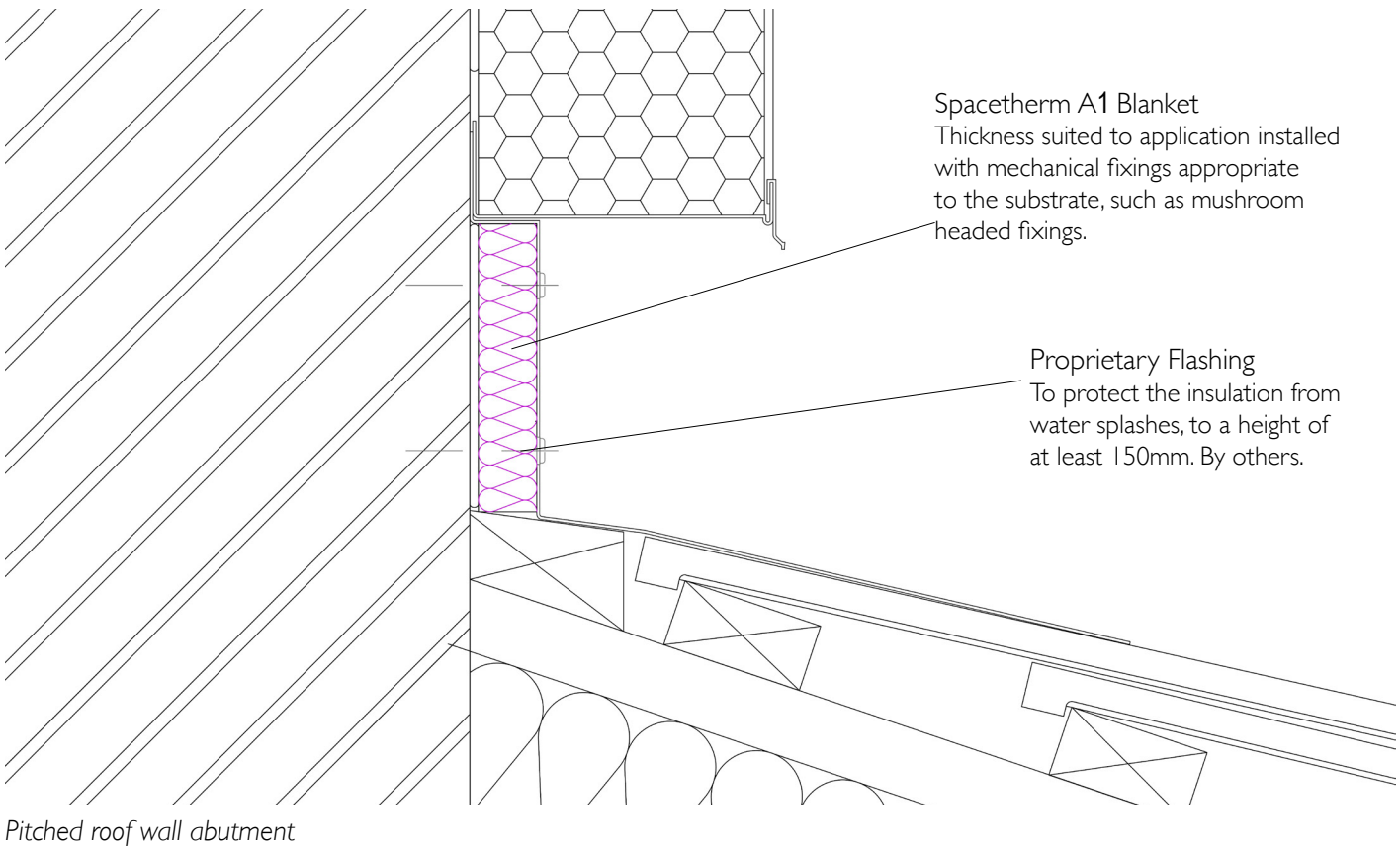
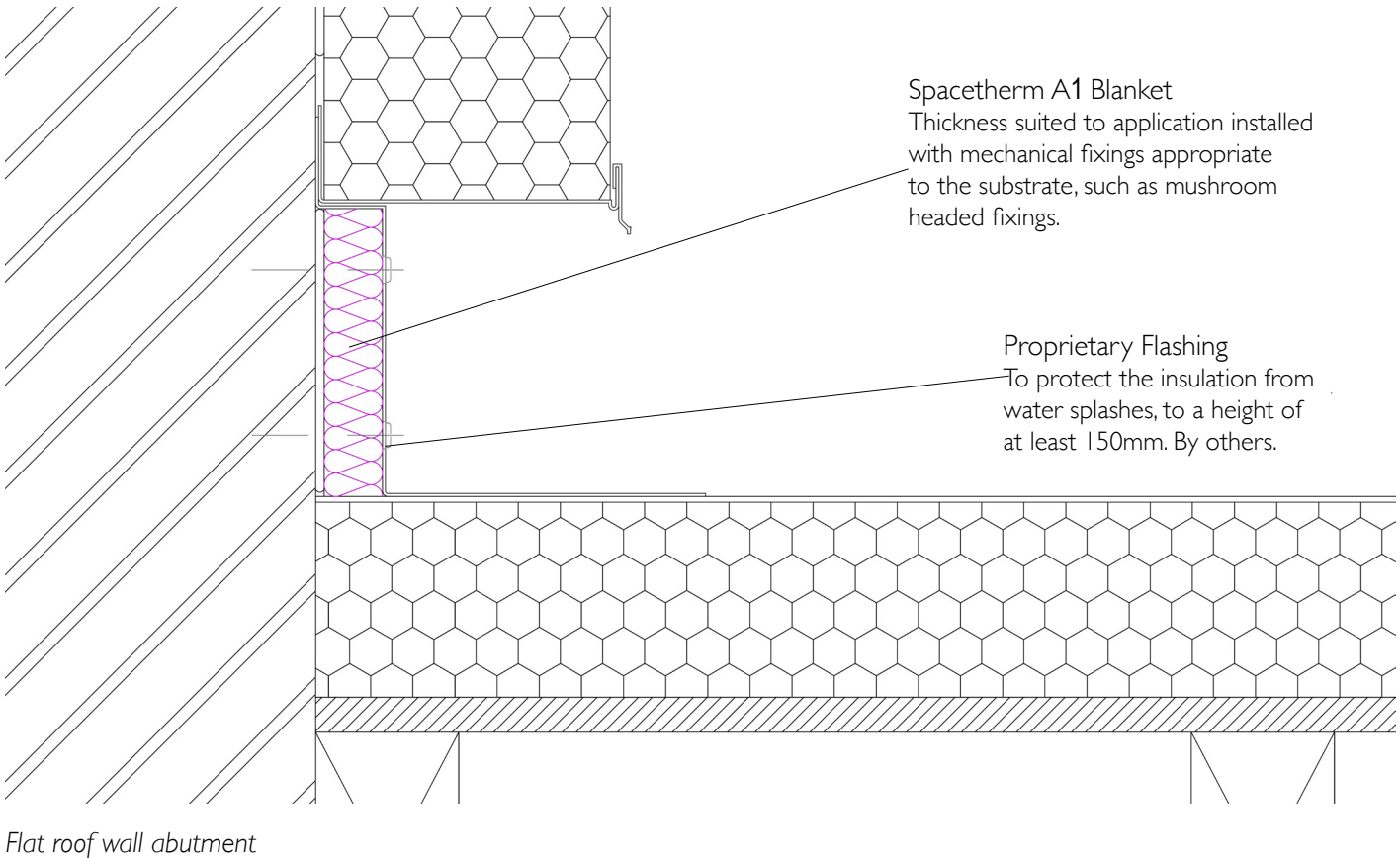
By incorporating Spacetherm A1 designers can maintain thermal continuity at the junction and improve internal surface temperatures at ceiling level.

