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DESIGN GUIDE FOR METAL ROOFING AND CLADDING TO COMPLY WITH ENERGY REQUIREMENTS OF UK BUILDING REGULATIONS (2006)

EPIC
ENGINEERED PANELS IN CONSTRUCTION

THE METAL CLADDING & ROOFING MANUFACTURERS ASSOCIATION LIMITED

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Foreword

This publication has been produced as a guide to good practice and construction for use of metal roof and wall cladding to comply with the following parts of the revised Building Regulations – Conservation of Energy

For buildings other than dwellings

- Part AD-L2 :2006 England & Wales
- Part F :2006 Northern Ireland
- Section 6 :2007 Scotland

Guidance is provided for typical profiled metal twin skin and insulated panel systems to aid compliance with the relevant parts of the national calculation methodology used by the above building regulations. The freely available iSBEM (interface for Simplified Building Energy Model) v1.2.a has been used for the examples.

This joint publication has been prepared by The Metal Cladding & Roofing Manufacturers Association Limited (MCRMA) and Engineered Panels in Construction Limited (EPIC) for guidance in the design and use of profiled metal roof and wall cladding.

MCRMA Technical Paper 14 (January 2002) is quoted as a reference document in the AD-L2 2006 for England and Wales and Technical Booklet F for Northern Ireland. This guide updates the sections of MCRMA Technical Paper 14 with new information on the recommended metal cladding junction details and provides guidance on entering metal cladding systems into the National Calculation Methodology.

1.0 Introduction

The European Energy Performance of Buildings Directive (EPBD) requires member states from January 2006 to establish methods of assessing the energy use of buildings. The Building Regulations for England and Wales, Northern Ireland and Scotland are being amended to use a new calculation tool – Simplified Building Energy Method (SBEM) to comply with the directive.

The traditional method of compliance based on limiting U-values for the various building elements with allowance for thermal bridging can no longer be used and is superseded by the whole building method introduced in the new regional Building Regulations.

The new method to demonstrate compliance requires the use of the National Calculation Methodology (NCM) for determining the energy use of the whole building, including the building fabric, lighting, heating, ventilation and cooling system. The NCM uses the SAP rating system for dwellings and residential property and SBEM for buildings other than dwellings. This document does not consider the requirements of the SAP rating system.

This MCRMA/EPIC publication illustrates how -

- Good design of metal clad buildings with roofs of 0.25 W/m^2 K U-value and walls of 0.35 W/m^2 K (0.30 in Scotland) U-value, together with an air permeability no greater than 10 $m^3/(h.m^2)$ can achieve compliance with the required 2006 level of CO_2 emissions.

- Major savings on CO_2 emissions can be achieved by improvements to the controlled services including lighting, heating and, if installed, air conditioning; these savings typically exceed three times those available by changes to the building fabric of metal clad portal frame buildings.

- Good detailing and workmanship on as-built building is essential to achieve compliance. The changes have introduced, for the first time in the UK, checks on services and workmanship at completion and a requirement to verify the as-built performance against the original design concept. This new methodology needs to be understood and explained to the whole construction team. A cheaper component is no longer acceptable unless it has equal or better performance than the original design requirements.

This publication illustrates both basic design details for insulated metal cladding constructions to achieve the default air tightness and limits for thermal bridging (Ψ values) given in table 4 of BRE IP 01/06 and also alternative recommended details to achieve improved Ψ values. The recommended design details and default Ψ values are made available to assist the designer, manufacturer and installers of metal roof and wall cladding on buildings other than dwellings, to achieve levels of best practice for the following critical factors:

- **U-value of the external fabric**
- **Minimise energy loss due to thermal bridging (Ψ values)**
- **Minimise energy loss due to air permeability through the building envelope**
- **Minimise the risk of surface condensation**

Compliance with the above factors is considered in relation to the energy use associated with natural and artificial lighting, heating, forced ventilation and cooling. References are provided to other guidance documents intended to aid compliance and the use of renewable energy sources.

Compliance using the iSBEM method can be demonstrated by meeting five separate criteria as follows:

Criterion 1: **The predicted rate of carbon dioxide emissions from the building (BER) is not greater than the target rate (TER) as defined in the Building Regulation.**

Criterion 2: **The performance of the building fabric and the heating, hot water and fixed lighting systems are no worse than the design limits set out in the Building Regulation.**

Criterion 3: **Those parts of the building that do not have comfort cooling systems have appropriate control measures to limit solar gains.**

Criterion 4: **The performance of the as-built building is consistent with the prediction made in the BER.**

Criterion 5: **The necessary provisions for enabling the efficient operation of the building are put in place.**

Approved Document L2A 2006 edition, Conservation of fuel and power in new buildings other than dwellings of Building Regulations England and Wales states:-

Building fabric

67 The building fabric should be constructed to a reasonable quality so that:

a. The insulation is reasonably continuous over the whole building envelope; and

b. the air permeability is within reasonable limits.

Continuity of insulation

68 The building fabric should be constructed so that there is no reasonably avoidable thermal bridges in the insulation layers caused by gaps within various elements, at joints between elements and at edges of elements such as those around window and door openings.

69 Reasonable provision would be to:

a. Adopt design details such as

ii. For cladding systems, to adopt the guidance given in the MCRMA Technical Note; or

b. to demonstrate that the specified details deliver an equivalent level of performance using the guidance in BRE IP 01/06.

This publication illustrates the design of insulated metal cladding constructions to achieve the default Ψ values given in Table 4 of BRE IP 01/06. These same default Ψ values are available from the menu for *junctions including metal cladding* in iSBEM.

The Building (Scotland) Regulations Section 6 does not quote either BRE IP 01/06 or any MCRMA Technical Paper as reference documents. However, calculation using BRE iSBEM is an approved method of demonstrating compliance in Scotland and will involve the use of some junction Ψ values for metal cladding.

Members of EPIC and MCRMA should be able to provide improved designs with Ψ values calculated or tested to the approved methods, for use in SBEM calculations to demonstrate compliance with the regional variations of the UK Building Regulations. Guidance is given in this document where particular junction details may be improved to significantly reduce the energy loss to aid with compliance.

2.0 Insulation - U-values

With the exception of Part F – Northern Ireland, the U-values for roof and wall cladding have not changed since 2002 see table 1. The calculation of U-values for metal faced cladding systems continues to use the methods introduced in 2002, updated in BR 443: Conventions for U-value calculations, 2006 edition as summarised in Appendix A of this publication.

In general, the cladding manufacturer will provide U-values for their system either based on calculations or testing to one of the methods in the documents listed in the relevant part of the regional Building Regulations.

Building Control bodies may ask for proof that U-values have been determined in an approved manner by competent persons. Designers and contractors should therefore satisfy themselves before purchase that system manufacturers quoted values are appropriate for the intended use.

- There is a common misconception that the 2006 changes require about 25% better insulation to comply with the energy saving target. In fact, 25% thicker insulation will NOT achieve compliance, because the new methodology now encompasses air tightness and the whole range of emission factors for the different fuel types including heating, ventilation and lighting such that the required CO_2 saving CANNOT BE ACHIEVED BY ONE FACTOR ALONE.

In addition to U-value the thermal mass of the cladding element (Cm kJ/m^2) is used in the iSBEM calculation to determine the effects of intermittent heating etc.

The typical target U-value and Cm value for metal faced cladding elements are quoted in Table 1 for the regional variations of the Building Regulations.

The following assumptions have been made about values quoted by the system manufacturer:

- The values will have been determined by a competent person using one of the methods quoted in the Building Regulations.
- The quoted U-value for the plane area of a built-up twin skin system includes the numerical value for the thermal bridge caused by any spacer system or through fixing.
- The quoted U-value for the plane area of an insulated panel system includes the numerical value for the thermal bridge at side laps and any through fixings.
- The Cm values include an average thermal mass for a steel portal frame and sheeting rails on the heated side of the liner face. Wall systems with the sheeting rail between liner and external face or external columns may therefore have different Cm values.

The performance requirements for extensions and refurbishment of existing buildings may vary from those shown in table 1 of this document, for England and Wales refer to the separate document AD-L2B.

Element	Limiting area-weighted average U-value (W/m^2 K)	Thermal mass average (kJ/m^{2}K)
Wall- metal built-up systems and metal faced insulated panels	0.35 (except 0.30 for Scotland)	7.0*
Floor	0.25	
Roof - metal built-up systems and metal faced insulated panels	0.25	7.0*
Windows, roof window, rooflights and curtain walling	2.2	
Pedestrian doors	2.2	
Vehicle access doors	1.5	
High usage entrance doors	6.0	
Roof ventilators (inc. smoke vents)	6.0	

*Thermal mass see section 3.

Table 1: New Construction - U-value and thermal mass

The method of calculating U values is set out in BRE Report 443 2006 edition. BRE U-value calculation programme and other software packages may be used to determine the effective U value of plane elements for example, floors for entry into iSBEM; however, built-up metal systems and insulated panels require the use of finite element analysis to include repeating thermal bridges at, for example, interlocking joints and spacers.

3.0 Thermal mass Cm value

The limiting U-value 2.2 W/m^2 K for rooflights quoted in AD-L2A Table 4 is based on the U-value having been assessed with the rooflight in the vertical position. Current versions of iSBEM including v1.2.a use a default U-value = 1.83 W/m^2 K for triple layer rooflights which is adjusted to about 2.2 U-value in the horizontal plane within the calculation of CO_2 emissions. When entering the rooflight U-value in iSBEM it is necessary to check which value has been quoted by the manufacturer (horizontal or vertical) and enter a vertical or worst case value in iSBEM. Current versions of ISBEM will incorrectly print a non compliance message if the permitted limiting 2.2 W/m^2 K U-value is entered, this will, we understand, be corrected in future versions.

Roof ventilators including smoke vents are not included the CO_2 emissions calculation with the current version of iSBEM, although they appeared in earlier versions.

The area-weighted average U-value for each element is calculated using the following formula -

$$U_{av} = \frac{(U_1 \times A_1) + (U_2 \times A_2) + (U_3 \times A_3) + \ldots}{A_1 + A_2 + A_3 + \ldots}$$

For metal cladding using built-up systems and insulated panels the U-value quoted by the system manufacturer will be the weighted average including any spacers, side lap joints and fixings.

If the design includes other components (excluding windows, rooflights and doors which are elements with their own U-value limits) for example, vertical feature trims around columns, the weighted average for the wall elevation may need to be calculated.

When the set air temperature in a building is varied to reflect the hours of use, the thermal mass of the building will influence the energy input for heating. The temperature of the internal walls and floors will be affected by the internal air temperature.

A building with high thermal mass components will require more energy to raise the air temperature but will remain warm for longer periods if the heating is turned off. A building with low thermal mass will be quicker to heat for the same energy but with little heat storage the air temperature will vary with the heat settings.

A European Standard is being written on the method for calculating effective thermal capacity of an element (Cm value). The method may be summarised as follows:-

Calculate the contribution of each layer of construction as
Density (kg/m^3) × thickness (m) × specific heat capacity kJ/(kg K).
Add the contribution of each layer together to give the Cm value for the element according to the following rules

- Until the total thickness of layers from the internal face exceeds 0.1 m.
- or until the mid-point of the construction is reached.
- or until an insulating layer (defined as having a thermal conductivity of 0.08 W/mK or less is reached).

The Cm value may therefore include an average thermal mass for any steel portal frame and sheeting rails on the heated side of the liner face. Typical metal cladding systems referred to in this publication will only have a 0.4 to 0.7mm thickness metal liner on the internal face of the insulation. Wall systems with the sheeting rail between liner and external face or external columns, may therefore have different Cm values.

BRE iSBEM contains a data base of element constructions with U-values and Cm values. Versions up to and including v1.2.a, have assorted Cm values for otherwise similar cladding constructions in the range 0.7 to 0.25 U-value.

MCRMA/EPIC calculations for typical portal frame buildings with metal cladding systems have determined values in the range 3 to 10 kJ/m^3 K with an average of 7 kJ/m^3 K. It is recommended that a value of 7 kJ/m^3 K is used for metal cladding roof and wall systems in iSBEM until the assorted values quoted in v1.2.a and earlier versions have been amended.

4.0 Thermal bridging Ψ values

A method to assess the additional heat loss through repeating thermal bridges was introduced by the England and Wales Part AD-L2: 2002. The additional heat loss for junctions for example, roof to wall at the eaves is calculated as a linear heat loss coefficient Ψ value (Psi value) W/mK.

System manufacturers should provide Ψ values calculated by competent persons to an approved method for typical junction details. Currently Ψ values may be calculated using finite element computer programmes certified to comply with the method of BS EN ISO 10211. Work is on-going to refine the method and provide approved calculations which will be acceptable to Building Control bodies without further justification.

Worst case basic junction details are illustrated in sections 8 and 9 of this publication which meet the BRE IP01/06 values which can be selected from the library in iSBEM for metal cladding. These thermal bridge values may be used for insulated metal twin skin (section 8) and insulated panel systems (section 9) provided the junction complies with the relevant illustration and is built to a reasonable standard of workmanship including continuity of insulation and air seals.

Alternative recommended junction details are illustrated in both section 8 and 9 which limit energy loss through the junction and will provide savings of CO_2 emissions from the building envelope.

Using the recommended MCRMA/EPIC details and corresponding Ψ values will therefore provide a saving of CO_2 emissions for the actual building BER and resultant target TER. Alternative details for lower and more energy efficient Ψ values may be provided by system manufacturers for most of the common junctions.

The building plan and elevation dimensions, except for height, are not entered into iSBEM, the program therefore makes assumptions about the length of a limited number of junction and height/width of windows etc., which may lead to inaccuracies. In particular, only one roof-wall Ψ value is entered which includes both the eaves and any verge.

