EPIC
ENGINEERED PANELS IN CONSTRUCTION

Insulated Panels for external roof and wall cladding




Conservation of Fuel and Power Building Regulations (2013-14)

England: AD Part L2
Wales: Part L2
Northern Ireland: Part F
Scotland: Section 6 (2015)

Guidance on compliance using Insulated Panel Systems

Issued June 2015

Introduction – 2013 & 2014 Energy Regulations

New regulations – non-domestic buildings

The latest amendment to the England AD-L2 and Wales L2 Regulations for the conservation of fuel and power (2013) came into effect on 6 April and 31 July 2014 respectively. This is the third amendment following the introduction of these mandatory regulations in 2002. The revision to Section 6 Scotland becomes effective on 1 October 2015.

The 2013-15 Amendments are the latest stage in the planned progress to nearly net zero energy buildings by 2019. The emphasis is based on setting challenging on-site targets based on what levels of improvement would be cost-effective over the next few years.

AD-L2 [England], L2 [Wales] and Section 6 [Scotland] follow the principle of the 2010 Regulations but with significant changes in the definition of the types of buildings that make up the aggregate mix. As before, the whole building is assessed using the SBEM 'whole building methodology' that expresses the energy performance. Since it is the building services that emit CO_2 and not the building elements, the total building energy performance takes account of the CO_2 emissions resulting from the provision of heating, hot water, ventilation, cooling and lighting. It is therefore based on the building's use in occupation. In addition the Welsh Regulations have introduced an additional requirement that assesses Primary Energy Consumption.

The EPIC guide

This Guide has been prepared by EPIC to assist Architects and Specifiers who are using Insulated Panels in the design of Industrial, Commercial, Leisure, Transport, Education, Health and other buildings.

Sections 1-6 of the Guide cover the new requirements as they are applied to new buildings.
Sections 7-9 summarise the requirements applied to the refurbishment and extension of buildings.
Sections 10 & 11 summarise the requirements applied to the shell and fit out of buildings.

The EPIC Guide gives information on:

- The data that is required to be inputted for Insulated Panels including the junctions and details as well as the airtightness of the building fabric
- How to understand the SBEM Calculation Tool and the influence of the various elements that affect energy consumption
- Which systems are penalised by the methodology and discouraged from use
- Keys to achieving compliance

	Title	Implementation date	Download
England	Approved Document L2A (New build) and L2B (Refurbishment) – Conservation of fuel and power	6 April 2014	www.planningportal.gov.uk/buildingregulations/approveddocuments/partl/approved#ApprovedDocumentL2A:ConservationoffuelandpowerNewbuildingsotherthandwellings
Wales	Approved Document L2A (New build) and L2B (Refurbishment) – Conservation of fuel and power	31 July 2014	www.wales.gov.uk/topics/planning/buildingregs/publications/part-l-energy/?lang=en
Scotland	Building (Scotland) Regulations – Technical Handbook: Section 6 Energy	1 October 2010* *Revision effective from 1 Oct 2015	www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/s62015
Northern Ireland	DFP Technical Booklet F2 (2012) – Conservation of fuel and power in buildings other than dwellings	Current October 2012	www.dfpni.gov.uk/tb_f2_online_version-2.pdf 2014 amendments www.legislation.gov.uk/nisr/2014/44/regulation/6/made

Whilst every attempt has been made to verify the guidance given, it should not be regarded as definitive. Because individual manufacturers' products vary, the performance should always be confirmed with them.

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Download information from the EPIC website

This guide to the amendments to the Building Regulations 2013-15 together with the other EPIC Guides can be readily downloaded from the EPIC website at www.epic.uk.com

England AD-L2A New build
Implications of the 2014 requirements

New compliance targets

The 2013 Amendment is the latest stage in the Government's planned progress to nearly net zero energy buildings by 2019. The emphasis is based on setting challenging on-site targets based on what levels of improvement would be cost-effective over the next few years.

This latest amendment to the England Part L Regulations for the conservation of fuel and power (2013) came into effect on 6 April 2014. It is the third amendment following the introduction of these mandatory regulations in 2002.

The AD-L2: 2013 amendment significantly changes the way non-domestic buildings – industrial, commercial, retail, leisure, schools and health – are assessed in terms of the energy consumed and the associated carbon dioxide emitted.

The national calculation methodology that underpins the Building Regulations is reliant on the principle of comparing the actual design of the building with a notional building of the same shape and size based on a recipe of fabric and services standards. To comply, the carbon emissions from the actual building shall not exceed the target CO_2 emission rate for the notional building as calculated by the SBEM model or equivalent.

In Part L 2010, two notional buildings were defined for top-lit (warehouses) and side-lit (all other) buildings. In Part L 2013 notional buildings reflect the different energy profiles and building services plant likely to be found in the buildings and are defined for:

- Top-lit (warehouses – further defined by size)
- Side-lit (heated only)
- Side-lit (heated and cooled)

New prescriptive building types

The major change for non-domestic buildings is that they have been divided into seven building types (Table 1) to conform to the national building specifications. A specific Notional Building has been calculated for each within the SBEM model. The main building types have been allocated a target energy/carbon emission saving over 2010 levels that is considered achievable with improvements only to the fabric and services in the notional building. This approach represents an average saving over all building types of 9%.

The target savings are different for each group and have been programmed into SBEM or the equivalent compliance models. These improvements do not assume the use of any renewable energy component e.g. photovoltaics.