This is particularly beneficial in retrofit EWI projects.



* The risk of surface condensation or mould growth assessment follows the criteria in BRE Information Paper IP 1/06 Assessing the effects of thermal bridging at junctions and around openings

The result has been generated using: **AutoPsi Thermal Modeling Tool: AutoPSI.co.uk**. The details have been calculated in accordance with BR497 2nd Edition 2016.



2. Window Reveals and Heads

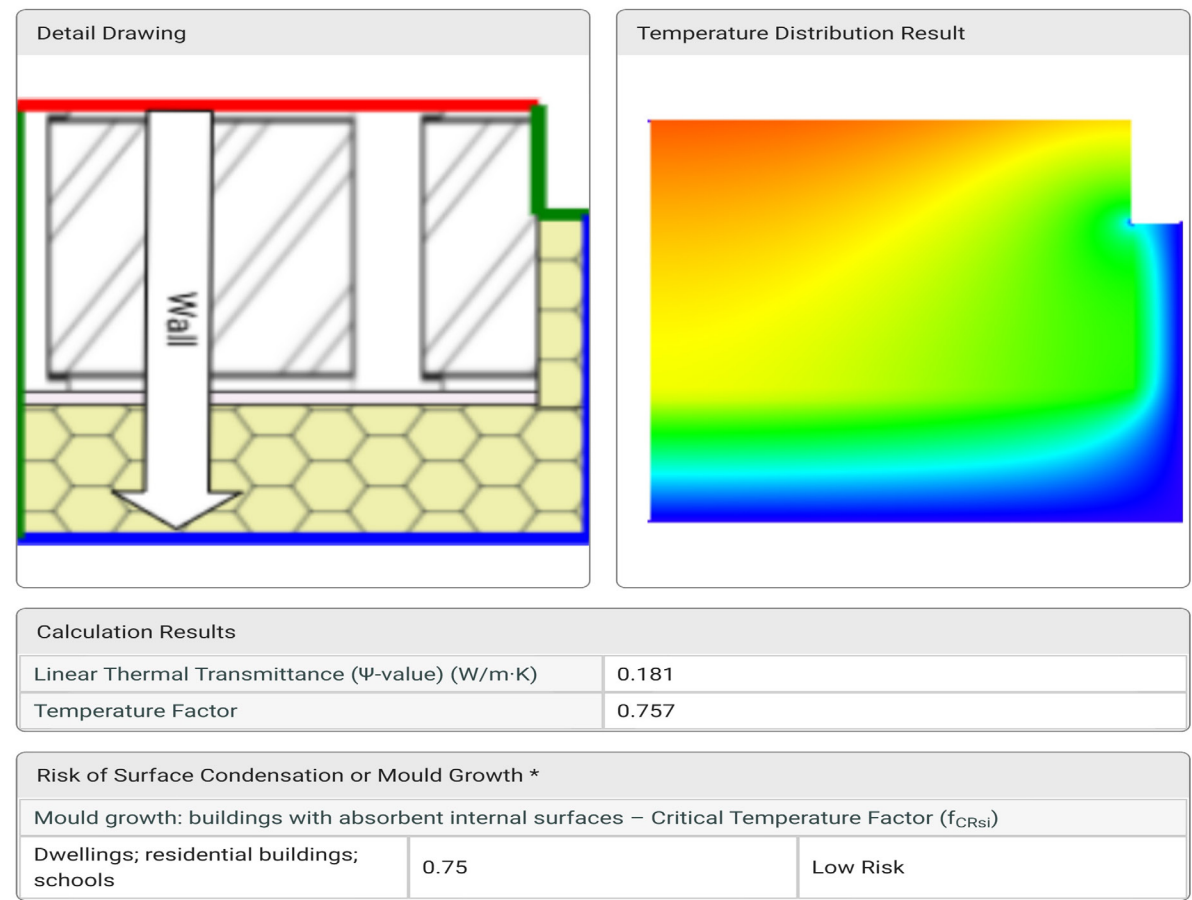
Window junctions are among the highest risk areas for thermal bridging and condensation.

Standard approaches often result in:

- Reduced insulation thickness at reveals
- Cold bridging at lintels and heads
- Increased risk of mould growth internally

Using Spacetherm A1 at window reveals and window heads enables insulation within minimal depth, improved surface temperature factors (fRsi) and enhanced comfort and reduced condensation risk.

This is especially valuable where frame positioning limits available space or existing openings are limited.