Roof-wall Ψ value

The equation used by iSBEM to calculate the combined eaves & verge detail:-
Roof-wall Ψ value = ⅓ × (2 × eaves Ψ value + 1 × verge Ψ value)

e.g. using BRE IP 01/06 metal cladding library values
Roof-wall = ⅓ × (2 × 0.32 eaves + 1 × 1.15 verge) = 0.60 W/mK.

A more flexible approach is to sum the actual types of each roof junction length × Ψ value divided by the total perimeter length. For example, four sided roof of 200m perimeter with parapet and boundary wall gutters at the eaves
Roof – wall = (120m × 0.79.Ψ parapet & gutter + 80m × 0.34 Ψ verge & parapet)/200m = 0.61 W/mK.

If Ψ values are used in the iSBEM calculation in place of the default or library value, then these will be identified in the iSBEM compliance report. Where better values are used, Building Control bodies may request justification and copies of calculations to an approved method.

Other thermal bridges

Other thermal bridges for example, valley gutters which are not included in the standard menu can be entered into iSBEM. The current methodology does not include them in the calculation of energy loss from the Notional Building, therefore their inclusion will result in a disproportionate penalty on the actual building BER and TER against the Notional Building benchmark unless the best recommended details are adopted and correctly installed.

As a matter of good practice, designers should adopt details which minimise thermal bridging irrespective of the requirements of compliance with the NCM and Building Regulations.

Ψ values: regional versions of Building Regulations

The Building Regulations England and Wales and Northern Ireland quote BRE IP01/06 as the reference document for Ψ values. The Ψ values shown in this document are calculated in accordance with the methods quoted in BS EN ISO 10211 and BRE IP 01/06.

The Regulations (Scotland) quote Ψ values for typical traditional constructions but do not refer to IP 01/06 or other sources of evaluated Ψ values for constructions including metal cladding.

In all three regions the Ψ values used in iSBEM calculations may need to be justified by demonstrating compliance with the method given in BS EN ISO 10211.

5.0 Condensation risk

Minimising condensation risk should be a design criteria for all buildings for which Building Regulations refer to the methods of BS 5250. Especially with high humidity environments such as swimming pools, designers have to take measures to minimise the risk of surface condensation which may form near thermal bridges. **Condensation risk analysis is not included in the compliance requirements of NCM, but is directly related to best practice for details with the minimum thermal bridge**.

BS 5250: 2002 establishes five classes of internal humidity by the intended use of the building as shown in Table 2.

Insulated metal systems which comply with the U-value for Building Regulations will not normally be at risk of surface condensation unless there is a significant thermal bridge.

A surface temperature factor f_{min} value is calculated by the approved software programs used to determine Ψ values for thermal bridging. Table 2 shows typical building use with the expected humidity class and minimum f value necessary to minimise the risk of condensation forming near thermal bridges.

Humidity class	Building type/use	Minimum f value
1	Storage areas	0.30
2	Offices, shops	0.50
3	Dwellings with low occupancy	0.65
4	Dwellings with high occupancy, sports halls, kitchens, canteens; Buildings heated with un-flued gas heaters.	0.80
5	Special buildings for example, laundry, brewery, swimming pools	0.90

Table 2: Internal humidity classes defined by BS 5250 and the minimum temperature factor recommended by building use

The junction details illustrated in sections 8 and 9 of this publication have f values suitable for use in humidity class 1 to 3.

The recommended details are suitable for more humid conditions, but designers should consult the system manufacturer for full product recommendations in the more severe conditions for example, swimming pools.

6.0 Air permeability

Air permeability testing of completed buildings is mandatory in almost all cases of new build in England and Wales from April 2006 and in Northern Ireland from November 2006. The Scottish Regulations include the same air permeability limit for use in compliance with the NCM, although testing buildings at completion is only mandatory if a lower limit is selected.

The England and Wales Building Regulations require that the completed building envelope is tested for air permeability and achieves a standard of no more than 10 $m^3/(h.m^2)$ at 50 Pa pressure.

Better, that is, lower design values of air permeability may be used for iSBEM compliance calculations, however the completed building envelope will have to achieve the stated lower rate when tested.

The details illustrated in sections 8 and 9 of this publication are intended with a reasonable standard of workmanship to achieve the limit of 10 $m^3/(h.m^2)$ at 50 Pa. for metal cladding sections of the envelope. Air permeability is measured for the whole envelope and therefore poor quality air sealing of other materials and components forming the air barrier may cause greater air loss than achieved through the metal cladding.

Metal cladding manufacturers will be able to provide junction details for their systems which achieve lower air permeability values than the Building Regulations limit. Where these enhanced details are used with limited areas of other materials also designed to minimise air leakage, designs may consider adopting lower air permeability values.

As building size increases the length of junctions in metal cladding which may leak, air reduces and the area of almost impermeable metal cladding increases. As a result the air permeability of large buildings should reduce as floor area increases. The values in Table 3 are suggested as achievable with metal clad buildings built to a reasonable standard of workmanship.

Plan area of metal clad building	Air permeability
0 to 2,500 m^2	10.0 $m^3/(h.m^2)$
2,501 to 10,000 m^2	7.5 $m^3/(h.m^2)$
over 10,000 m^2	5 to 6 $m^3/(h.m^2)$

Table 3: Guidance on air permeability vs building size

7.0 Junction details - introduction

The common types of metal cladding junction which have to be entered in iSBEM calculations are illustrated in section 8 for built-up metal cladding and section 9 for insulated panel cladding. In each case a basic design is illustrated which will at least equal the corresponding worst case Ψ value as quoted in table 4 of BRE IP 01/06. These values are available from the default menu in iSBEM.

Recommended details with better Ψ values are also illustrated for most junctions which if adopted will aid compliance with the building's target emissions. Specific systems may include improved designs which should be used to achieve best practice.

The pages may be copied and used as a checklist for the design against SBEM calculations.

BRE IP 01/06 gives advice that where the Ψ value of a particular junction detail is unknown, but where the junction detail is as recommended in MCRMA/ EPIC Technical Paper 17 for metal cladding constructions, then the value of Ψ can be taken to be the Ψ value for the equivalent junction detail or it can be taken to be the default value from Table 4 of IP 01/06 as appropriate.

The BRE IP 01/06 values for junctions including metal cladding are included as the library defaults in iSBEM, with the exception of roof-wall as explained in section 4.

Junction detail	Library Ψ value for corresponding IP 01/06 details in iSBEM	Detail No. for detail to IP 01/06 criteria	
		Built-up metal	Metal panels
Roof –wall (combines eaves & verge)	0.6	1&2	11&12
Wall ground floor	1.15	3	13
Wall-wall corner	0.25	4	14
Wall floor not ground	0.07	5	15
Lintel above window or door	1.27	6	16
Sill below window	1.27	7	17
Jamb at window or door	1.27	8	18

Table 4: Summary of Ψ values found in iSBEM

8.0 Junction details - built-up metal cladding

8.1 The Ψ value quoted in Table 4 of BRE IP 01/06 metal cladding values are included in the menu of iSBEM and may be selected as junctions including metal cladding as IP 01/06.

8.2 Constructed with adequate site workmanship these basic details comply with the requirements of the Building Regulations for insulation as a minimum standard which can and should be improved in the actual design.

8.3 MCRMA and EPIC members have produced generic details with improved Ψ values shown in each case as figure b; these designs will reduce CO_2 emissions by reducing energy loss through the junction. This can provide a reduction on the total building CO_2 emissions.

8.4 System manufacturers should be able to provide other details using their products with Ψ values, calculated by competent persons, which can be substituted for those illustrated in this guide. These alternative values can be manually entered in iSBEM. Building Control bodies may require proof that any such improved values are correct and have been used in the actual construction.

Detail 1 eaves with gutter for built-up systems

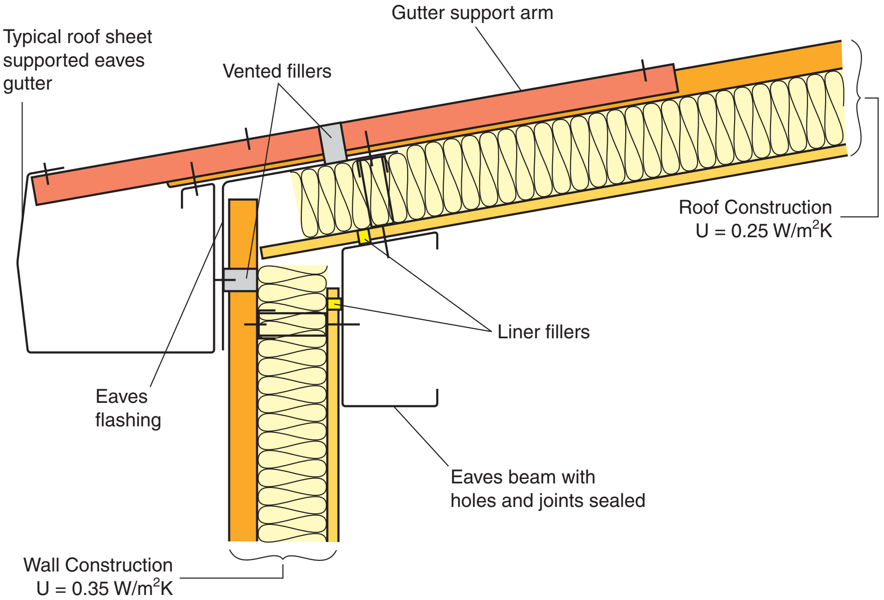

Fig 1a Basic eaves and gutter
Built-up metal roof construction of 0.25 U-value and 0.35 U-value wall. Roof liner extends to almost touch the outer sheet or trim of wall, air gap between wall and roof.
Ψ value = 0.25 W/mK **f_{min} = 0.76**

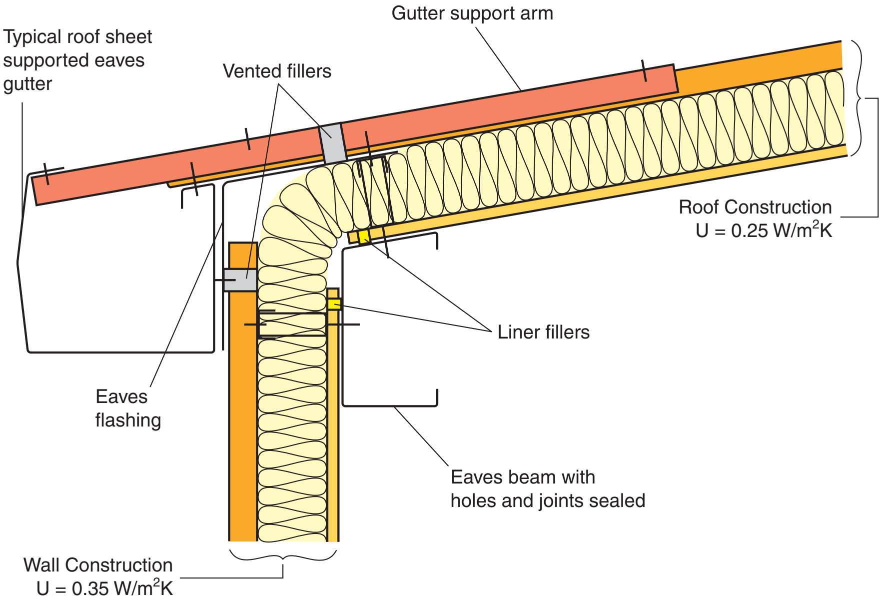

Fig 1b Recommended design for eaves
as fig 1a above but the liner sheets do not cross the insulation which is continuous from wall to roof.
Ψ value = 0.02 W/mK **f_{min} = 0.95**

Key features
- Roof supported gutter avoids thermal bridge issues. Gutters with brackets fixed to walls might require additional supports, and create thermal bridges.
- Seal all holes and joints in eaves beam to avoid bypassing liner seals.
- All fixings and seals must be to manufacturer's recommendations.

iSBEM menu provides a single roof-wall Ψ value, not the IP 01/06 eaves value.
(see section 4 calculation method for combined roof-wall Ψ value)
MCRMA & EPIC Technical Paper 17- detail No. 1 – built-up metal system

Detail 2 verge for built-up metal system

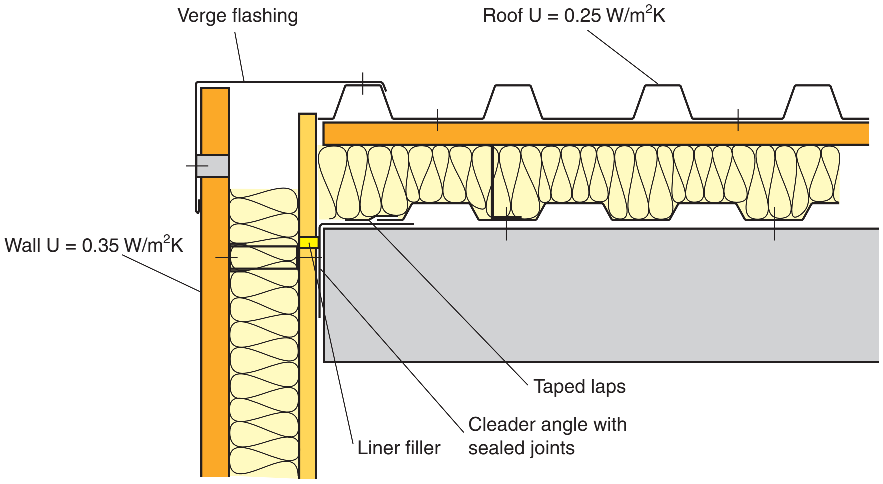

Fig 2a Basic verge for built-up metal roof & wall
Built-up system with either roof or wall liner sheet bridging across insulation.
Ψ value = 0.28 W/mK **f_{min} =0.79**

