Thermal Bridging

energy saving experts

Thermal Bridging Part L1A – A Practical Guide

Thermal Bridging Part L1A

This paper discusses Thermal Bridging in SAP 2009, and to how gain compliance with Part L1A 2010. It is aimed primarily at anyone involved in the design of buildings and is intended, by use of the accompanying excel spreadsheet, to be a useful guide in determining thermal bridging values and construction details.

What is Thermal Bridging?

A thermal bridge is created when materials that are poor insulators come in contact, allowing heat to flow through the path created. Insulation around a bridge is of little help in preventing heat loss or gain due to thermal bridging; the bridging has to be eliminated, rebuilt with a reduced cross-section or with materials that have better insulating properties, or with an additional insulating component (a thermal break).

Thermal bridges are categorised into three types, Repeating, Non-Repeating and Random.

Repeating Thermal Bridges

A common repeating thermal bridge is where timber studs bridge a layer of insulation in a cavity wall. As this occurs regularly throughout the element, ie the wall, this is deemed a repeating bridge and must be accounted for in the U Value calculation for the element by making the appropriate corrections.

Non-Repeating Thermal Bridges

A non-repeating thermal bridge would be, for example, where the ground floor and external wall joins, a common bridge here is where the insulation in the wall and the floor do not join, forming a cold bridge at the corner. This type of thermal bridge needs to be accounted for in any SAP calculation as the combined heat loss from non-repeating thermal bridges over an entire building can account for up to 15% of the total.

If the building thermal envelopes have very low U Values and the junctions between each are not accounted for in the design details, the percentage of heat loss through the non-repeating bridges increases.

The visual effect of cold bridging is condensation forming in the corners of rooms, and mould growing in due course. This is particularly a problem where external corners are exposed to the cold, or if internally wardrobes and other furniture obscure corners and there is little movement of warm air to circulate.

Random Thermal Bridging
Random bridging is where there is a one off bridge, for example a steel beam in a wall construction. These are dealt with in SAP by applying a procedure to account for it in the U Value calculation as detailed in BR443. However, good building practice would dictate that this type of bridge be minimised as much as possible.

This paper is concerned with Non-Repeating Thermal Bridges only.

How are Thermal Bridges accounted for in SAP?
Psi (Ψ) values
The Ψ value is a measurement of heat loss, in Watts/meter. Kelvin (W/m.K) across a given junction between the external wall and another element.
When multiplied by the length of that junction this becomes the linear thermal transmittance, or y value. All of the different y values are added together to provide the one figure that is then divided by the heat loss areas and input into the SAP software.

This can be expressed as follows:
- Junction length (m) x Ψ value = y value

- Sum y values / Sum area of heat loss envelopes (A heat loss floor+ A heat loss walls + A heat loss roof) = total y value.

Thermal bridging in SAP 2006/ Part L 2005
Previously the designer of a building had various choices when determining which thermal bridging details would be entered into the SAP software.

If designing his or her own details, the default Ψ value would be used, or a user defined one if known, multiplied by the linear length of each appropriate junction would give the overall y value.

Alternatively if Accredited Construction Details (ACD) were used an overall y value figure of 0.08 could be applied, if Enhanced Construction Details (ECD) were used then 0.04 would be used, or if no detailing defined a figure of 0.15 would be used.
In rare cases a user defined overall y value, as defined in BRE IP 1/06 and BR497, could be applied.

Thermal bridging in SAP 2009/ Part L 2101
In the latest Building Regulations Part L 2010 there is a requirement now to account for non repeating thermal bridges within the SAP 2009 calculation, however, unlike the 2006 Regs previously, the Ψ value must be multiplied by the linear thermal length of the junction in all cases, and overall y value figures if using ACDs for example cannot be used any longer.

This means that SAP assessors now must measure the length of each of the junctions listed in the table below and multiply it by an appropriate Ψ value to gain the y value for the junction. These are added together to provide the total, which is then divided by the total area of all the heat loss envelopes, to give the y value, as mentioned above. This is the figure input into the Sap and which goes into the calculation when determining the DER.

Only junctions that conform to ACDs are measured in SAP 2009, although approved details do exist for different junctions in other schemes, however these are not accounted for in SAP2009.

Thermal Bridging Junctions accounted for in SAP
The full list of junctions measured in SAP 2009 and applicable to ADL1A is shown below in Table 1.

Appendix 1 : Thermal bridges

This Appendix specifies how to treat junction types not specifically listed in SAP Table K1. The tables indicate which junction descriptor to select in SAP calculations. In most cases the default psi value will be applicable.

SAP Table K1 : Values of Ψ for different types of junctions

	Ref	Junction detail	Accredited Ψ (W/m·K)	Default Ψ (W/m·K)
Junctions with an external wall	E1	Steel lintel with perforated steel base plate	0.50	1.00
	E2	Other lintels (including other steel lintels)	0.30	
	E3	Sill	0.04	0.08
	E4	Jamb	0.05	0.10
	E5	Ground floor	0.16	0.32
	E6	Intermediate floor within a dwelling	0.07	0.14
	E7	Intermediate floor between dwellings (in blocks of flats) [a]	0.07	0.14
	E8	Balcony within a dwelling [b]	0.00	0.00 *
	E9	Balcony between dwellings [a] [b]	0.02	0.04 *
	E10	Eaves (insulation at ceiling level)	0.06	0.12
	E11	Eaves (insulation at rafter level)	0.04	0.08
	E12	Gable (insulation at ceiling level)	0.24	0.48
	E13	Gable (insulation at rafter level)	0.04	0.08
	E14	Flat roof	0.04	0.08
	E15	Flat roof with parapet	0.28	0.56
	E16	Corner (normal)	0.09	0.18
	E17	Corner (inverted – internal area greater than external area)	-0.09	0.00
	E18	Party wall between dwellings [a]	0.06	0.12
Junctions with a party wall [a]	P1	Ground floor	0.08	0.16
	P2	Intermediate floor within a dwelling	0.00	0.04
	P3	Intermediate floor between dwellings (in blocks of flats)	0.00	0.04
	P4	Roof (insulation at ceiling level)	0.12	0.24
	P5	Roof (insulation at rafter level)	0.02	0.04