Calculation Results

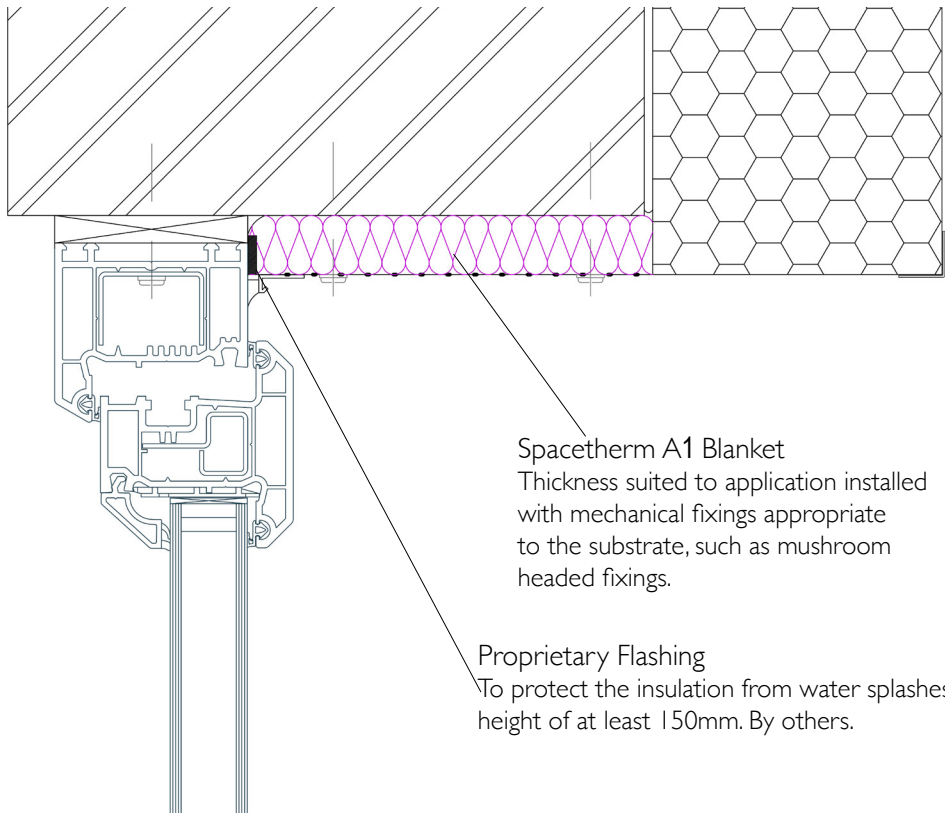
Linear Thermal Transmittance (Ψ -value) (W/m ² ·K)	0.181
Temperature Factor	0.757

Risk of Surface Condensation or Mould Growth *

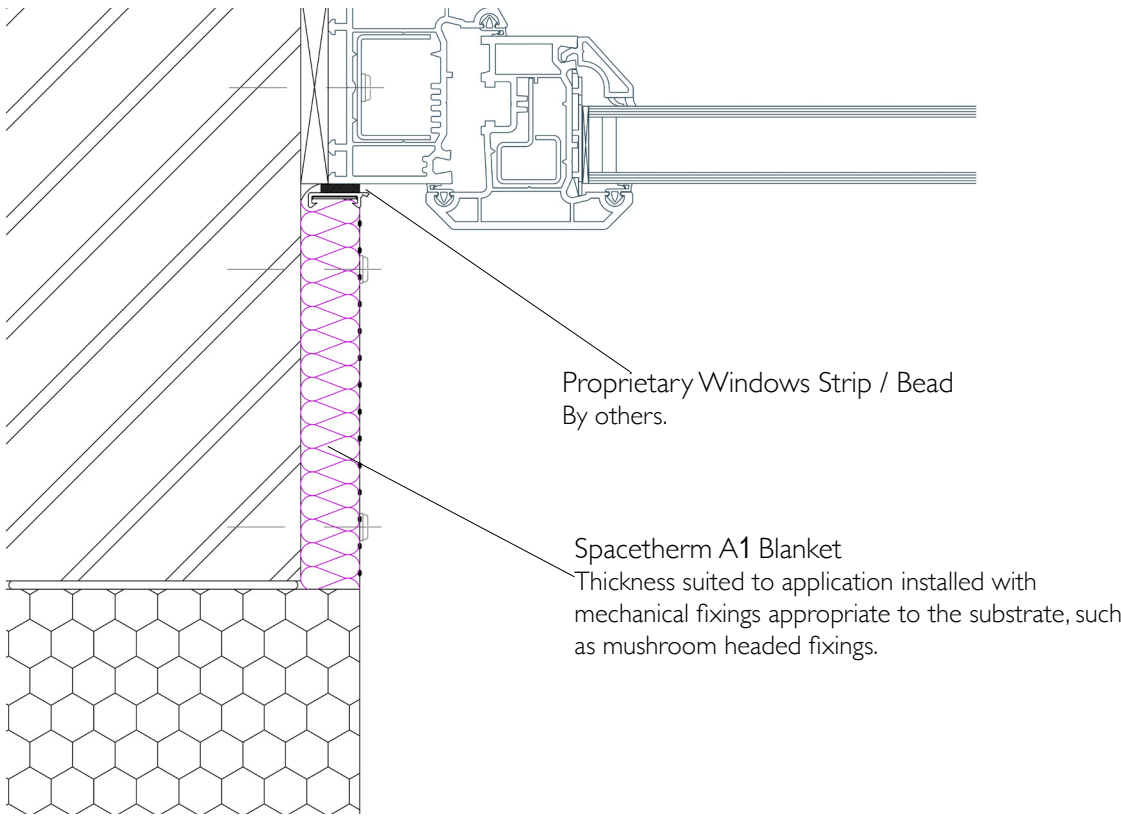
Mould growth: buildings with absorbent internal surfaces – Critical Temperature Factor (f _{CRsi})		
Dwellings; residential buildings; schools	0.75	Low Risk