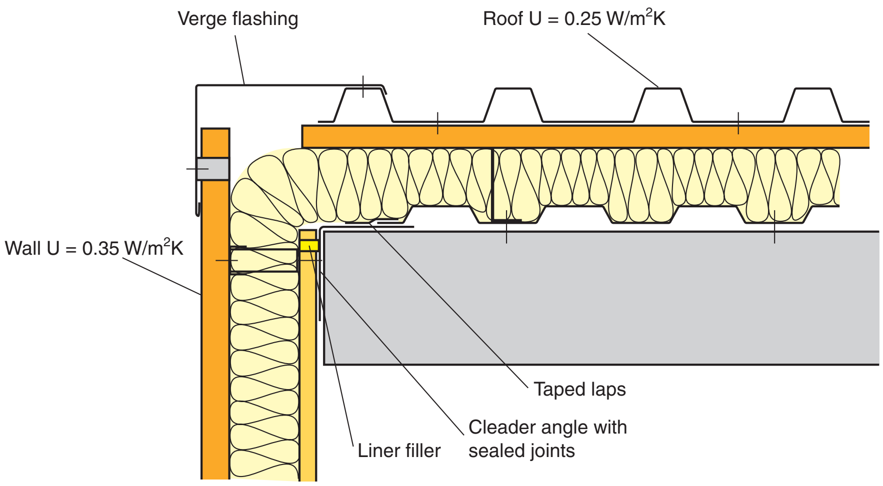

Fig 2b Recommended design for verge
As fig 2a above but with liner sheets that do not cross the insulation which is continuous from wall to roof.
Ψ value = 0.02 W/mK **f_{min} = 0.95**

Key features

- Cleader angle required to provide structural support and air sealing between purlins. Joints must be structural and not interfere with seals.
- Fasteners securing cleader angles to purlins must not interfere with seals.
- Seal all holes and joints in cleader angles to avoid bypassing liner seals.
- All fixings and seals must be to manufacturer's recommendations.

iSBEM menu provides a single roof-wall Ψ value, not the IP 01/06 verge value.
(see section 4 calculation method for combined roof-wall Ψ value)
MCRMA & EPIC Technical Paper 17- detail No. 2 – built-up metal system

Detail 3 drip sill (junction at base of cladding wall)

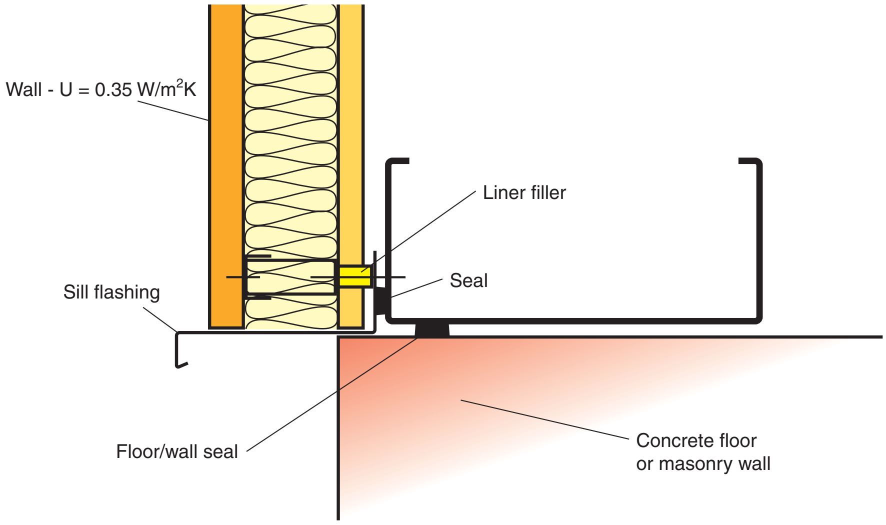

Fig 3a Basic drip sill below wall
Wall to floor junction with little or no wall insulation below floor level.
Ψ value = 1.15 W/mK **f_{min} = 0.48**

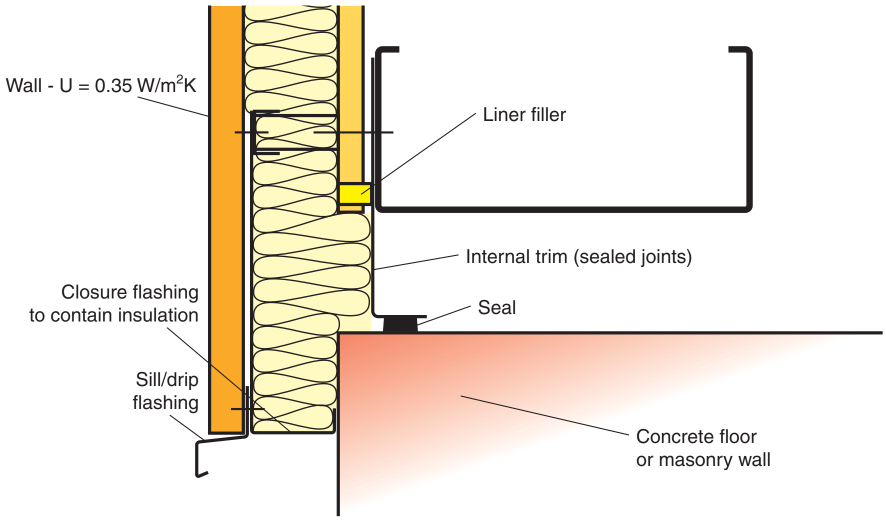

Fig 3b Recommended design for drip sill
Wall insulation extends down side of floor slab and drip fixed to outer sheet so that it does not bridge insulation. Floor slab k = 1.0 W/mK.
Ψ value = 0.75 W/mK **f_{min} = 0.71**

Key features

- The same principles of construction apply to vertical or horizontal profiled external metal cladding.
- Thermal bridging is minimised in the metal construction, provided that the insulation covers at least 100mm of wall/floor.
- The Ψ value is largely controlled by the wall/floor materials, light weight blocks for example will improve the Ψ value. Floor assumed 250mm thick and k = 1.0 W/mK.
- Internal trim should be typically 1.5mm thick, with sealed joints.
- The seal at wall/floor junction must be substantial to cater for inevitable variation in concrete/masonry.
- Ensure internal trim fixing heads do not compromise air seals. Use rivets, or remove temporary hex head types, as work progresses.
- All fixings and seals must be to manufacturer's recommendations.

Basic IP 01/06 metal cladding Ψ = 1.15 W/mK quoted in iSBEM menu.
MCRMA & EPIC Technical Paper 17- detail No. 3 – built-up metal system

Detail 4 corner (junction between two perpendicular cladding walls)

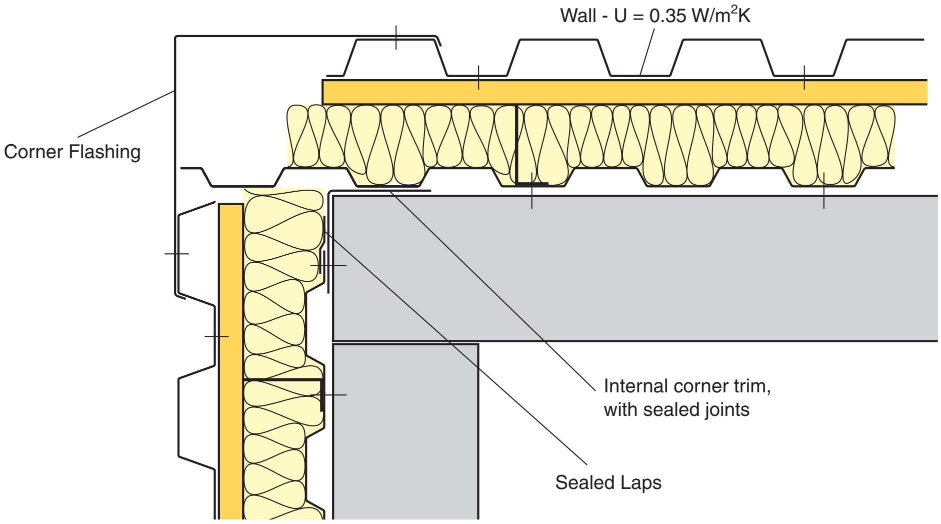

Fig 4a Basic insulated corner
Built-up cladding with liner bridging insulation
Ψ value = 0.25 W/mK **f_{min} = 0.76**

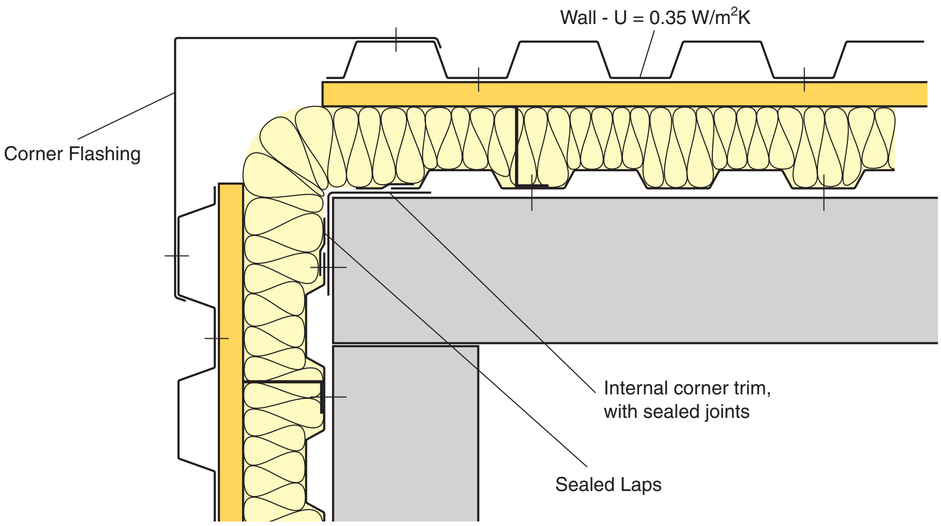

Fig 4b Recommended design for insulated corner
As fig 4a above but the liner sheets do not bridge across insulation which is continuous around corner.
Ψ value = 0.02 W/mK **f_{min} = 0.95**

Key features

- The same principles of construction apply to vertical or horizontal profiled external metal cladding.
- The liners must be sealed to the corner trim or cleader and fixed as necessary to ensure the seal is effective in the long term.
- The insulation fitted around the corner must be continuous.
- The same principles can be used for internal corners.
- Ensure internal trim fixing heads do not compromise air seals. Use rivets, or remove temporary hex head types, as work progresses.
- All fixings and seals must be to manufacturer's recommendations.

Basic IP 01/06 metal cladding Ψ = 0.25 W/mK quoted in iSBEM menu.
MCRMA & EPIC Technical Paper 17- detail No. 4 – built-up metal system

Detail 5 wall – floor (not ground floor)

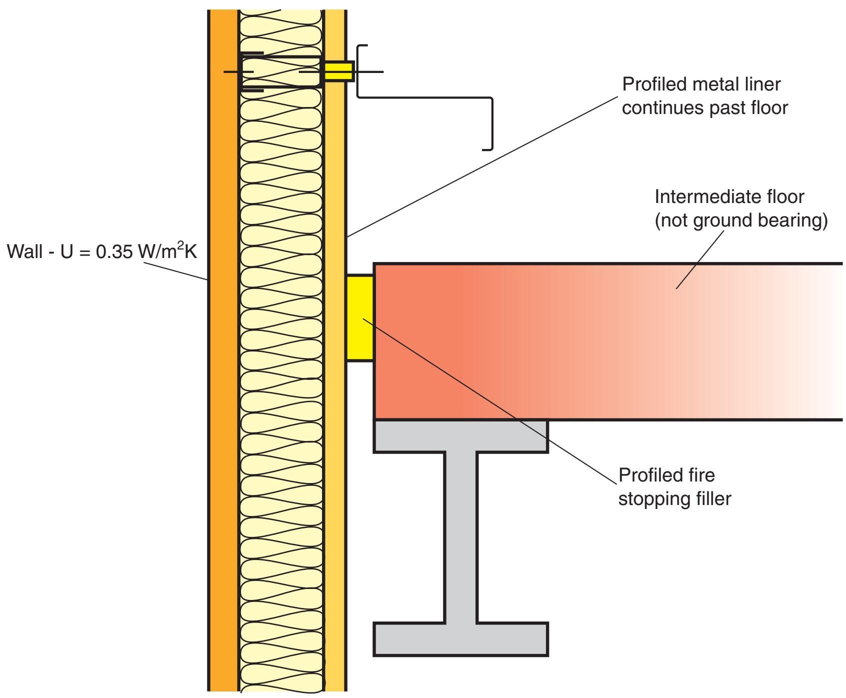

Fig 5

Ψ value = 0.0 W/mK **f_{min} = 1.0**

Note. There is no common detail for metal cladding where the floor structure creates a thermal bridge through the metal clad wall insulation.

Key features

- The same principles of construction apply to vertical or horizontal profiled external metal cladding.
- Identical detail for built-up metal and insulated panel systems, primary fasteners and any spacers included in U value calculation of the external wall.
- External cladding continues at full thickness pass the floor (does not apply to ground floor) and is fixed to sheeting rails.
- No fasteners penetrate the wall insulation and floor or support beam.