[a] Value of Ψ is applied to each dwelling
[b] This is an externally supported balcony (the balcony slab is not a continuation of the floor slab) where the wall insulation is continuous and not bridged by the balcony slab
* Value valid only if balcony support does not penetrate the wall insulation. If it does so penetrate, either a Ψ-value must be calculated for the junction, or the SAP calculation uses the default overall thermal bridging of y = 0.15
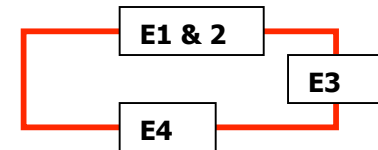
Table 1: SAP Table K1

A quick look at Table 1 and it can be seen that some junctions have more of an impact than others. For example, a Ψ value for a Gable wall with insulation at rafter level is 6 times less than if insulated at ceiling level. A flat roof is 7 times lower than a flat roof with a parapet.

Lintels values are high, as is the ground floor junction, and as mentioned above a gable insulated at ceiling level, these should be considered first as their impact on the total result is greatest.

Each Junction detail has been assigned a reference number to make it easier to identify, as shown in Table K1 above. Their positions are shown on the drawings below.


P5

P5

P4

P2

P1

E18

E18

E5

E6

E5

E10

E10

E6

E13

E13

E12

E16

E6

E8

E6

E16

E5

E5
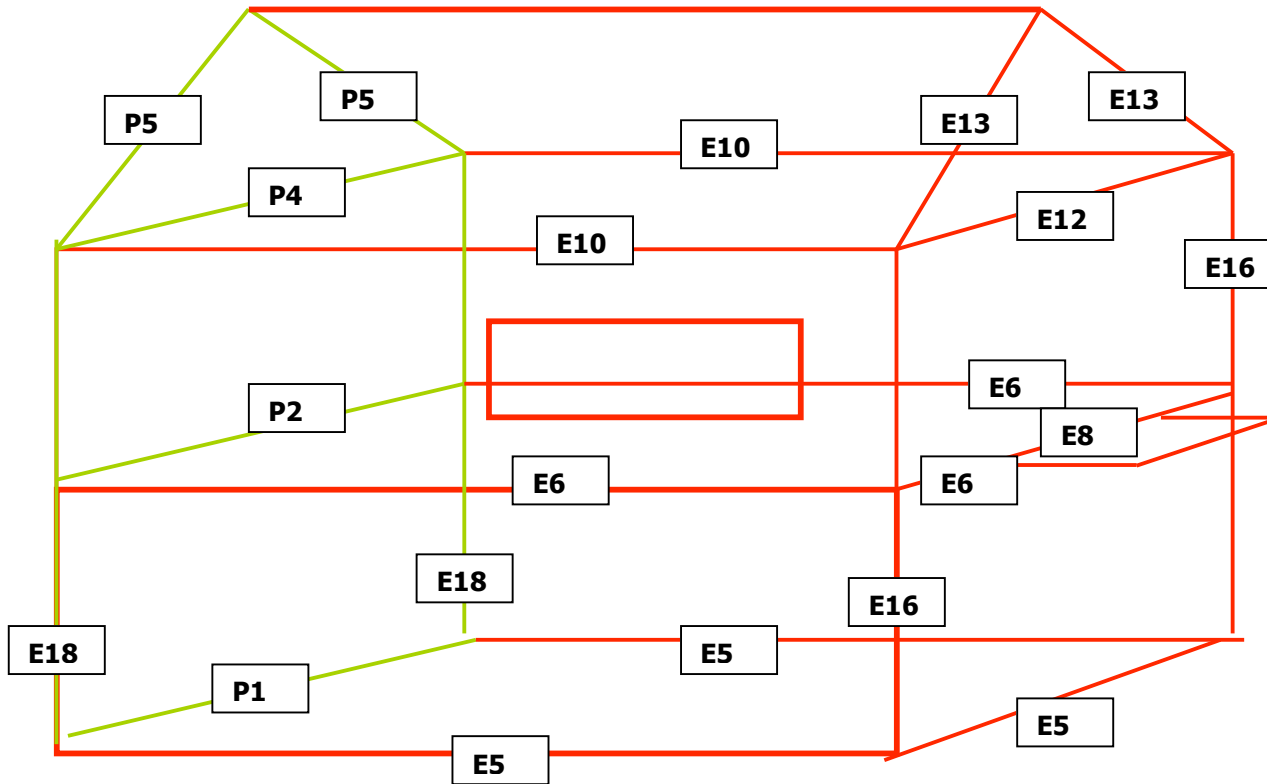
Drawing 1 Thermal Bridging Reference numbers