* The risk of surface condensation or mould growth assessment follows the criteria in BRE Information Paper IP 1/06 Assessing the effects of thermal bridging at junctions and around openings

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Window Head



Window Reveal

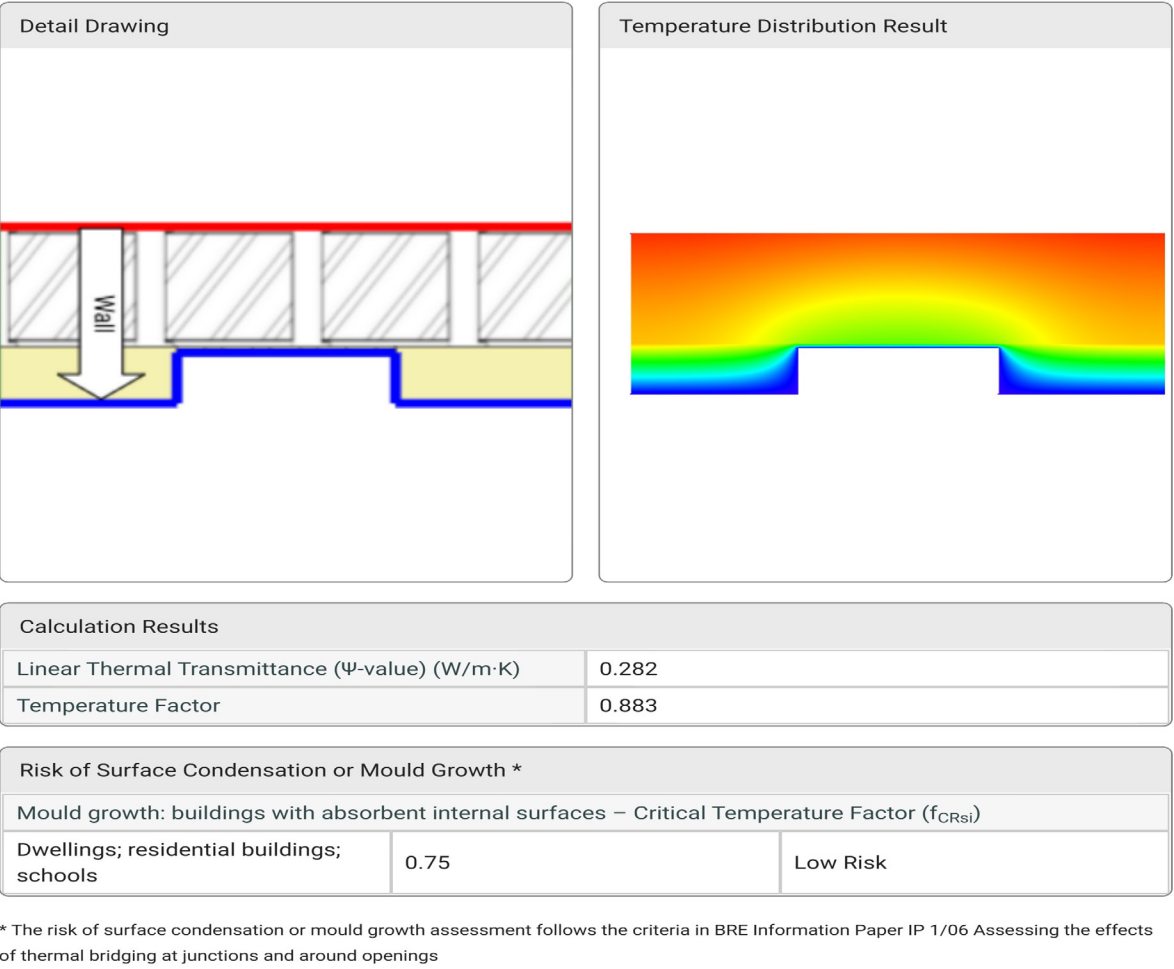
3. Recessed and Constrained Wall Areas

Wall recesses and areas which cannot accommodate full thickness EWI frequently suffer from:

- Interrupted insulation layers
- Complex geometry that is difficult to insulate effectively
- Colder areas of wall internally

The use of Spacetherm A1 in these applications allows:

- Continuity of insulation without increasing build-up thickness
- Simplified detailing in otherwise complex junctions
- Reduction in cold bridging