Gap between floor and wall liner is filled with insulation e.g. fire stopping product.
Basic IP 01/06 metal cladding Ψ = 0.07 W/mK quoted in iSBEM menu.
MCRMA & EPIC Technical Paper 17- detail No. 5 – built-up metal system

Detail 6 window or door head

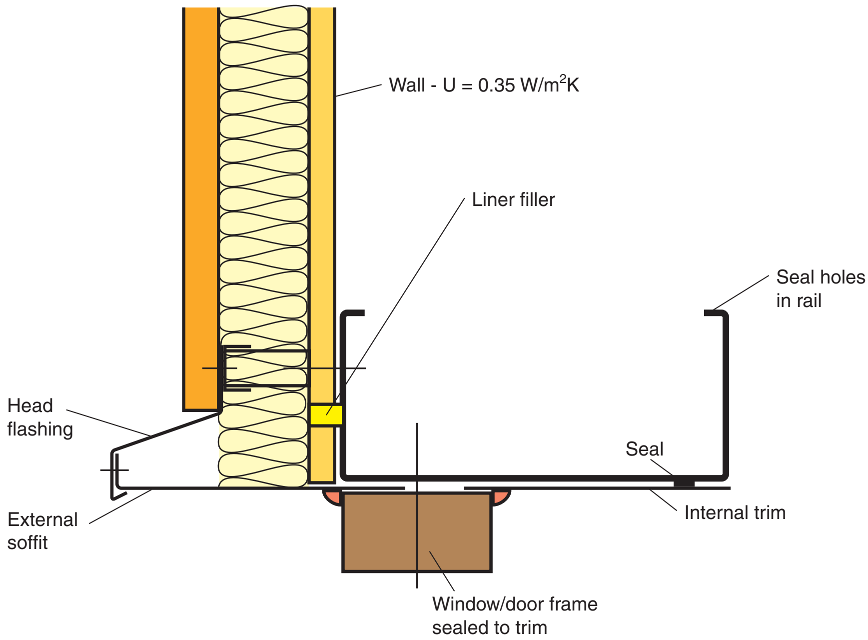

Fig 6a Basic window or door head
Ψ value = 1.27 W/mK **f_{min} = 0.46**

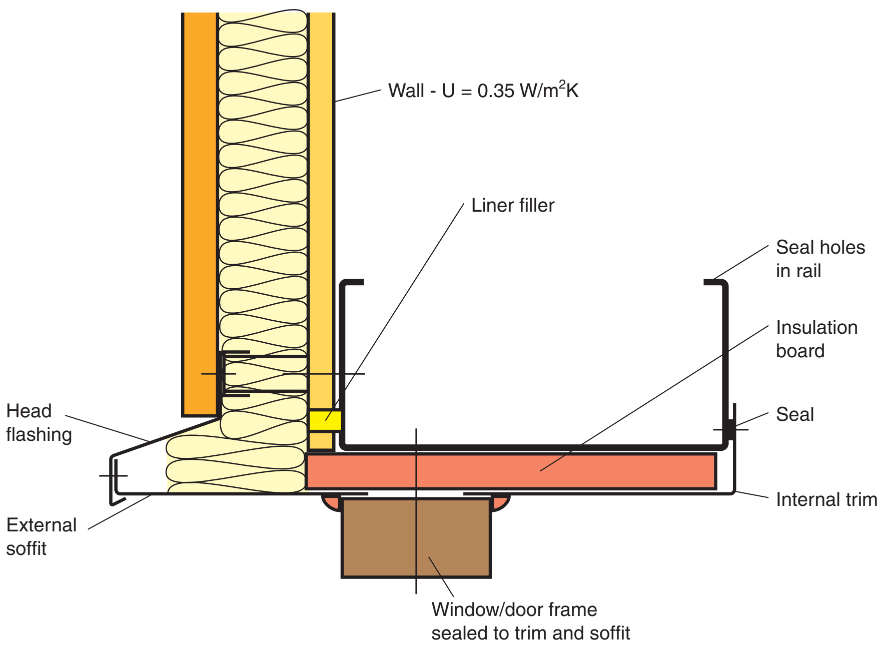

Fig 6b Recommended design with insulation board between soffit and rail
Ψ value = 0.05 W/mK **f_{min} = 0.95**

Key features
- The same principles of construction apply to vertical or horizontal profiled external metal cladding.
- An insulation board should be fitted between both external soffit/internal trim and rail.
- It is important to keep the soffit flashing separate from the internal trim.

Basic IP 01/06 metal cladding Ψ = 1.27 W/mK quoted in iSBEM menu.
MCRMA & EPIC Technical Paper 17- detail No. 6 – built-up metal system

Detail 7 window sill

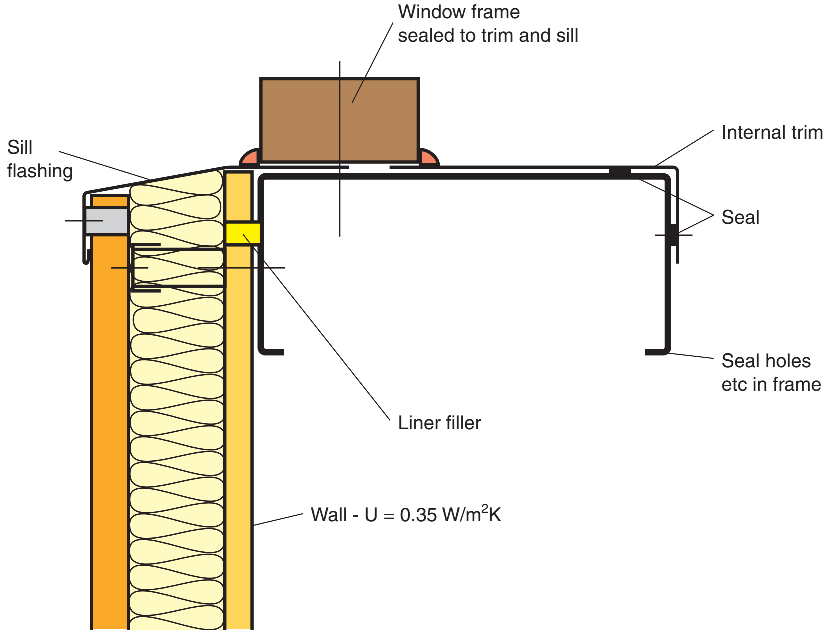

Fig 7a Basic design for sill

Ψ value = 1.27 W/mK **f_{min} = 0.46**

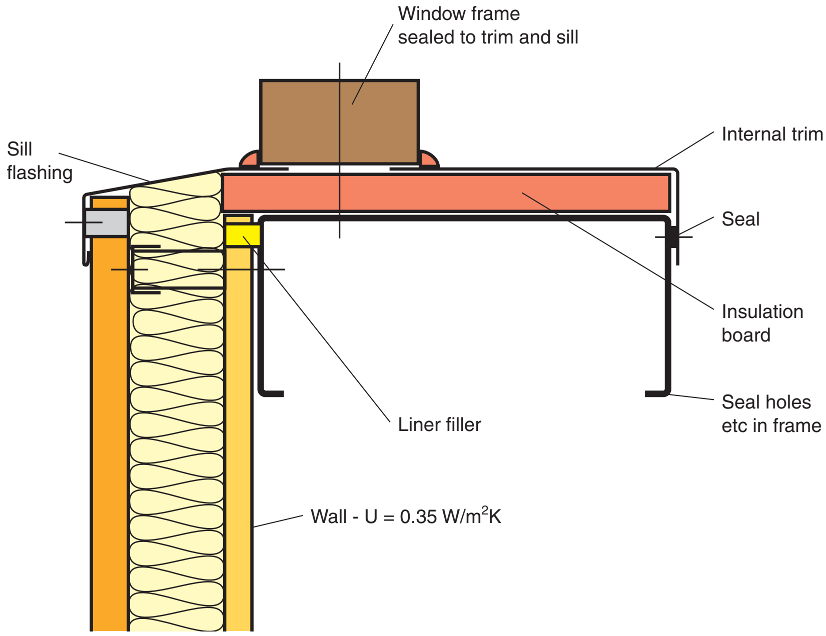

Fig 7b Recommended design for an insulated sill

Ψ value = 0.05 W/mK **f_{min} = 0.95**

Key features

- The same principles of construction apply to vertical or horizontal flat or profiled external metal cladding.
- An insulation board should be fitted between both external sill/internal trim and rail.
- It is important to keep the sill flashing separate from the internal trim.

Basic IP 01/06 metal cladding Ψ = 1.27 W/mK quoted in iSBEM menu.

MCRMA & EPIC Technical Paper 17- detail No. 7 – built-up metal system

Detail 8 window or door jamb

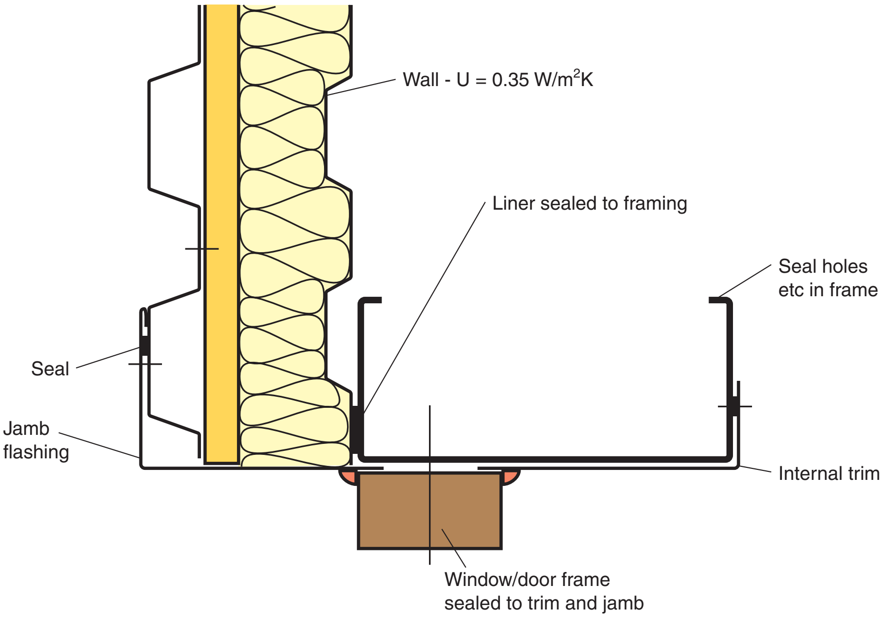

Fig 8a Basic jamb for window or door frame
Ψ value = 1.27 W/mK **f_{min} = 0.46**

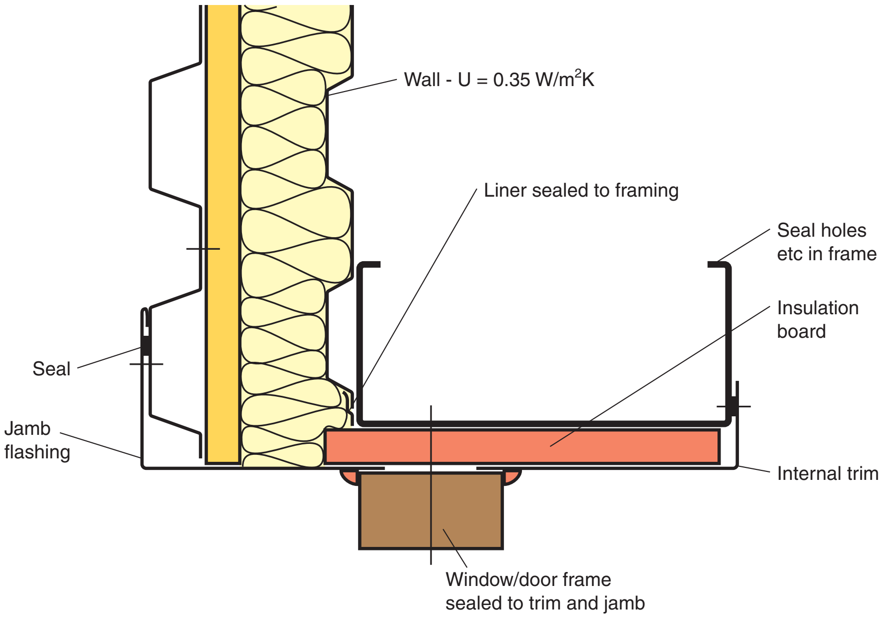

Fig 8b Recommended design for an insulated jamb
Ψ value = 0.05 W/mK **f_{min} = 0.95**

Key features

- The same principles of construction apply to vertical or horizontal flat or profiled external metal cladding.
- An insulation board should be fitted between both external jamb/internal trim and rail.
- It is important to keep the jamb flashing separate from the internal trim.

Basic IP 01/06 metal cladding Ψ = 1.27 W/mK quoted in iSBEM menu
MCRMA & EPIC Technical Paper 17- detail No. 18 –insulated panels

Detail 9 valley gutter for built-up metal system

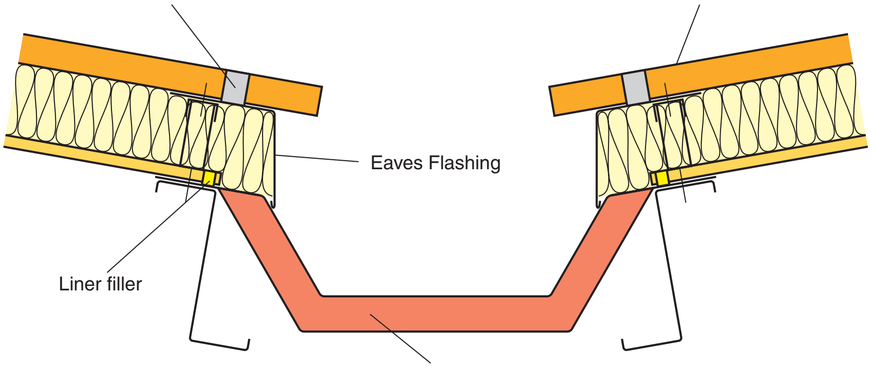

Fig 9 Valley gutter

Built-up metal roof of 0.25 U-value roof and 0.35 U-value gutter.

Ψ value = 1.95 W/mK **f_{min} = 0.64**

Improved Ψ values are available for particular systems with thermal breaks at gutter head e.g. , Ψ value = 0.39 W/mK f_{min} = 0.95, consult manufacturer for details.

Key features

- Gutter thickness and thermal bridging detail will vary, depending on manufacturer; manufacturer's accredited designs may have Ψ values better than 0.50 W/mK.
- Ideally, the metal gutter outer surface should not bridge the insulation layer.
- In all designs the roof liner should not bridge the gutter insulation layer.
- If the gutter is a traditional pre-2002 design, the thermal bridge value will exceed that quoted.
- Insulation must fill the gutter liner, leaving no voids.
- All joints in gutter flanges must be sealed.
- All fixings and seals must be to manufacturer's recommendations.