E1 & 2

E3

E4

Drawing 2 Thermal Bridging Reference numbers around openings

Dormers are included, See Diagram 3 below, however, they are due to be updated within the SAP software to include some junction lengths not currently included and possibly to account for different construction types. In many situations the construction of a dormer will differ from that of the main walls, for example a masonry cavity wall and a timber framed dormer wall. In this instance an area weighted value is input into the SAP software.
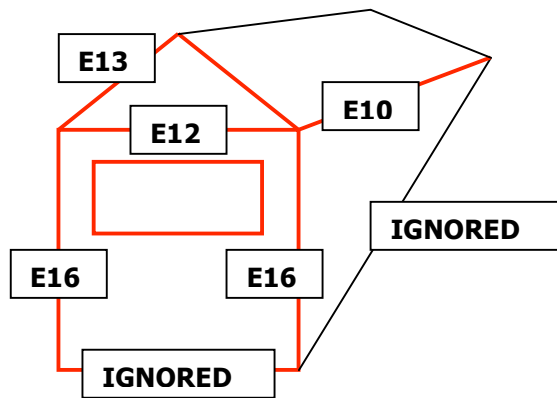
Diagram 2 Dormer Thermal Bridging Reference numbers

Note: Windows carry the same reference numbers as above

Applying the Regulations

With the changes to the Building Regulations in October 2010 and the introduction of SAP 2009 there are some distinct differences to the old practices.

The previous overall figures for the ACD and ECD have now gone, instead if using these details the individual ACD or ECD Ψ values for each junction, multiplied by its length, are used to calculate the total figure.

Using the overall figure of 0.15 is still an option but in reality the likelihood of gaining an overall pass for the building is extremely slim.

Another way and which seems to be the most prevalent today, is designers are encouraged to design their own details, and the default Ψ values would apply.

A better option would be to have the Ψ values calculated by a competent person, and these used instead of the default figures. In this situation a 25% or 0.02 confidence factor would be applied to each of the resulting heat loss figures, this is because the designed detail has not been proven in its buildability and therefore a Q& A checking, unlike the ACD and ECD figures. This should provide a better overall result than if using the default figures. In both the above, the linear thermal bridging lengths would be calculated and multiplied by the appropriate Ψ values used.

There will eventually be schemes that 'quality assure the calculation of the linear transmittance (Ψ values), accredit details in terms of buildability and have an associated quality assurance regime that inspects a sample of sites to confirm that the details are being implemented correctly.' ACD values will be absorbed into these schemes Ψ values and many more details will gradually become available and confidence factors will not need to be applied.

However in reality no additional approved schemes are in place today, and the deadline of Oct 2011 when the first ones were due to be approved has been put back, seemingly indefinitely, at present. Therefore, although a competent person may be employed to calculate the Ψ value he or she will not at present be a member of a scheme that will have a Q&A regime, a confidence factor would need to be applied. It should be noted that the resulting Ψ values will nearly always be an improvement on the default values, however, they may not be as good as one from an existing ACD scheme.

The current ACD and ECD schemes, Scottish ACDs, and the AECB Silver and Gold Carbonlite standards are the only approved schemes at present. These details may be used by anyone wishing to do so, and whose Ψ values may be applied to the linear calculation.

Most details from the existing schemes have a checklist and a unique reference number. The reference numbers of any details to be used must be given to the SAP assessor at the design stage, and once the building is complete, good practice would suggest that the signed and dated checklists should be given to the SAP assessor to demonstrate compliance.
Examples of each are shown on the next page and there are web links below to all the checklists themselves.

Accompanying this paper is an excel spreadsheet detailing all of the Ψ values from every approved scheme, per junction type below, cross referenced, so that the most similar type can be compared.

Links to the various Accredited Constructions detailed information.

Accredited Construction Details Ψ(ACD)
http://www.planningportal.gov.uk/buildingregulations/approveddocuments/partl/bcassociateddocuments9/acd

Enhanced Construction Details Ψ (ECD)
http://www.energysavingtrust.org.uk/business/Business/Housing-professionals/Interactive-tools/Enhanced-Construction-Details
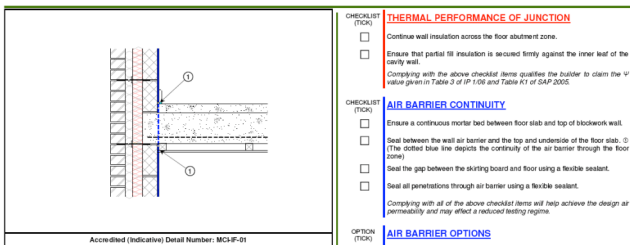
Scottish Accredited Construction Details ACDsΨ (SACD)
http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/profinfo/techguide/acdscot

AECB Silver Standard Ψ

AECB Gold Standard Ψ
http://www.aecb.net/standards_and_guidance.

CHECKLIST (TICK) — **THERMAL PERFORMANCE OF JUNCTION**

Continue wall insulation across the floor abutment zone.

Ensure that partial fill insulation is secured firmly against the inner leaf of the cavity wall.

Complying with the above checklist items qualifies the builder to claim the Ψ value given in Table 3 of IP 1/06 and Table K1 of SAP 2005.

CHECKLIST (TICK) — **AIR BARRIER CONTINUITY**

Ensure a continuous mortar bed between floor slab and top of blockwork wall.

Seal between the wall air barrier and the top and underside of the floor slab. ① (The dotted blue line depicts the continuity of the air barrier through the floor zone)

Seal the gap between the skirting board and floor using a flexible sealant.