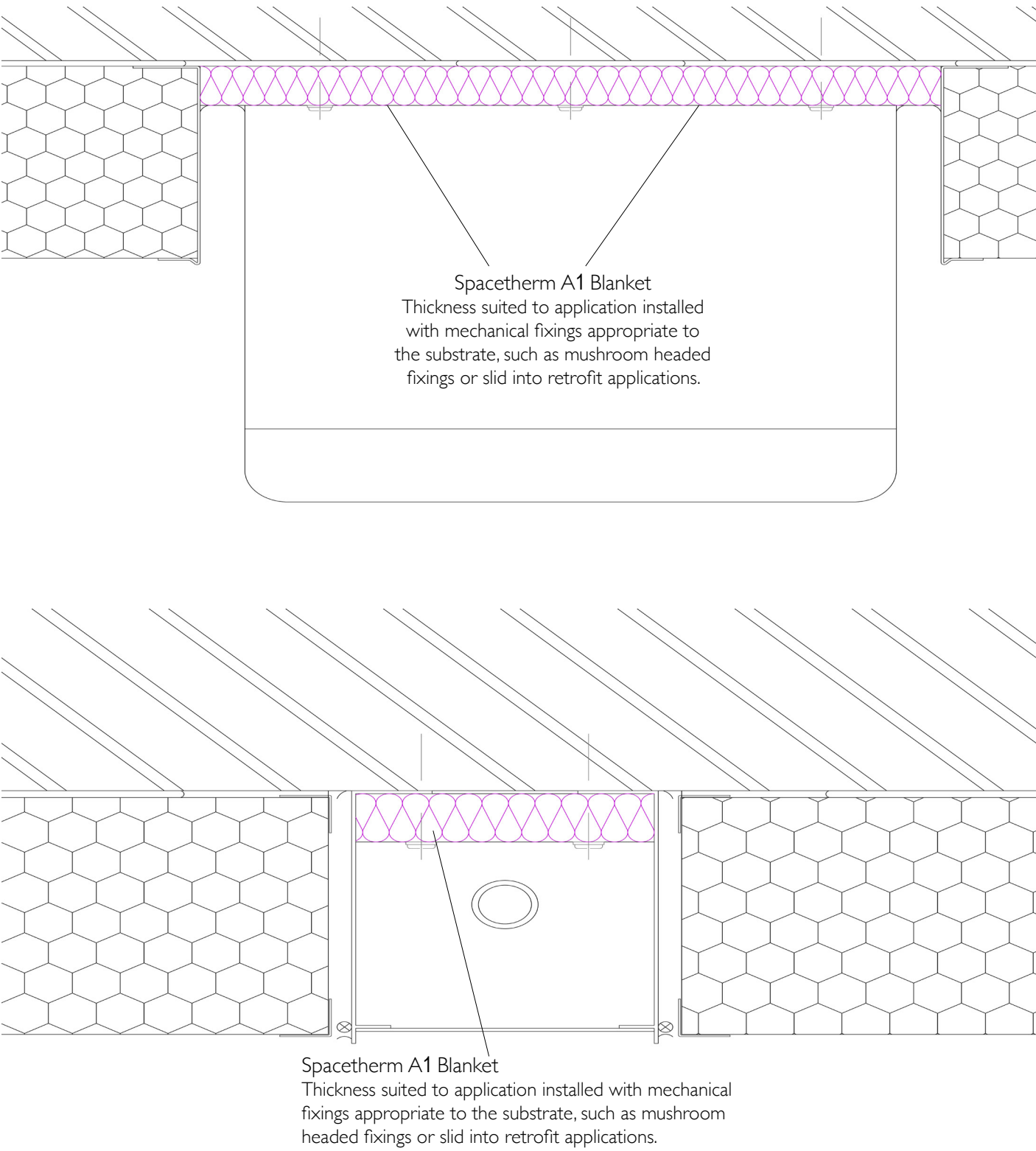


The result has been generated using: **AutoPsi Thermal Modeling Tool: AutoPSI.co.uk**. The details have been calculated in accordance with BR497 2nd Edition 2016.

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4. Services and Meter Box Interfaces

Service penetrations and meter boxes are often overlooked but represent significant localised thermal bridges. Incorporating Spacetherm A1 within inset service zones and meter box surrounds provides targeted thermal upgrading without impacting access requirements, improves overall envelope performance and reduces risk of cold spots around service penetrations.



Construction and Conclusion

Insulation must be installed correctly, with no gaps, misalignments, or excessive compression. Even small defects can significantly reduce effectiveness, so ensuring the material choices and detailing do not introduce unnecessary challenges on site goes a long way to reducing these impacts.

In conclusion, thermal bridging is a fundamental aspect of building performance that cannot be overlooked.

One of the most important things to remember is that continuity of insulation is just as important as insulation thickness itself. A well-insulated wall with poor detailing at junctions and opening can perform worse than a moderately insulated wall with well-designed continuity.

Thermal bridging also highlights the importance of good detailing. Poorly designed or hard to build junctions not only waste energy but can also reduce usable internal space, compromise comfort and increase the risk of condensation.

By addressing thermal bridging from the earliest design stages through to construction and verification, it is possible to create buildings that are not only energy-efficient but also comfortable, durable, and future-ready.

Expertise and know-how to support your project

CONDENSATION RISK ANALYSIS