No Ψ value for a valley gutter is quoted in iSBEM menu, the Ψ value and gutter length can be added on the roof construction input page.

MCRMA & EPIC Technical Paper 17- detail No. 9 – built-up metal systems

Detail 10 ridge trim built-up metal system

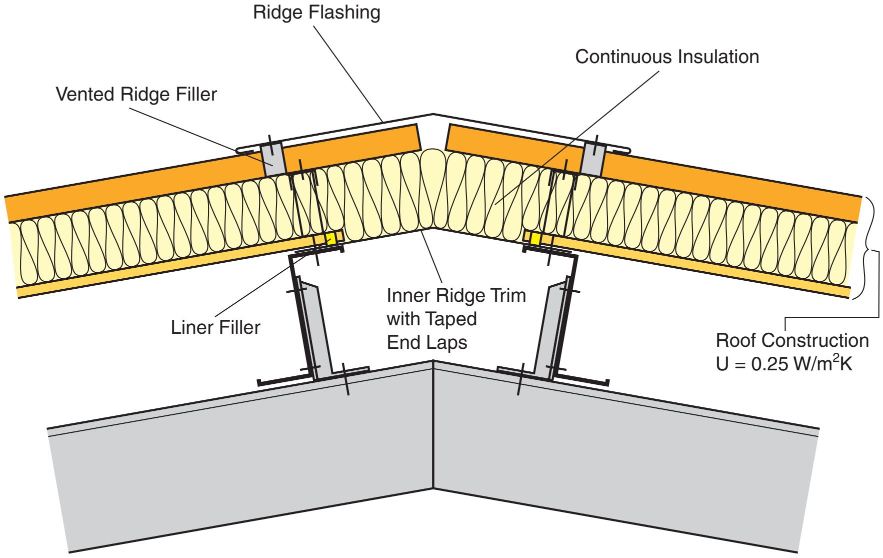

Fig 10 Ridge Trim – built-up metal roof construction of 0.25 U-value.

Ψ value = 0.01 W/mK **f_{min} = 0.95**

Fully insulated as shown a ridge trim should not form a significant thermal bridge in a roof construction.

Key features of the design and workmanship are

- Insulation must be continuous over the ridge.
- If canister applied foam insulation is used, it will also act as a partial air barrier.
- Inner ridge trim can be flat or profiled, but in either case must be sealed at laps and at joints with the roof liner.
- The ridge flashing should be fixed through, or downslope from the filler when fillers are set back 80 to 100mm to avoid bird damage.
- The filler must be kept clear of roof fasteners, ideally downslope.
- All fixings and seals to manufacturer's recommendations.
- On most roofs with well constructed ridge as detailed above, the additional heat loss is so small that there is no need to enter the ridge in SBEM.

No Ψ value for a ridge is quoted in iSBEM menu, the Ψ value and ridge length can be added on the roof construction input page.

MCRMA & EPIC Technical Paper 17- detail No. 10 – built-up metal systems

9.0 Junction details – insulated metal panels

9.1 The Ψ value quoted in Table 4 of BRE IP 01/06 metal cladding values are included in the menu of iSBEM as junctions including metal cladding as IP 01/06.

9.2 Constructed with adequate site workmanship these basic generic details comply with the requirements of the Building Regulations for insulation as a minimum standard, which can and should be improved in the actual design.

9.3 EPIC and MCRMA members have produced recommended details with improved Ψ values shown in each case as figure b, these designs will reduce CO_2 emissions by reducing energy loss through the junction. This can provide a significant reduction on the total building CO_2 emissions.

9.4 System manufacturers should be able to provide other details using their products with Ψ values, calculated by competent persons, which can be substituted for those illustrated in this guide. These alternative values can be manually entered in iSBEM. Building Control bodies may require proof that any such improved values are correct and have been used in the actual construction.

Detail 11 eaves with gutter for insulated panels

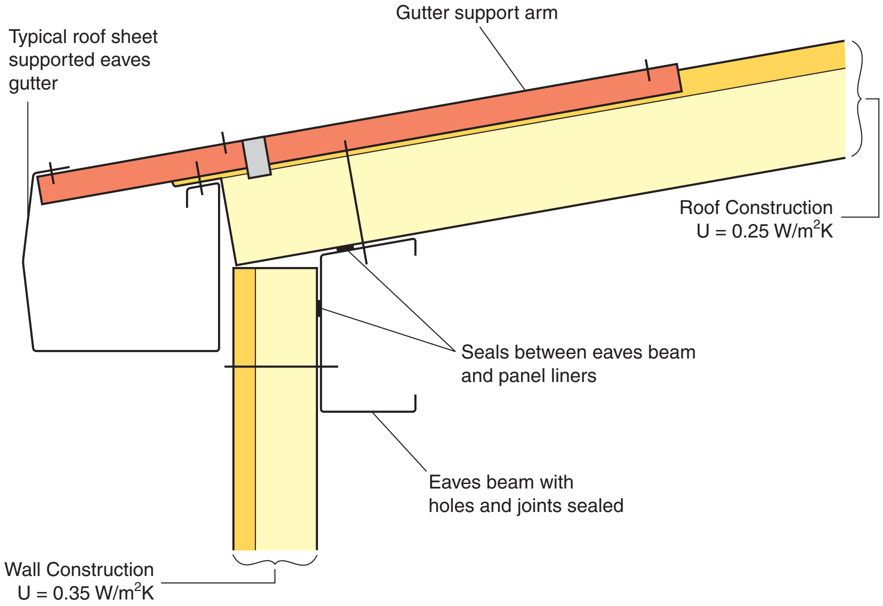

Fig11a Eaves with gutter
insulated panel roof and liner across top of wall panel
Ψ value = 0.25 W/mK **f_{min} = 0.76**

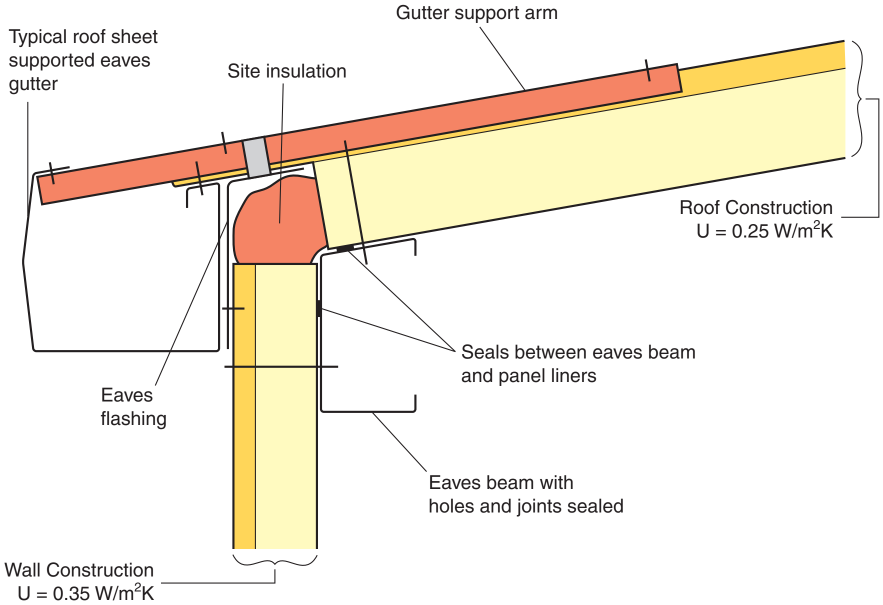

Fig11b Recommended design for eaves with gutter
As fig 11a above but with insulation in corner and liner which does not cross the insulation.
Ψ value = 0.02 W/mK **f_{min} = 0.95**

Key features

- Roof supported gutter avoids thermal bridge issues. Gutters with brackets fixed to walls might require additional supports, and create thermal bridges.
- Seal all holes and joints in eaves beam to avoid bypassing liner seals.
- All fixings and seals must be to manufacturer's recommendations.

iSBEM menu provides a single roof-wall Ψ value not the IP 01/06 eaves value.
(see section 4 calculation method for combined roof-wall Ψ value)
MCRMA & EPIC Technical Paper 17- detail No. 11 – insulated panels

Detail 12 verge for insulated panels

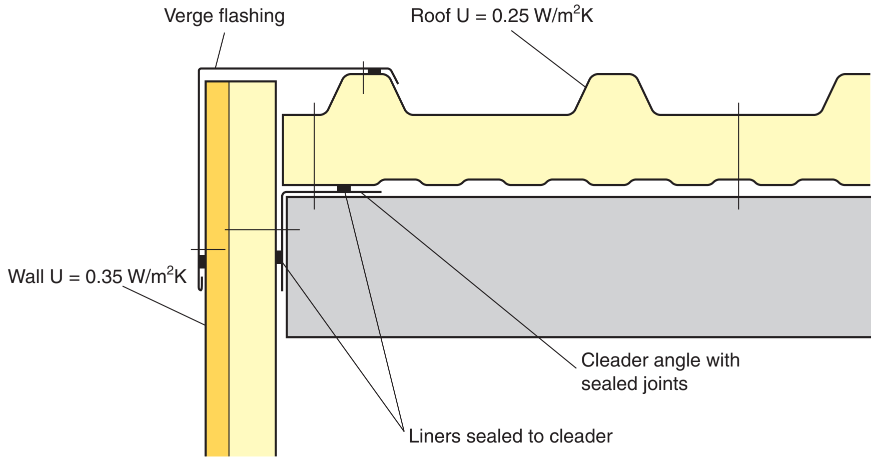

Fig 12a Basic design for verge
Verge of insulated panel with wall liner passing insulation of the roof.
Ψ value = 0.28 W/mK **f_{min} = 0.79**

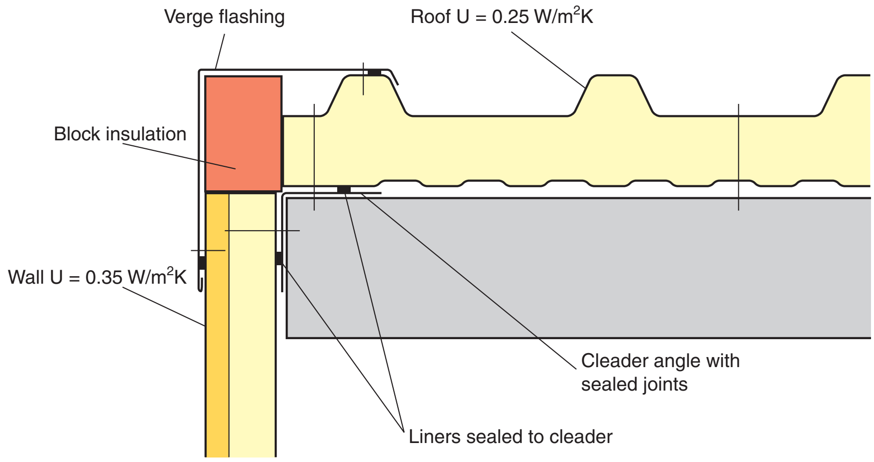

Fig 12b Recommended design for verge
As fig 1a above but the liner sheets do not cross the insulation which is continuous from wall to roof.
Ψ value = 0.02 W/mK **f_{min} = 0.95**

Key features

- Cleader angle required to provide structural support and air sealing between purlins. Joints must be structural and not interfere with seals.
- Fasteners securing cleader angles to purlins must not interfere with seals.
- Seal all holes and joints in cleader angles to avoid bypassing liner seals.
- All fixings and seals must be to manufacturer's recommendations.

iSBEM menu provides a single roof-wall Ψ value not the IP 01/06 verge value.
(see section 4 calculation method for combined roof-wall Ψ value)
MCRMA & EPIC Technical Paper 17- detail No. 12 – insulated panels

Detail 13 drip sill (junction at base of cladding wall)

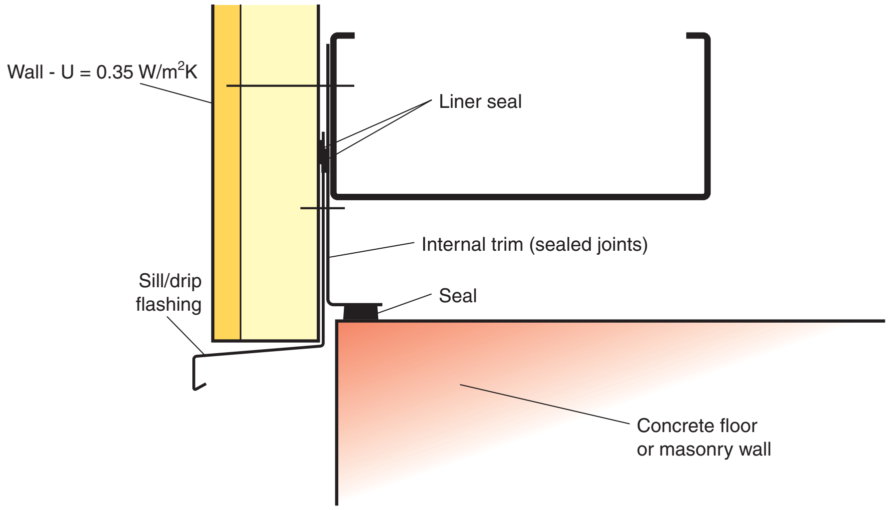

Fig 13a Basic drip trim below wall
Insulated panel wall stops almost level with floor.
Ψ value = 1.15 W/mK **f_{min} = 0.48**

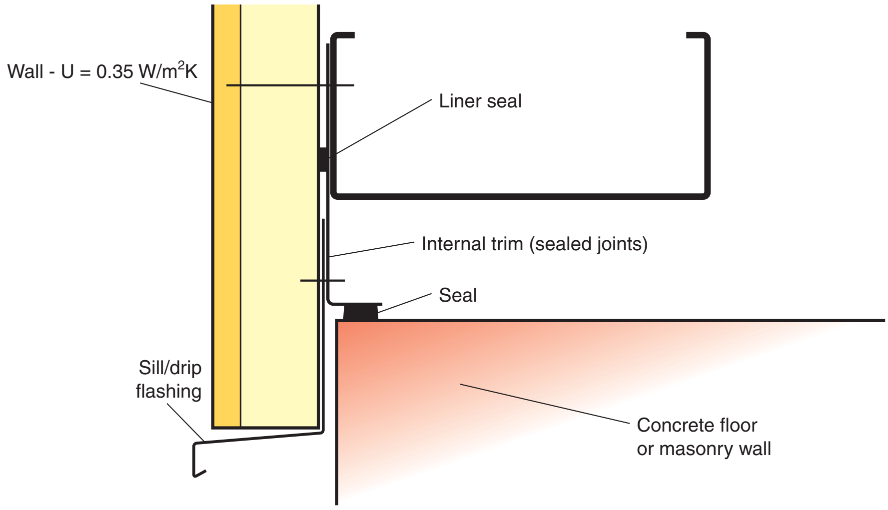

Fig 13b Recommended design of drip sill
As fig 1a above with increased wall depth below floor and floor k = 1.0 W/mK.
Ψ value = 0.99 W/mK **f_{min} = 0.70**

Key features

- Flat or profiled external metal cladding may be vertical or horizontal; the same principles of construction apply.
- Thermal bridging is minimised in the metal construction, provided that the insulation covers at least 100mm of wall/floor. The liner and sill of flat panel systems bridge the insulation.
- The Ψ value is largely controlled by the wall/floor materials, light weight blocks for example will improve the Ψ value. Floor assumed 250mm thick and k = 1.0 W/mK.
- Internal trim should be typically 1.5mm thick, with sealed joints.
- The seal at wall/floor junction must be substantial to cater for inevitable variation in concrete/masonry.
- Ensure internal trim fixing heads do not compromise air seals. Use rivets, or remove temporary hex head types, as work progresses.
- All fixings and seals must be to manufacturer's recommendations.