Seal all penetrations through air barrier using a flexible sealant.

Complying with all of the above checklist items will help achieve the design air permeability and may effect a reduced testing regime.

OPTION (TICK) — **AIR BARRIER OPTIONS**

Plaster coat, or

Blockwork inner leaf/parging coat applied to internal face of inner leaf with plasterboard over

Plasterboard on dabs with continuous ribbon of adhesive around all openings, along the top and bottom of the wall, and at internal and external corners.

Accredited (Indicative) Detail Number: MCI-IF-01

GENERAL NOTES

- Ensure that cavities are kept clean of mortar snots or other debris during construction.
- This detail is diagrammatic only. Where the floor is a separating floor, this would normally have an acoustic ceiling and further treatments would be provided. See requirements of Approved Document E.

The above indicative guidance illustrates good practice for the design and construction of interfaces only in respect to ensuring thermal performance and air barrier continuity. The above guidance must be implemented with due regard to all other requirements imposed by the Building Regulations.

SITE MANAGER/ SUPERVISOR:	SITE NAME:	PLOT No:	DATE:

MCI-IF-01 Concrete Intermediate Floor.   Masonry Cavity Wall Insulation

ACD Checklist

Suggested construction sequence including site check list ✓

Pack compressible insulation between last truss/joist and gable wall.

Fix ceiling air barrier/vapour control layer to underside of trusses/joists with a lap of 300 mm down wall.

Fix insulation with minimum thermal resistance of 1.30m²K/W to underside of ceiling, with edge tight to air barrier/vapour control layer lapped down wall.*

Ensure checklist on Plasterstop Bead Detail P8 Pb1 has been completed.

First fix services to wall (and underside of ceiling where necessary).

Plaster blockwork to provide Air Barrier to wall.

Fix 50 mm wide (depth dependent on services to be provided) battens at maximum 600 mm centres perpendicular to trusses.

Erect internal walls with header plate secured to underside of ceiling battens.

Place plasterboards to ceiling, and tape joints or provide skim finish.

Place ceiling insulation between/over trusses/joists and ensure that the full depth of insulation over trusses/joists extends to inner edge of blockwork. N.B. This stage can be completed at any point from * above.

Provide mastic seal to all service penetrations.

Ψ = 0.057 W/mK

vapour control/air barrier

see enlarged detail of plaster lap with air barrier

❶ Thermal conductivity of blockwork adjacent to ceiling insulation must provide a minimum thermal resistance of 1.74m²K/W over the distance shown by the arrow.
❷ Minimum thermal resistance of this insulation layer to achieve 1.30 m²K/W.

Only when three complementary Energy Saving Trust Enhanced Details are used together, and in conjunction with all other relevant ACDs, can a y-value of 0.04 be used in SAP2005. See Introductory Document for full details.

This indicative guidance illustrates best practice for design and construction in respect to ensuring thermal performance and air barrier continuity, and must be implemented with due regard to site conditions and all other requirements imposed by Building Regulations.

Site Manager/Supervisor:	Site Name:	Plot No:	Date: / /

❶: Thermal Performance
❷: Air Barrier

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Enhanced Detail MV01 Gable
Use this detail instead of ACD: MCI-RG-01

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ECD Checklist

Thermal continuity checklist

1. Ensure that insulation layers in roof are fitted perpendicularly, to cover junctions
2. Check that roof insulation butts against the cavity wall insulation, with minimum of 50mm overlap at narrowest point
3. Install cavity barrier at the top of the wall.

Ventilation gap equivalent to 5mm minimum continuous opening at ridge is required where the roof pitch is greater than 35° or the roof span is more than 10m

Air tightness checklist

1. Check that any air tightness barrier used in the ceiling overlaps with the layer in the wall

Proprietary cross flow ventilator to maintain minimum 25mm air gap

Timber batten to provide fixing for plasterboard sheet

Vapour control layer in wall and ceiling

Ventilation gap equivalent to 10mm minimum continuous opening is required where roof pitch is above 15° or ventilation gap equivalent to 25mm minimum continuous opening is required where the roof pitch is below 15°

Insulation between the studs. This insulation to be tightly fitted against the wall, leaving no gaps

Cavity barrier giving 30 minute fire resistance - ensure cavity barrier is not breached by inappropriate rigid sheathing insulation material

Design advice

Minimising condensation risk

1. Check ventilation paths are clear before installing insulation above the ceiling

Thermal Resistance of insulation used in details:
Wall (cavity) - 2.500 (m²K/W
Wall (inner leaf) - 2.272 (m²K/W
Roof - 9.500(m²K/W

Note: See detail numbers 2.02 and 2.21 for other junctions using this roof construction

HEAT 2.7 software image of isotherms through junction detail. For illustrative purposes only.
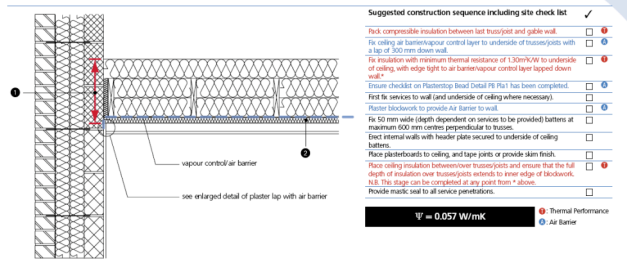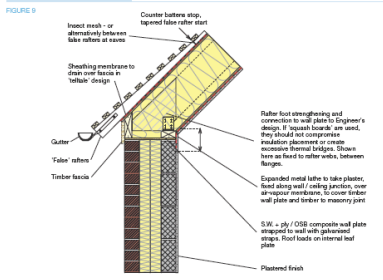
This example should be read in conjunction with the guidance in the introduction to this document. It illustrates the reduction of unwanted infiltration in buildings and provides a Psi value for this junction situation which can be used in calculation provided the principles outlined and any identified component specification are followed.