Condensation can significantly reduce the effectiveness of insulation, and result in damage to the building fabric. A Condensation Risk Analysis evaluates the likelihood of interstitial condensation in your roof or wall construction. These calculations are regularly required by building control to demonstrate compliance with building regulation requirements. Calculations are performed free of charge when using our products.

THERMAL BRIDGING CALCULATION

This software is designed to support designers and specifiers obtaining PSI values and further address the issue of achieving a healthy building with the output including surface temperature factor, or fRSI. Where the calculated PSI value gives a value for heat loss, the surface temperature factor indicates the internal surface temperature at the junction detail.

Using the PSI value and, in particular, the fRSI calculated by the software, the specialist technical team at the Proctor Group can then advise on appropriate solutions utilising our ultra-thin Spacetherm® insulation solutions as well as our extensive range of membranes, if required, to contribute to the overall building performance goals.

BIM DATA

Available through NBS Chorus and NBS Source, specifiers can now access a full suite of digital products and technical specifications for many of our product solutions. The collaboration with NBS provides architects and designers with a technical specification writing service. In addition, specifiers have access to the manufacturer's specification data, BIM objects, literature and third-party certifications.

U-VALUE CALCULATION

U-value Calculations evaluate the thermal performance of a building element, such as a roof, floor or wall. The building regulations require you to prove the thermal performance obtained by a building element, and a U-value calculation provides this proof.

Designed to assist architects, designers, developers, and contractors to accurately carry out assessments to ensure compliance with the latest requirements of the Part L building regulations. The software is an essential online tool for meeting the new standards and improving the energy performance of new and existing buildings.