IP 01/06 metal cladding Ψ value = 1.15 quoted in iSBEM menu
MCRMA & EPIC Technical Paper 17- detail No. 13 – insulated panels

Detail 14 corner (junction between two perpendicular cladding walls)

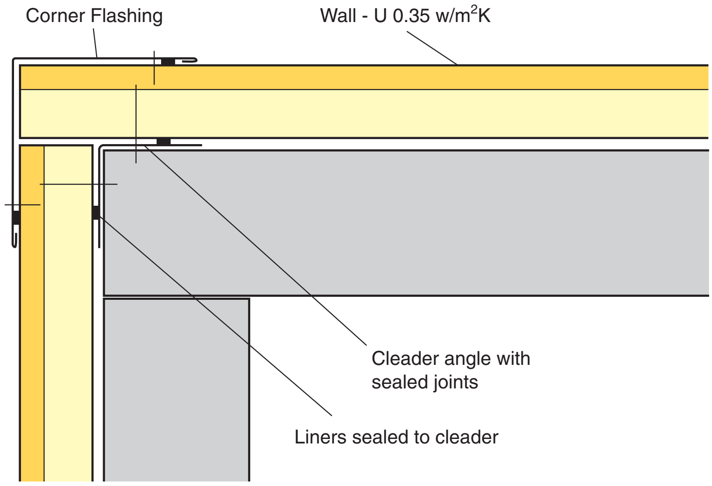

Fig 14a Basic insulated corner
Insulated panel corner with liner bridging insulation.
Ψ value = 0.25 W/mK **f_{min} = 0.76**

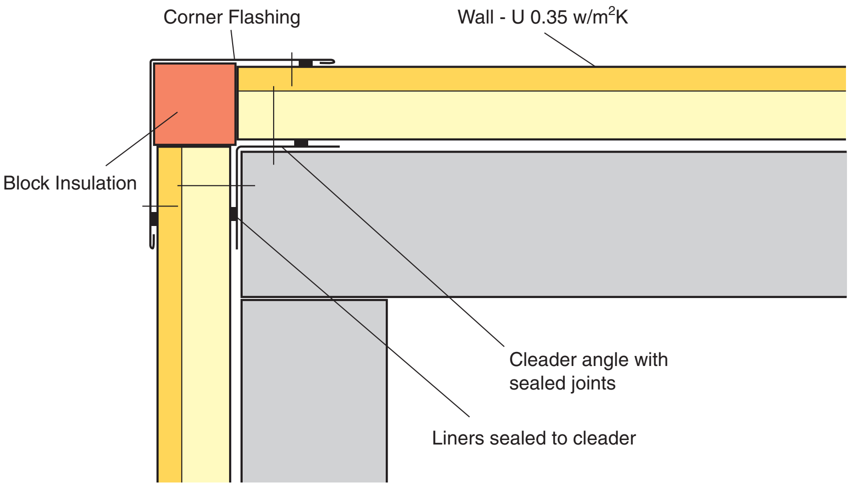

Fig 14b Recommended design for insulated corner
As fig 1a above but the liner does not cross the insulation which fills corner trim.
Ψ value = 0.02 W/mK **f_{min} = 0.95**

Key features
- Flat or profiled external metal cladding may be vertical or horizontal; the same principles of construction apply.
- The liners must be sealed to the corner trim or cleader and fixed as necessary to ensure the seal is effective in the long term.
- The corner trim must be filled with insulation.
- The same principles can be used for internal corners.
- Ensure internal trim fixing heads do not compromise air seals. Use rivets, or remove temporary hex head types, as work progresses.
- All fixings and seals must be to manufacturer's recommendations.

IP 01/06 metal cladding Ψ value = 0.25 quoted in iSBEM menu
MCRMA & EPIC Technical Paper 17- detail No. 14 –insulated panels

Detail 15 wall – floor (not ground floor)

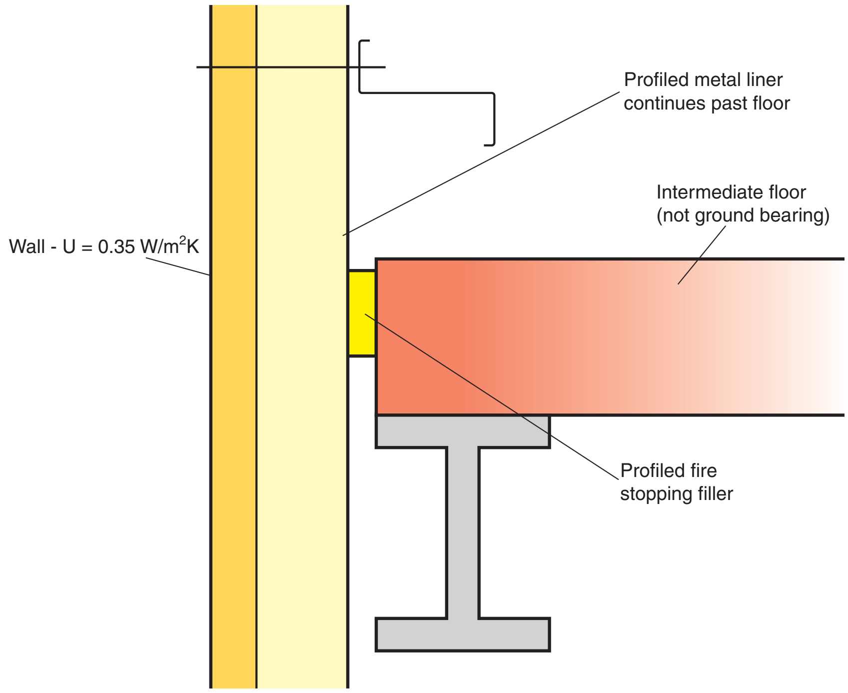

Fig 15

Ψ value = 0.0 W/mK **f_{min} = 1.0**

Note. There is no common detail for metal cladding where the floor structure creates a thermal bridge through the metal clad wall insulation.

Key features

- The same principles of construction apply to vertical or horizontal flat or profiled external metal cladding.
- Identical detail for built-up metal and insulated panel systems, primary fasteners and any spacers included in U value calculation of the external wall.
- External cladding continues at full thickness past the floor (does not apply to ground floor) and is fixed to sheeting rails.
- No fasteners penetrate the wall insulation and floor or support beam.
- Gap between floor and wall liner is filled with insulation for example, fire stopping product.

Basic IP 01/06 metal cladding Ψ = 0.07 W/mK quoted in iSBEM menu.

MCRMA & EPIC Technical Paper 17- detail No. 15 – insulated panel

Detail 16 window or door head

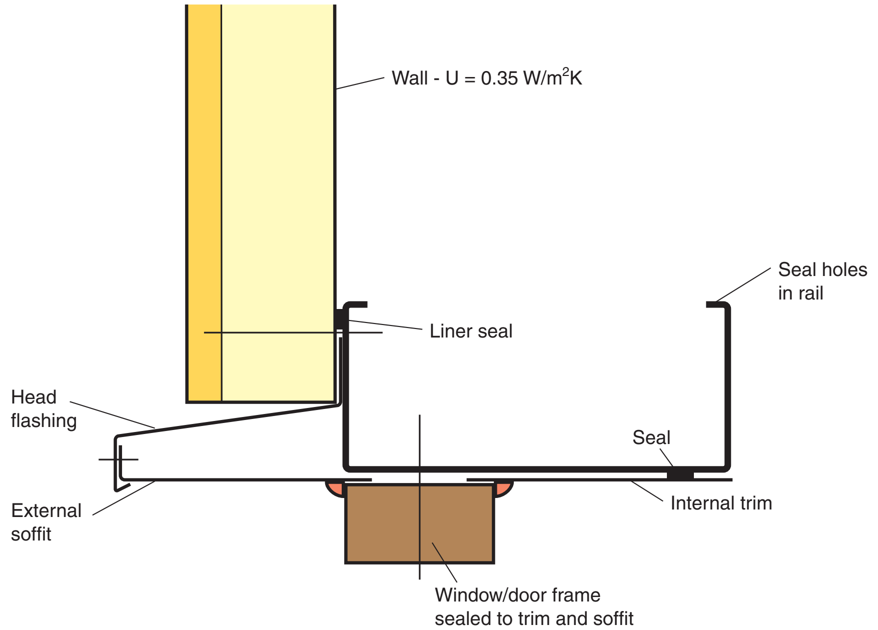

Fig 16a Basic window or door head
Ψ value = 1.27 W/mK **f_{min} = 0.46**

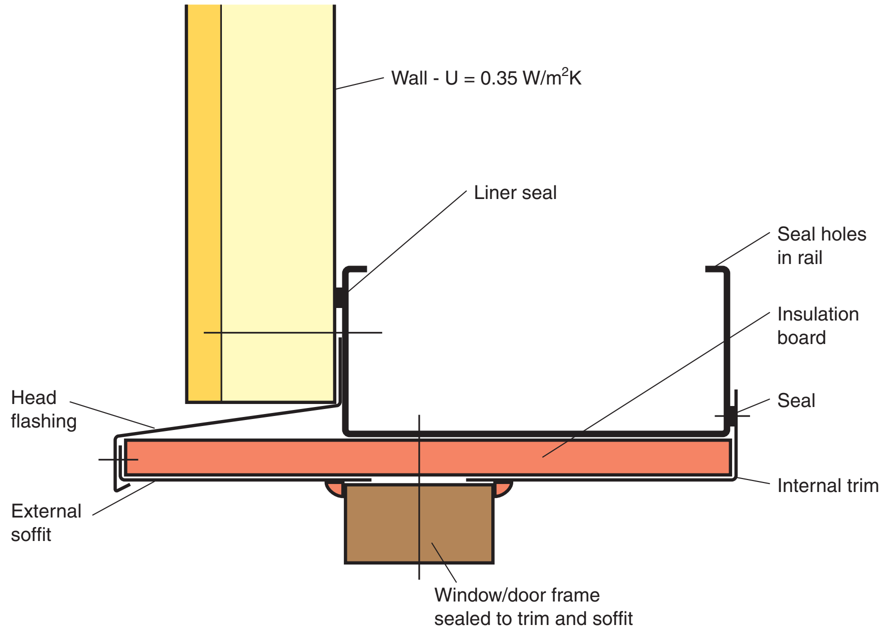

Fig 16b Recommended design with insulation between soffit and rail
Ψ value = 0.70 W/mK **f_{min} = 0.58**

Key features

- The same principles of construction apply to vertical or horizontal flat or profiled external metal cladding.
- An insulation board should be fitted between both external soffit/internal trim and rail.
- It is important to keep the soffit flashing separate from the internal trim.