Psi value = 0.0392W/mK	Masonry: Cavity Wall Insulation - Partial fill Pitched Roof: Ventilated Roofspace - Eaves	Detail 2.01

Scottish ACD Detail

SECTION 2

FIGURE 9

Insect mesh - or alternatively between false rafters at eaves

Counter battens stop, tapered false rafter start

Sheathing membrane to drain over fascia in 'telltale' design

Gutter

'False' rafters

Timber fascia

Rafter foot strengthening and connection to wall plate to Engineer's design. If 'squash boards' are used, they should not compromise insulation placement or create excessive thermal bridges. Shown here as fixed to rafter webs, between flanges.

Expanded metal lathe to take plaster, fixed along wall / ceiling junction, over air-vapour membrane, to cover timber wall plate and timber to masonry joint

S.W. + ply / OSB composite wall plate strapped to wall with galvanised straps. Roof loads on internal leaf plate

Plastered finish

ψ values for linear thermal bridges

|	ψ in W/mK	ψ ext W/mK
As shown		
Eaves	0.03	-0.08
Compare UK Accredited Constructions	0.04	
Verge (For verge, assuming continuous insulation between wall and roof)	0.03	-0.08
Variations		
Without cavity closer	0.00	-0.11

Notes

1 It is not necessary to install a cavity stop as long as the insulation is continuous.

2 The plant-on rafter foot, reducing to match the roofing counter-batten, is a convenient way to deal with composite I beam eaves. It allows the gutter to be placed exactly where it is needed.

3 One must sometimes also consider the impact of elements such as purlins and ridge beams on ψ values; they may constitute further linear non-repeating thermal bridges.

Isotherms
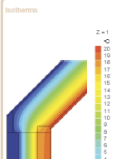
AECB Detail

Thermal Bridging Junction Details
All are Junctions with an External Wall

**E1** Steel Lintel with Perforated steel base plate
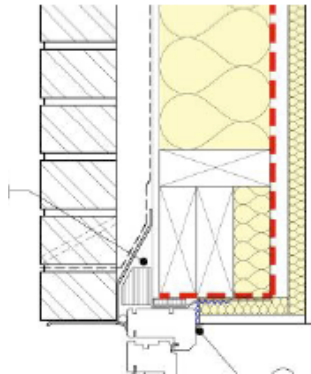
E2 All other lintels including other steel lintels

The combined lengths are taken automatically from the window dimensions as entered into the SAP software, then multiplied by the appropriate Ψ values.

E3 Sill & **E4** Jamb

The combined lengths are taken automatically from the window dimensions as entered into the SAP software, then multiplied by the appropriate Ψ values.
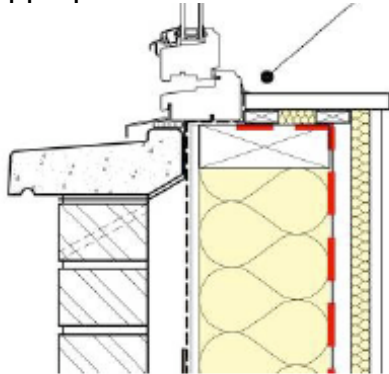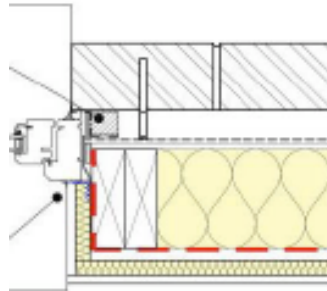
Sill   Jamb

E5 Ground Floor

This is taken as the exposed heat loss perimeter on the ground floor.

E6 Intermediate floor within dwelling

This is the exposed heat loss perimeter of all the floors above the ground floor.

E7 Intermediate floor between dwellings

This applies to flats only, and is the exposed heat loss floor perimeter (other than ground floor) and exposed heat loss ceiling perimeter (other than top floor) of each flat.

E8 Balcony within a dwelling

The width of the balcony, if a balcony does not bridge the wall insulation, but is externally supported ACDs can apply.

E9 Balcony between dwellings
This applies to flats only and is the same as above.

E10 Eaves insulation at ceiling level & **E11** Eaves insulation at rafter level
The length of eaves is measured for both.

E12 Gable insulation at ceiling level
The width of the gable end is measured

E13 Gable insulation at rafter level
The length of the rafter at the gable end is measured

E14 Flat Roof
The perimeter of the flat roof

E15 Flat Roof with Parapet
As above

E16 Normal Corner
These are the lengths of all the external corners added up

E17 Inverted corners
These are the lengths of all the internal corners added up

E18 Party Wall between dwellings
This is the vertical length of the external wall where it meets the neighbouring property

Junctions with a Party Wall

P1 Ground floor
This is the width of the party wall at ground floor level

P2 Intermediate floor within dwelling
This is the width of the party wall of all the floors above the ground floor.

P3 Intermediate floor between dwellings
This applies to flats only, and is the floor width joining the party wall (other than ground floor) and is the ceiling width joining the party wall (other than top floor) of each flat.