Discover more by clicking the links



Case Study - Grade II listed townhouse, Bath

A Grade II listed Georgian townhouse in the historic city of Bath is set to become more energy efficient following the installation of Spacetherm® Multi insulation.

The challenge of dealing with heating inefficiencies, major heat loss and high heating costs are a common problem with many listed buildings and solid wall dwellings.

Property owner Mike Mower explains, "I obtained planning permission to insulate the top floor of my Grade II listed Georgian townhouse as it is single skin 6" Bath stone (Oolite) and very heat inefficient, all walls have the original lime render and skim and so they need to breathe. The property in Bath was built in 1818 and has been in my family for 101 years since 1919! I am the 3rd generation to live in it and it was last renovated in 1935 so it needs serious upgrading!

"The architect originally specified another insulation but this would have required encroaching 100mm into the room and would necessitate moving door frames and rebuilding window reveals. After extensive research, I identified the Spacetherm Multi aerogel product from the A. Proctor Group.

"The architect was so impressed by the thermal efficiency of the Spacetherm Multi. With a total thickness of 20mm when rendered, this will not encroach onto the floor space, and the door frames and windows will not need to be altered. Subsequently we included Spacetherm Multi on the planning application as an alternative to the traditional insulation originally specified, which was approved by the Conservation officer and building control."

The renovation of the house is being managed and installed directly by the owner and a lime plaster finish will be applied professionally by a contractor upon completion of the installation.

At just 16mm thick, the use of Spacetherm Multi has virtually no negative impact on floor space, making it ideal for refurbishment projects where space is at a premium.

Typically, a solid wall will have a U value of around 2.1 W/m²K. Following the application of Spacetherm Multi, this can be reduced to around 0.8 W/m²K, dependent on the wall structure.

Finally, Mike Mower commented "I think Spacetherm Multi is ideal for listed building insulation as it has a minimal effect on the infrastructure



of the original building. It has the potential to be used extensively in old buildings such as we have in Bath where heat loss is at a maximum, the original walls need to be able to breathe when insulated and insulation has hitherto been impossible due to the visual impact encroaching on the listed building. I am also seeking planning permission to use the product to insulate the basement floor and walls."

Case Study - Balloch Farm, Inverness

A homeowner in Inverness has seen immediate benefit from using Spacetherm® Multi insulation boards to insulate existing concrete floors in his traditional farmhouse.

Construction industry professional Gregor MacKinnon wanted to improve the thermal efficiency and comfort of the existing ground floors, while preserving the traditional building fabric as much as possible. He also wanted to avoid the disruption of breaking up the slabs.

After liaising with the Proctor Group technical team, Gregor chose to install 16mm Spacetherm Multi.

The best-performing, commonly available insulation products for slab floors are typically offered in a minimum thickness of 20mm or 25mm. This is thick enough to have a significant impact on existing features such as skirting boards and door thresholds/heights.

Plastic-based insulants are also vapour impermeable, preventing moisture vapour transport through the floor construction.

In contrast, aerogel is hydrophobic, so it does not absorb liquid water in the 'wet slab' scenario (i.e. there is no DPM). At the same time, its vapour openness allows the passage of moisture vapour, reducing the likelihood of the floor build-up 'sweating' and risking mould growth.

Spacetherm Multi features aerogel blanket bonded to magnesium oxide (MgO) board. To upgrade his floor slabs, Gregor chose the 16mm product: 10mm of aerogel bonded to a 6mm board.

Paying a premium for a thin insulation solution, has made it possible to retain kitchen units, skirtings and doors – thereby avoiding additional



costs associated with changing or replacing those items.

Installing the insulation has made an immediate and noticeable difference to the performance of the floors.

"Aerogel is a quality product and an investment," said Gregor. "It's a solution I won't ever need to change, and the installation has made an immediate difference. The environment feels fresher, and there's no moisture build-up or mould risk compared to an impermeable insulation.

"Most importantly, the floors feel good underfoot. I don't find myself running across them because they feel cold to stand on."





“ I believe the success of the A. Proctor Group is down to a solid foundation of innovation backed up by an excellent, loyal and committed team, every one of them playing an important role in our continued success. Scotland provides us with a unique platform to launch our ideas, systems and products. I am fiercely proud of this heritage and our brand.”

Keira Proctor

Managing Director, A. Proctor Group Ltd



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