Basic IP 01/06 metal cladding Ψ = 1.27 W/mK quoted in iSBEM menu.
MCRMA & EPIC Technical Paper 17- detail No. 16 –insulated panel

Detail 17 window sill

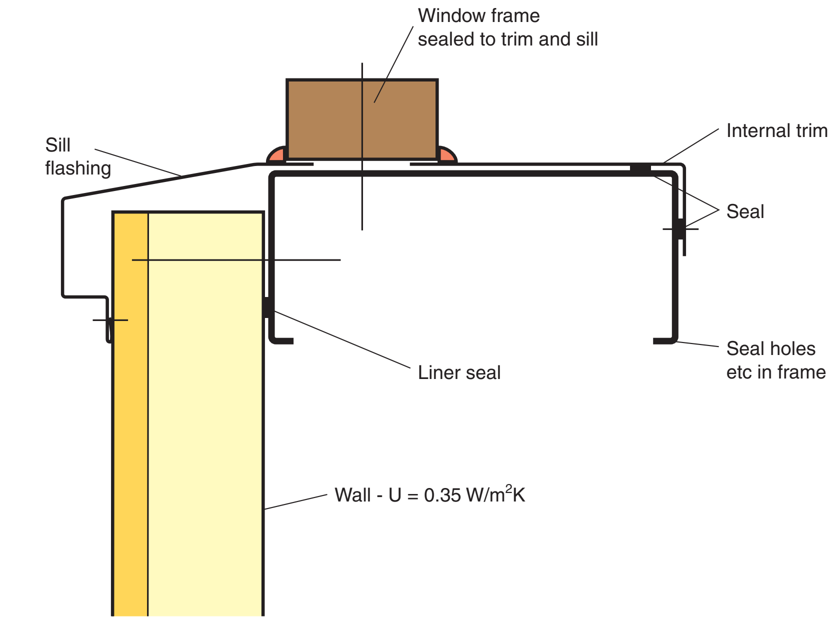

Fig 17a Basic window sill
Ψ value = 1.27 W/mK **f_{min} = 0.46**

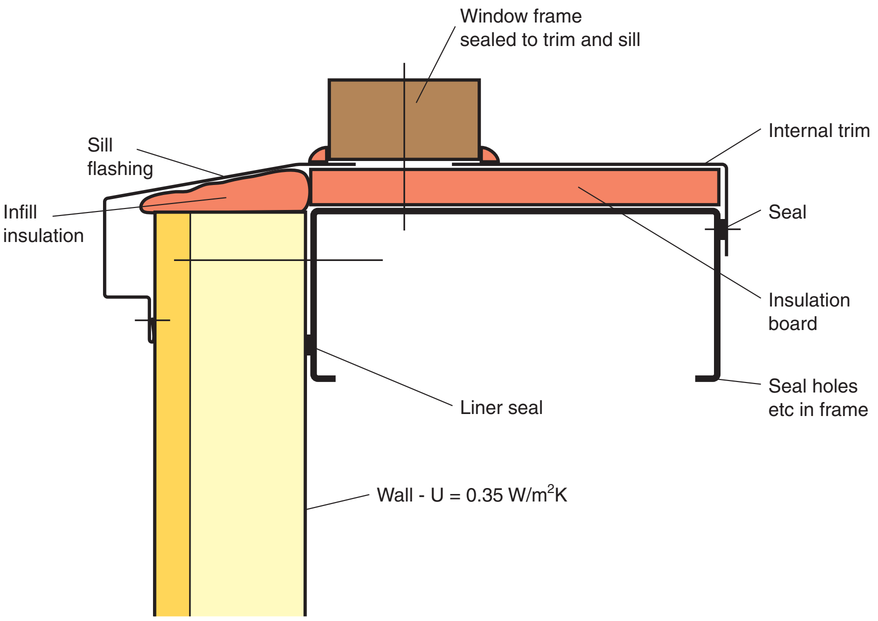

Fig 17b Recommended design for insulated sill
Ψ value = 0.03 W/mK **f_{min} = 0.96**

Key features

- The same principles of construction apply to vertical or horizontal flat or profiled external metal cladding.
- An insulation board should be fitted between both external sill/internal trim and rail.
- It is important to keep the sill flashing separate from the internal trim.

Basic IP 01/06 metal cladding Ψ = 1.27 W/mK quoted in iSBEM menu
MCRMA & EPIC Technical Paper 17- detail No. 17 – insulated panels

Detail 18 window or door jamb

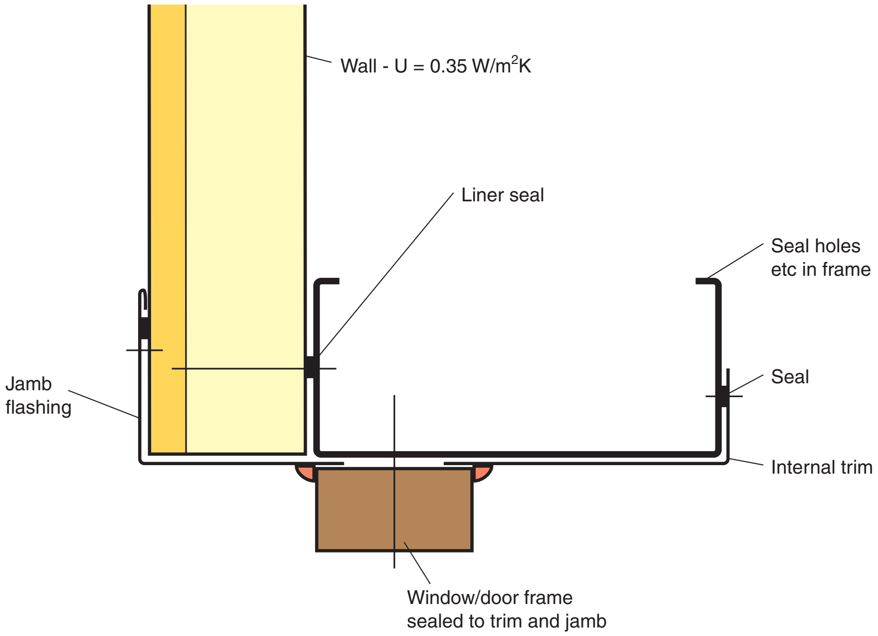

Fig 18a Basic jamb for widow or door frame

Ψ value = 1.27 W/mK **f_{min} = 0.46**

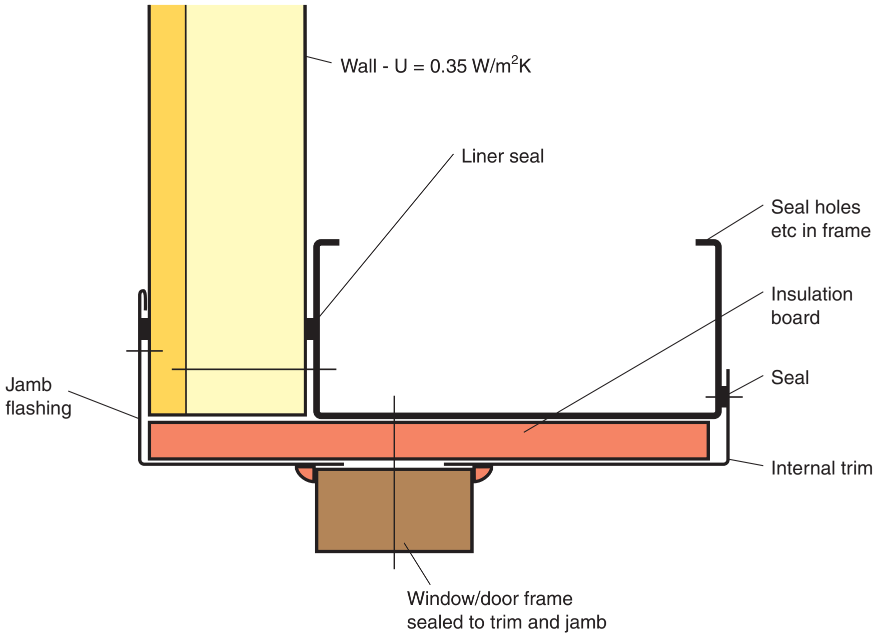

Fig 18b Recommended design for insulated jamb

As fig 1a above but the liner sheets do not cross the insulation which is continuous from wall to roof.

Ψ value = 0.03 W/mK **f_{min} = 0.96**

Key features

- The same principles of construction apply to vertical or horizontal flat or profiled external metal cladding.
- An insulation board should be fitted between both external jamb/internal trim and rail.
- It is important to keep the jamb flashing separate from the internal trim.

Basic IP 01/06 metal cladding Ψ = 1.27 W/mK quoted in iSBEM menu

MCRMA & EPIC Technical Paper 18- detail No. 18 –insulated panels

Detail 19 valley gutter for metal panel system

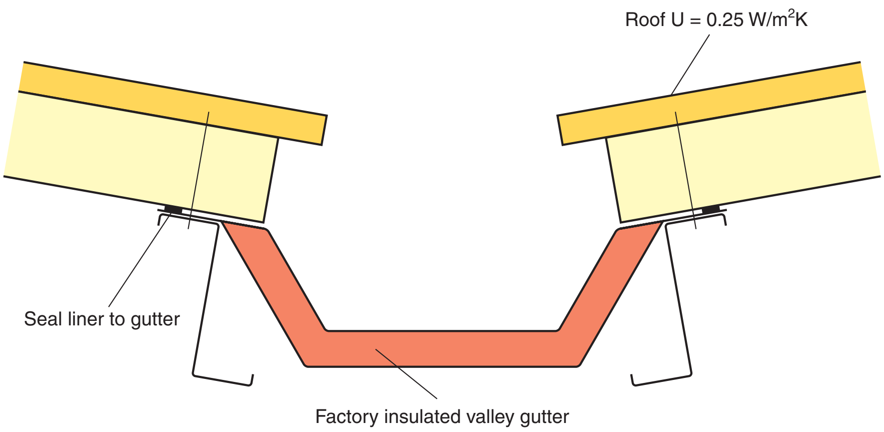

Fig 19 Valley gutter
Insulated panel roof of 0.25 U-value roof and 0.35 U-value gutter.
Ψ value = 1.95 W/mK **f_{min} = 0.64**

Improved Ψ values are available for particular systems with thermal breaks at gutter head e.g. , Ψ value = 0.39 W/mK f_{min} = 0.95, consult manufacturer for details.

Key features
- Gutter thickness and thermal bridging detail will vary, depending on manufacturer, manufacturer's accredited designs may have Ψ values better than 0.50 W/mK.
- Ideally, the metal gutter outer surface should not bridge the insulation layer.
- In all designs the roof liner should not bridge the gutter insulation layer.
- If the gutter is a traditional pre 2002 design, the thermal bridge value will exceed that quoted.
- Insulation must fill the gutter liner, leaving no voids.
- All joints in gutter flanges must be sealed.
- All fixings and seals must be to manufacturer's recommendations.

No Ψ value for a valley gutter is quoted in iSBEM menu, the Ψ value and gutter length can be added on the roof construction input page.
MCRMA & EPIC Technical Paper 17- detail No. 19 – insulated panels

Detail 20 ridge trim metal panel system

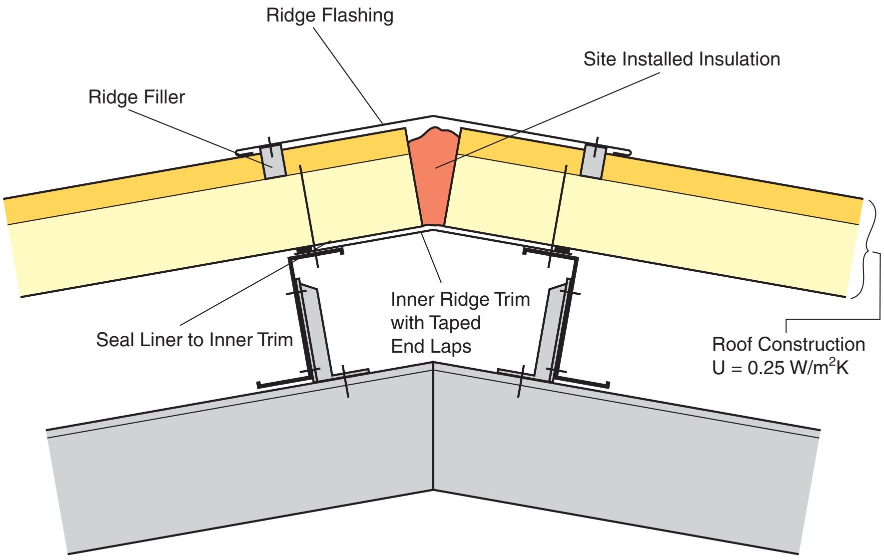

Fig 20 Recommended ridge trim
Insulated panel metal roof construction of 0.25 U-value.
Ψ value = 0.01 W/mK **f_{min} = 0.95**

Fully insulated as shown a ridge trim should not form a significant thermal bridge in a roof construction.

Key features of the design and workmanship are

- Insulation must be continuous over the ridge.
- If canister applied foam insulation is used, it will also act as a partial air barrier.
- Inner ridge trim can be flat or profiled, but in either case must be sealed at laps and at joints with the roof liner.
- The ridge flashing should be fixed through, or downslope from the filler when fillers are set back 80 to 100mm to avoid bird damage.
- The filler must be kept clear of roof fasteners, ideally downslope.
- All fixings and seals to manufacturer's recommendations.
- On most roofs with well constructed ridge as detailed above, the additional heat loss is so small that there is no need to enter the ridge in SBEM.

No Ψ value for a ridge is quoted in iSBEM menu, the Ψ value and ridge length can be added on the roof construction input page.
MCRMA & EPIC Technical Paper 17- detail No. 20 – insulated panels

10.0 Checklist for recommended data entry

Element	iSBEM default values	Other values (typical) required for entry of metal cladding systems into iSBEM
Roof – metal twin skin or insulated panel	0.25 U-value W/m^2 K area weighted average (0.35 for any individual element)	Enter as flat in iSBEM if less than 10˚ pitch. Cm = 7 kJ/m^2 K (typical insulated metal system)
Wall– metal twin skin or insulated panel	0.35 U-value W/m^2 K area weighted average, except Scotland 0.30 U-value W/m^2 K area weighted average (0.70 for any individual element)	Cm = 7 kJ/m^2 K (typical insulated metal system)
Junctions Thermal bridges for metal cladding (IP 01/06 values) Roof – wall Wall ground floor Wall – wall corner Wall – floor not ground Lintel above window or door Sill below window Jamb at window or door	As-built Ψ values W/mK, should be no worse than 0.60 1.15 0.25 0.07 1.27 1.27 1.27 See fig 1 to 8 for built-up and 11 to 18 for panels	Recommended details are shown in preceding sections 8 & 9 with better Ψ values. See fig 1A to 8A for built-up and 11A to 18A for panels. Improved designs may be available from system manufacturers for their specific junction designs.
Profiled in plane rooflights	2.2 U-value W/m^2 K area weighted average e.g. triple skin profiled in plane plastic. up to 20% of roof area.	No frame. T solar = 0.5 L solar =0.5 Surface area ratio = 1.0 Transmission factor = 1.0
Pedestrian doors	2.2 U-value W/m^2 K area weighted average (3.0 for any individual element)	Cm = 6.8 kJ/m^2 K (iSBEM default)
Vehicle access doors	1.50 U-value W/m^2 K area weighted average (4.0 for any individual element)	Cm = 4.9 kJ/m^2 K (iSBEM default)
Roof ventilators including smoke vents	6.0 U-value W/m^2 K area weighted average and any individual element.	Note: Not included in current version of iSBEM calculation.