P4 Roof insulation at ceiling level
The length of eaves is measured at ceiling level across the party wall width

P5 Roof insulation at rafter level
The length of the rafter at the party wall gable end is measured

Thermal Bridging and Air Permeability

There is a close correlation between the air permeability of a building and thermal bridging, and often attention to the details in junction design means that a lower air permeability target can be set. In the example in Table 2 below, the actual y values vary considerably on their own, and their overall impact on the DER (Dwelling Emission Rate) may be quite small, it depends on the building. However the impact of lower air permeability figures on the overall DER can and do have a much bigger influence, therefore by paying greater attention to reducing the thermal bridges combined with lower y values, means that lower air permeability figures may be used, without risk of a failed air test.

An air permeability test is used to determine the unwanted heat losses through the building fabric, usually this is very adept at showing up easy to repair unwanted leaks, around service pipes and skirting boards for example, however, as the building is already constructed when this is done, it will also show up much more expensive and difficult to repair leaks in the building fabric if these have not been correctly designed and built.

DER	TER	AIR PERMEABILITY	Y VALUE
16.98	14.75	10	0.161*
14.15	14.75	5	0.064^

Table 2 – Example of how air permeability and y value are linked to the DER result.

The above y values have been calculated using the default Ψ values* with the Building Regulations minimum of 10 for air permeability to achieve a DER of 16.98, in this case a fail.

However, when calculated using ACD Ψ values ^ with the much lower air permeability of 5, this will achieve a DER of 14.15, a pass.

Case Studies

Below are two case study buildings, recently assessed in SAP 2009, showing the differences on the overall result by using the various ACD scheme Ψ values compared to the default values.

Case Study 1 - Detached House

GROUND FLOOR

FIRST FLOOR

FRONT ELEVATION
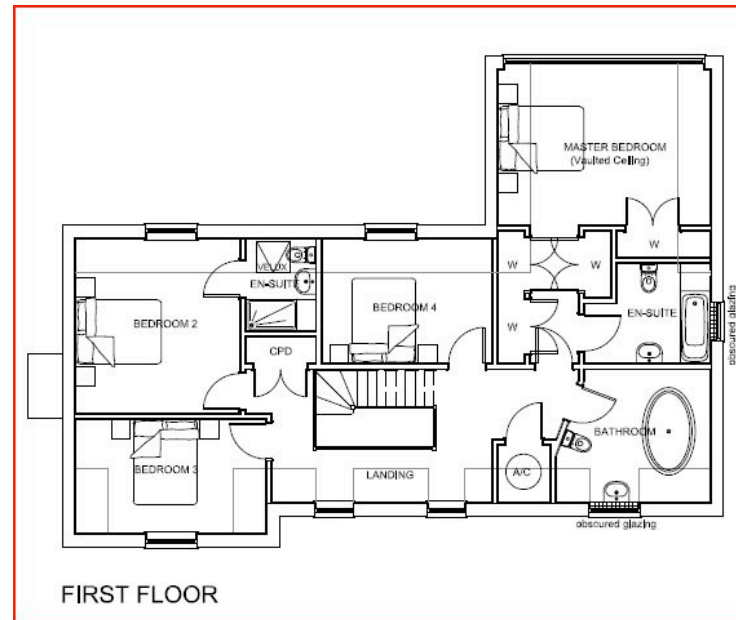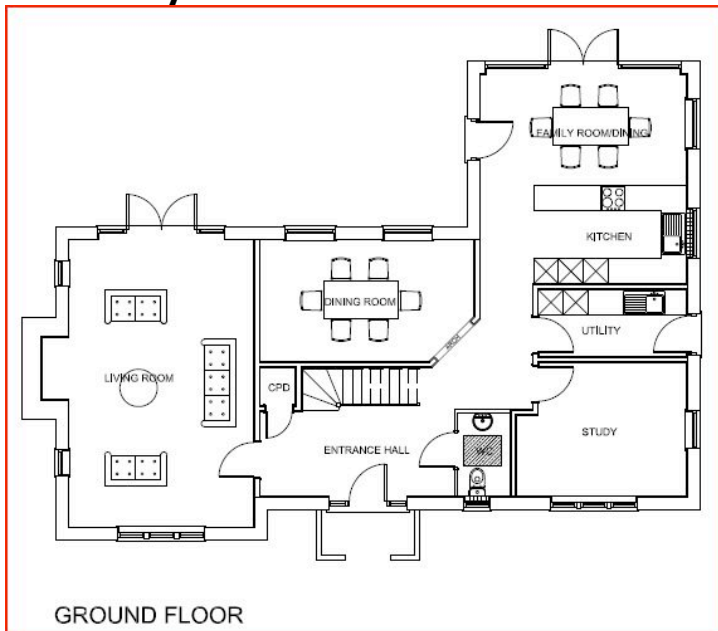
125 m2 Ground Floor Area
Construction & U Values:

- Beam and Block Ground floor 0.2

- Cavity Walls 0.25

- Roof insulated at both rafters and joists 0.23 & 0.15

- Timber framed Double Glazing 1.8

- Air Permeability 10

- **Ψ values used were the default values**

Junction	Length (M)	Default Ψ	ACD Ψ	ECD Ψ	Scot ACDΨ	AECB Silv Ψ	AECB Gold Ψ
E2	30.0	**1.0**	0.3	0.010	0.017	0.06	Silver
E3	30.0	**0.08**	0.04	ACD	0.09	0.03	Silver
E4	62.24	**0.1**	0.05	ACD	0.23	0.03	Silver
E5	51.75	**0.32**	0.16	0.081	0.19	0.1	0.061
E6	51.75	**0.14**	0.07	ACD	0.054	ACD	0.0
E10	8.4	**0.12**	0.06	ACD	0.04	ACD	0.33
E11	22.7	**0.08**	0.04	ACD	0.069	0.03	0.037
E12	13.8	**0.48**	0.24	0.057	0.14	ACD	ACD
E13	10.02	**0.08**	0.04	ACD	ACD	ACD	ACD
E16	40.10	**0.18**	0.09	ACD	0.064	0.06	0.066
E17	20.08	**0.0**	-0.09	ACD	0.12	-0.06	Silver
Total y value W/m.K		**0.16**	**0.064**	**0.034**	**0.079**	**0.039**	**0.033**

Table 3: Comparison of Ψ values from the various ACD schemes on a single detached house

If a Ψ value is not available in a scheme, the next best value has been assumed, this has been indicated in the column. For example, if AECB Gold were to be used, there is not an E2 in the Gold Standard but there is in the Silver, therefore the value of the Silver one has been used.

If user defined Ψ values were to be used, they are subject to a 25% or 0.02 increase in the value, this is because it's not been subjected to an accredited Q&A for buildability.

	Default Ψ	ACD Ψ	ECD Ψ	Scot ACDΨ	AECB Silv Ψ	AECB Gold Ψ
DER	**4.72**	4.40	4.30	4.45	4.32	4.30
TER	**14.75**	14.75	14.75	14.75	14.75	14.75
FEES	**68.12**	59.90	57.22	61.17	57.66	57.13

Table 4: Comparison of overall results on a single detached house

DER = Dwelling Emission Rate
TER = Target Emission Rate
FEES = Fabric Energy Efficiency Standard

As can be seen from the above table, the DER, which must be lower than the TER to gain an overall pass, varies by 0.42 from the lowest to the highest depending on which ACD scheme is used compared to the default values.
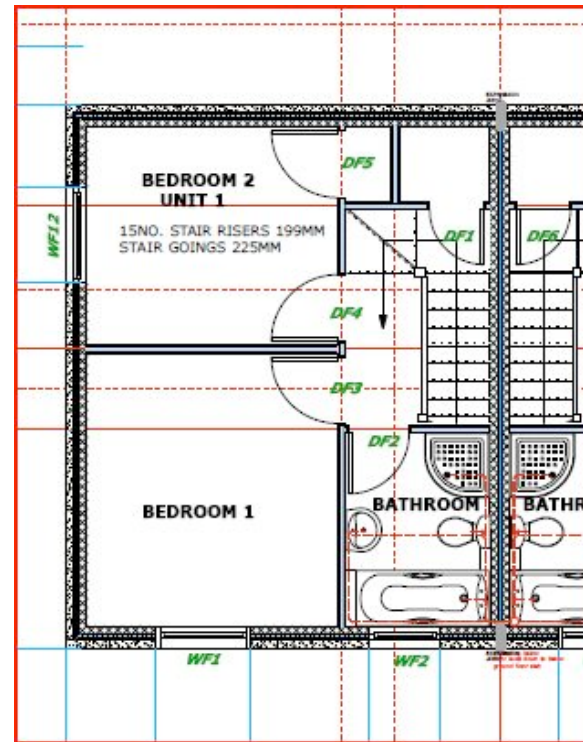
This particular dwelling had a biomass boiler with wood pellets delivered in bulk, which is why the DER is so much lower than the TER.

Should this dwelling have had a gas boiler, it would have failed with a DER of 16.85 and the thermal performance would need to have been significantly improved.

Case Study 2 End Terrace House
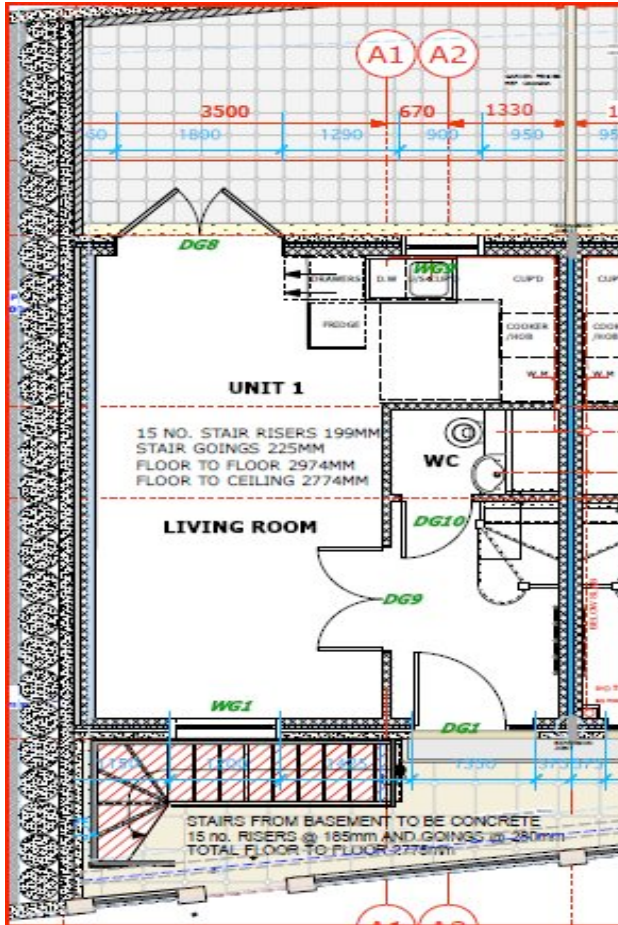
Ground Floor