Table 5: Checklist of recommended data entry for AD-L2A England and Wales, Part F Northern Ireland, Section 6 Scotland using BRE iSBEM.

11.0 Case study: portal frame metal clad building

The following case study illustrates the relative magnitude of % CO_2 emission savings obtainable on this particular design and selected services using iSBEM v1.2.a + patch 01. The actual % CO_2 emission savings on any particular design will vary with dimensions, intended use, installed services and fabric etc.

The case study achieved the target asset rating, 76% CO_2 emission savings against the notional building, as the benchmark before any changes. The size of % CO_2 emission savings for any selected design change varies according to how well the whole building complies.

Principal design factors for case study

Warehouse/industrial unit with small office, located in Birmingham

60 m long × 40 m wide 6 m to eaves
Portal frame construction.
Twin skin insulated metal roof 0.25 U value, with 15% triple skin rooflights 1.83 U-value (assessed in vertical position).
Insulated panel walls 0.35 U value
Junction details having manufacturer's Ψ values better than BRE IP 01/06 table 4.

Mains gas heating, boiler for offices, radiant heater for warehouse.
Full lighting design available based on watts/m^2 of floor area and CIBSE guidelines.
No renewable energy sources.

Emission results calculated using iSBEM		
Design of building for planning and construction BER	23.45 kg CO_2/m^2	Initial design was optimised by improving lighting, heating services and junction details
Notional Building	30.76 kg CO_2/m^2	
Target emissions for compliance with the standard of AD-L2A TER	23.52 kg CO_2/m^2	
Asset rating as % of that produced by notional building	76%	Initial design about 110% before optimisation

Table 6: Case study energy use

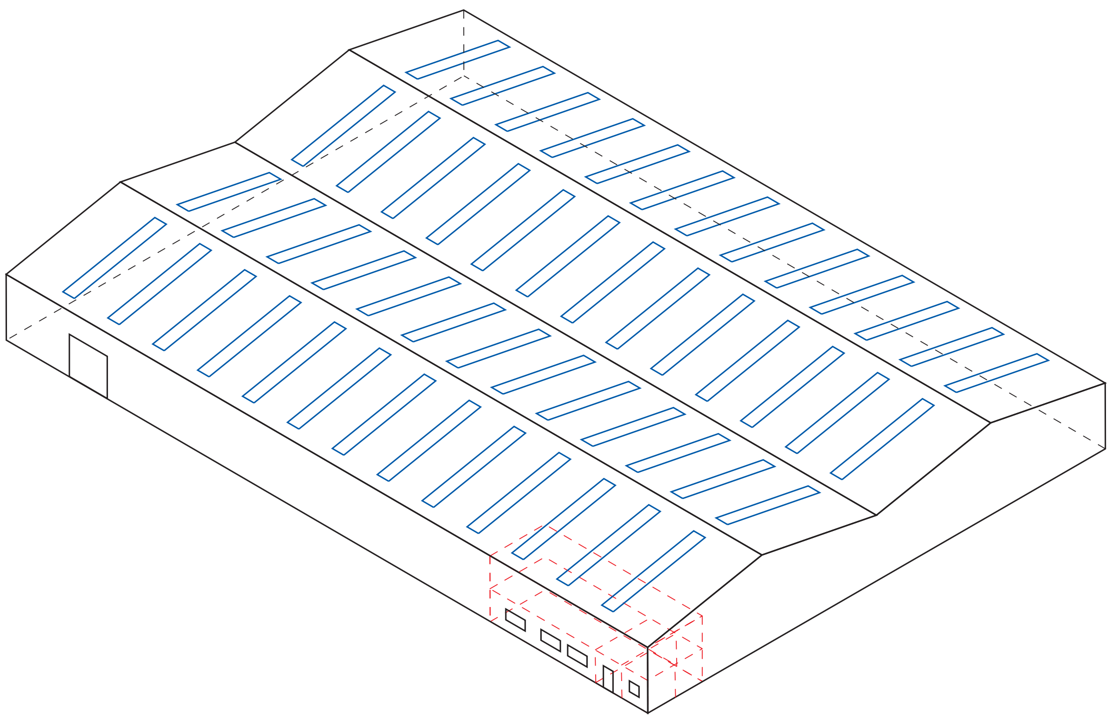

Figure 21: Case Study – 2,400m^2 portal frame metal clad industrial/warehouse unit.

About 51 % of the calculated kwh for the equivalent Notional Building are caused by electricity used for lighting. One kilowatt of mains grid supplied electricity is converted to 0.422 kg CO_2 whereas one kilowatt of natural gas converts as less than half the emissions to 0.194 kg CO_2, see Table 2 of AD-L2A.

Reducing the lighting energy usage from the Notional Building level to that accepted as practical in CIBSE guidelines and installing manual-on automatic-off switching in the warehouse and office reduced the CO_2 emissions by 9%.

The second major source of emissions is the controlled services for space heating (and cooling if installed). Changes from forced air convectors to multiburner radiant heaters in the warehouse provided calculated savings of 15% CO_2 emissions in this example.

In contrast, improving the U-value of the roof from 0.25 to 0.20 and walls from 0.35 to 0.30 W/m^2 K only reduced emissions by 2%.

The 2002 changes to Part L introduced a permitted 10% of heat loss through the building envelope by means of unavoidable thermal bridging at junctions etc. The Ψ values entered into the iSBEM calculation evaluate this heat loss and consequent CO_2 emissions. Improving Ψ values from the worst permitted case values published in BRE IP 01/06 to manufacturer's recommended details saved 3% emissions.

Reducing the air permeability of the envelope for this open space building only reduces % emissions by a small amount using the current version of iSBEM, whereas previous versions calculated a significant saving.

Changing the area of profiled GRP or Polycarbonate rooflights from 10% to the permitted maximum of 20% of roof area causes a small increase in CO_2 emissions according to the current version of iSBEM. If solar gain is added to future versions of iSBEM the relationship may change. The NARM guide to rooflights illustrates the case where photoelectric switching can save emissions if used with increased levels of daylight.

NOTE: Experience has shown that particular design changes may produce widely different magnitudes of energy saving when applied to different types and sizes of building.

The magnitude of savings varies according to which version of iSBEM is used and not necessarily in a predictable manner. Since older versions of the approved software remain in use for existing Building Control applications, the user should always ensure that they have the appropriate version of SBEM, which may not reproduce the above level of savings.

The case study was set in Birmingham, if the building was in London the calculated CO_2 emissions would increase by 3%. This value provides a rough guide to the significance of the above changes to the fabric and services.

Appendix A
Method of calculating U value for metal cladding

The regional versions of the Building Regulations refer to BR 443: 2006 Edition – Conventions for U-value Calculations, which provides methods for most building materials using the methods of BS EN ISO 6946. Section 4.10 of BR 443 for metal-faced roofing and wall cladding states:-

The U-value of metal-clad walls and roofs needs to take account of joints between panels and any metallic components within the insulation, including through fixings. The MCRMA Technical Paper 14 sets out the principles and contains information on how to carry out the calculations.

The method of finite element analysis set out in MCRMA Technical Paper No 14 :2002 remains valid, a more detailed explanation is provided in MCRMA Technical Paper 18 :2006. A number of commercial software packages are available which comply with BS EN ISO 10211 and may be used for this type of work.

Finite element analysis is normally used for insulated panels where the heat flow through joints is not perpendicular to the panel surface.

Twin skin metal systems with spacers which penetrate the insulation layer may be calculated by finite element analysis or in accordance with the following

The BRE U-value program provides a convenient calculation method for either Z-spacer or rail-and-bracket systems. It cannot be used for insulated panels or junction details.

EPIC and MCRMA members will provide U values calculated for their products using one of these methods.

Work is currently on-going to reduce the operator sensitivity of some finite element software when applied to complex often three dimensional metal bridges through insulation, by round robin testing, see Appendix B.

Appendix B
Method of calculating Ψ value for metal cladding

The Ψ value for a junction can only be calculated using finite element two and three dimensional analysis. The accredited details for dwellings have been calculated by this method and published for typical junction details on the Government's web site. Provided that the as-built details comply with these published generic designs and a good level of workmanship is achieved, the contractor may use the library Ψ values in iSBEM quoted for accredited details.

Currently, no similar approved scheme is available for junctions including metal roof and wall cladding. The junction details figures 1 to 20 in this publication and the Table 4 default junction values in BRE IP 01/06 have been calculated by finite element analysis.

MCRMA and EPIC members have established extensive libraries of typical junction details for their systems since the 2002 changes to Building Regulations based on similar numerical analysis. BS EN ISO 10211 sets the compliance criteria for finite element analysis programmes which can be used for this type of analysis.

Government-backed work is currently in progress to establish guidelines for users of the approved programmes to reduce the variation between operators which has been identified by round robin testing. A number of reports will be published recording the results of this work.

MCRMA Technical Paper 18 has been published as part of the work to improve guidelines and reduce variations between operators of finite element analysis programmes for thermal bridges in insulated metal cladding systems.

Readers should consult the EPIC and MCRMA web sites for the latest updates on this work.

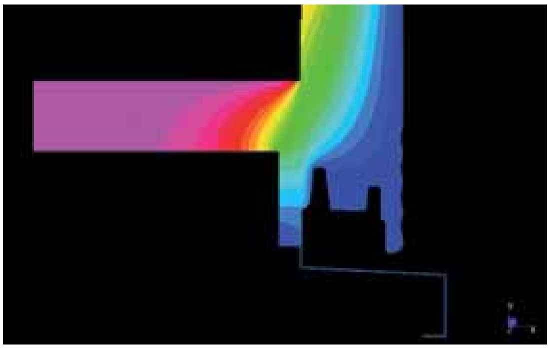

Figure 22: Typical heat flow pattern through insulated metal junction determined by finite element analysis.

Appendix C
Reference Documents

Building Regulations

England & Wales

AD-L2A	Conservation of fuel and power in new buildings other than dwellings – 2006 edition.
AD-L2B	Conservation of fuel and power in existing buildings other than dwellings – 2006 edition – obtainable from www.planningportal.gov.uk

Northern Ireland

Part F2	Conservation of Fuel and Energy – 2006 – obtainable from www.dfpni.gov.uk

Scotland

Section 6	Energy – 2007 – obtainable from www.sbsa.gov.uk

National Calculation Methodology

iSBEM obtainable from www.ncm.bre.co.uk

Building Research Publications

BRE IP 01/06	Assessing the effects of thermal bridging at junctions and around openings. BRE 2006.
BR 443	Conventions for U-value calculations. BRE 2006 edition.

British Standards

BS EN ISO 6946	Thermal performance of buildings and building components – Thermal resistance and thermal transmittance – Calculation method.
BS EN ISO 10211	Thermal bridges in building construction – Heat flows and surface temperatures.
BS 5250: 2002 + amendment 1	Code of practice for control of condensation in buildings.

Other Publications

MCRMA Technical Paper 14	Guidance for the design of metal roofing and cladding to comply with approved document L2: 2001.
MCRMA Technical Paper 18	Conventions for calculating U-values, f-values and Ψ values for metal cladding systems systems using two- and three-dimensional thermal calculations.
NARM	Designing with rooflights: supporting the guidance in Ad-L2A & AD-L2B (2006).

MCRMA technical papers

No 1	Recommended good practice for daylighting in metal clad buildings
No 2	Curved sheeting manual
No 3	Secret fix roofing design guide
No 4	Fire and external steel-clad walls: guidance notes to the revised Building Regulations, 1992 (*out of print*)
No 5	Metal wall systems design guide
No 6	Profiled metal roofing design guide
No 7	Fire design of steel-clad external walls for building: construction, performance standards and design
No 8	Acoustic design guide for metal roof and wall cladding
No 9	Composite roof and wall cladding panel design guide
No 10	Profiled metal cladding for roof and walls: guidance notes on revised Building Regulations 1995 parts L & F (*out of print*)
No 11	Metal fabrications: design, detailing and installation guide
No 12	Fasteners for metal roof and wall cladding: design detailing and installation guide
No 13	Composite slabs and beams using steel decking: best practice for design and construction
No 14	Guidance for the design of metal roofing and cladding to comply with Approved Document L2: 2001
No 15	New Applications: composite construction
No 16	Guidance for the effective sealing of end lap details in metal roofing constructions.
No 17	Design guide for metal roofing and cladding to comply with energy requirements of UK Building Regulations (2006)
No 18	Conventions for calculating u-values, f-values and Ψ-values for metal cladding systems using two- and three-dimensional thermal calculations.

Liability

Whilst the information contained in this design guide is believed to be correct at the time of going to press, the Metal Cladding and Roofing Manufacturers Association Limited and Engineered Panels in Construction Limited and their member companies cannot be held responsible for any errors or inaccuracies and, in particular, the specification for any application must be checked with the individual manufacturer concerned for a given installation.

The diagrams of typical constructions in this publication are illustrative only.

Updates and news on metal cladding and related building control issues are available from **www.mcrma.co.uk** and **www.epic.uk.com**.

THE METAL CLADDING & ROOFING MANUFACTURERS ASSOCIATION LIMITED

18 MERE FARM ROAD
PRENTON · WIRRAL
CHESHIRE CH43 9TT

TELEPHONE: 0151 652 3846
FACSIMILE: 0151 653 4080
mcrma@compuserve.com
www.mcrma.co.uk

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