First Floor

Front Elevation

33 m2 Ground floor Area
Construction & U Values:

- Beam and Block Ground floor 0.15

- Cavity Walls 0.2

- Party Wall 0.0

- Roof insulated at rafters 0.15

- Timber framed Double Glazing 1.4

- Air Permeability 4

- **Ψ value used were the ACD values**

Junction	Length (M)	Default Ψ	ACD Ψ	ECD Ψ	Scot ACDΨ	AECB Silv Ψ	AECB Gold Ψ
E1	1.2	1.0	**0.5**	0.07	ACD	0.06	Silver
E2	8.4	1.0	**0.3**	ACD	0.13	0.06	Silver
E3	9.6	0.08	**0.04**	ACD	0.02	0.03	Silver
E4	27.8	0.1	**0.05**	ACD	0.222	0.03	Silver
E5	16.57	0.32	**0.16**	0.067	0.067	0.1	0.061
E6	16.57	0.14	**0.07**	ACD	0.077	ACD	0.0
E11	10.12	0.08	**0.04**	ACD	0.034	0.03	0.037
E13	6.45	0.08	**0.04**	ACD	ACD	ACD	ACD
E16	12.52	0.18	**0.09**	ACD	0.064	0.06	0.066
E18	12.52	0.12	**0.06**	ACD	ACD	0.08	Silver
P1	6.45	0.16	**0.08**	ACD	0.051	ACD	ACD
P2	6.45	0.04	**0.00**	ACD	0.013	ACD	ACD
P5	6.45	0.04	**0.02**	ACD	0.224	ACD	ACD
Total y value W/m.K		**0.162**	**0.070**	**0.058**	**0.086**	**0.044**	**0.034**

Table 5: Comparison of Ψ values from the various ACD schemes on a single end terraced house

If a Ψ value is not available in a scheme, the next best value has been assumed, this has been indicated in the column. For example, if AECB Gold were to be used, there is not an E2 in the Gold Standard but there is in the Silver, therefore the value of the Silver one has been used.

If user defined Ψ values were to be used, they are subject to a 25% or 0.02 increase in the value, this is because it's not been subjected to an accredited Q&A for buildability.

	Default Ψ	ACD Ψ	ECD Ψ	Scot ACDΨ	AECB Silv Ψ	AECB Gold Ψ
DER	25.11	**22.49**	22.13	22.93	21.72	21.43
TER	22.62	**22.62**	22.62	22.62	22.62	22.62
FEES	76.02	**63.46**	61.77	65.57	59.82	58.44

Table 6: Comparison of overall results on a single end terraced house

DER = Dwelling Emission Rate
TER = Target Emission Rate
FEES = Fabric Energy Efficiency Standard

Dwelling Emission Rate (DER) is the actual kg CO2/m2/year for the building.

The Target Emission Rate (TER) is the kg CO2/m2/year for a building of the same size and dimensions of the actual building that complies with all the requirements of L1A.

Fabric Energy Efficiency Standard (FEES) is not currently part of L1A, however, there are plans to use as a measure of the thermal efficiency of the building at some point in the future. It is a measure in kWh/m2/year for a combination of U Values, Thermal Bridging, Air Permeability, Thermal Mass and Solar Gains.
Maximum figures to achieve are:
- 39 kWh/m2/yr are for Mid-terraced Houses/Flats/Maisonettes
- 46 kWh/m2/yr for End-terraced, Semi detached/Detached Houses.

Table of Thermal Bridging Values for SAP calculations (Separate excel spreadsheet)

How to use the spreadsheet:

If no Accredited Details or similar are to be used, then the Default value will be applied to the Thermal Bridging calculation.

However, if an alternative PSI (Ψ) value is required the various Schemes listed in the spreadsheet offer alternative proven solutions for some of the junctions with an external wall or party wall.

As far as possible each schemes PSI (Ψ) value is listed on the same line as the most comparable in each scheme to gain a comparison for like for like.

Example:

E5 Ground floor, if not using the default value and the wall is a masonry wall construction; there are a number of choices within each of the different schemes.

The values will indicate how they compare to one another, the actual construction details can be found by using the reference numbers and looking them up with the appropriate scheme.

NOTES:

Junction References used in the table:

ACD	SF = Steel Framed Construction
MCI = Masonry cavity walls	SACD
MII = Masonry Internal insulation	1 = Masonry Construction full fill cavity
MEI = Masonry External Insulation	2 = Masonry Construction Partial fill cavity
TFW = Timber Framed Wall	3 = Timber Framed Construction
STW = Steel Framed Wall	4 = Steel Framed Construction
ECD	AECB
MV = Masonry Construction	MW = Masonry Wall
TF = Timber Framed Construction	TW = Timber Wall

Other Junctions: these will not currently be assessed in SAP, however they are listed here for the designer should they be required.

Sources:

* Source: The Governments Standard Assessment, Procedure for Energy Rating of Dwellings: 2009 Edition, incorporating RDSAP 2009, BRE

** Source: Energy Saving Trust Enhanced Construction Details Matrix

*** Source: Accredited Construction Details (Scotland) October 2010 v1.2

W/mK*> The AECB Carbonlite Silver Standard V 1.0.0

W/mK*< The AECB Carbonlite Passivhaus/Gold Standard V 1.0.0

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