Table 1. New notional building types for 2013

Non-domestic building type	% increase over 2010
Distribution warehouse	4%
Deep plan office (Air conditioned)	12%
Shallow plan (Air conditioned)	13%
Retail Warehouse	8%
Hotel (5-star hotel was taken as a representative of all hotels)	12%
School (A secondary school was taken as a representative of all schools)	9%
Small warehouse unit	3%

Simplified Building Energy Model (SBEM)

The SBEM procedure remains the stated method for assessing compliance in AD-L2: 2013 (England); L2: 2014 (Wales); Section 6: 2010 (Scotland); and Part F: 2012 (Northern Ireland). SBEM is one of several approved software options for assessing compliance.

The latest SBEM programme and user guide can be downloaded from the following link:
www.ncm.bre.co.uk

Implications for designers

Changes in Notional Building

In common with previous Regulations, compliance is based on an assessment of the whole building performance – the envelope, lighting and services. However the balance between the savings contributions for the envelope, lighting and controls, and services has again changed in accordance with the increased number of building types.

In addition the NCM tool (SBEM) further sub-divides each building type. A basic design format is prescribed for each building sub-type, for example SBEM automatically assumes a given type of daylighting (side-lit windows or top-lit rooflights), hot water heating etc. It is vital that the correct type of building information is entered into SBEM, otherwise an incorrect computation could result in non-compliance.

Buildings are sub-divided into the seven principle categories (Table 1). These can be found in the drop-down menu within SBEM or equivalent programmes.

Designers should check against the NCM Handbook that the chosen notional building type has the same configuration as the design building particularly in terms of type of daylighting, lighting and control, and also assumed occupancy and type of building services.

The buildings are then further divided into zones, as with the previous SBEM, but new menus describe a choice of activities/demands. The selection is different for each of the building types in Table 1.

NOTE. The calculation showing that the target CO_2 emission rate is not exceeded has to be completed at design stage and submitted to Building Control together with a list of specifications of the building envelope and the fixed building services.

England AD-L2A New build
Implications of the 2014 requirements

Contributions towards compliance

The mechanism of compliance requires designers to look at the energy performance and efficiency of all elements and services affecting the consumption of energy. The contribution from each of these areas varies considerably and therefore it is essential that designers understand the workings of the calculation method and which areas represent the most cost effective route to compliance (see section 3).

Improvements to the building fabric performance and level of air permeability can make a significant contribution to the target savings. However trials using a range of buildings have shown that improving the fabric alone is not sufficient to achieve compliance. Improvements to services and particularly lighting and controls are also necessary to achieve compliance.

Improved values in the Notional Buildings

In order to achieve the 9% target improvement in energy/carbon emissions for 2013, the set values in the Notional Building have been further improved compared to 2010, including:-

- Lower air permeability rate
- Improvements to lighting and controls
- Improved efficiency of services and controls
- Limitations on the effect of solar gain
- Fabric U-values have been retained at 2010 levels

The overall level of improvement is so significant that in order to comply, **all** aspects of the building will have to be improved or made more efficient and fabric levels should at minimum be retained at the 2010 levels.

Interdependence of data

Significantly changing the performance in one area or of one element may create a change in other areas that may not necessarily be beneficial. For example increasing the roof daylighting percentage may reduce lighting energy requirement but will adversely affect the building fabric thermal weighted average and increase the effects of solar gain.

Notification on completion

After work has been completed the contractor/builder must notify the Building Control Body [BCB] of the target CO_2 emission rate [TER] and the building CO_2 emission rate [BER] and whether the building has been constructed in accordance with the list of specifications submitted to BCB before the work started. If not, a list of any changes to the design-stage list of specifications must be given to the BCB. [AD-L2A #2.15]

2 New build
Insulated Panels – labelling and cost effective compliance

The 2013 amendment is the latest stage in the Government's planned progress to nearly net zero energy buildings by 2019.

Designing buildings in accordance with AD-L or the other National Regulations is part of the long-term implementation of the European EPBD (Energy performance of Building Directive). The EPBD includes a requirement for the energy labelling of buildings including the determination of Operational Ratings for all buildings.

The EPBD Directive has led to a new focus on the long-term energy performance of building envelope systems. Disclosure of the Operational Rating has already become a legal requirement for a number of government owned and other buildings and any drop in performance during the life of the cladding systems could materially affect the potential sale value and letability. Insulated Panels offer sustained performance over future years.

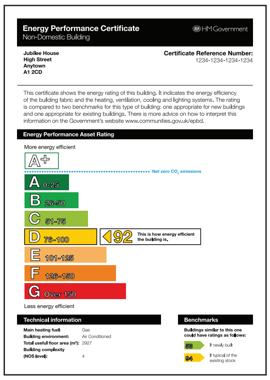
PIR Insulated Panels offer sustainable performance during the life of the building

Building certification and labelling

Energy Performance Certificates (EPCs) are now mandatory and are required for all buildings that are being built, let or sold. They are part of the establishment of Operational Ratings for buildings and are part of the new build process.

The calculation compliance summary from the SBEM or equivalent calculation methodology is used by the registered person as part of their assessment of the as-built construction and is checked against the reference building to create the EPC. An EPC lasts for 10 years.

EPCs should not be confused with DECs (Display Energy Certificates) for public buildings that are based on actual energy consumption and are reviewed annually.


Energy Performance Certificate
Non-Domestic Building
HM Government

Jubilee House
High Street
Anytown
A1 2CD

Certificate Reference Number:
1234-1234-1234-1234

This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one appropriate for new buildings and one appropriate for existing buildings. There is more advice on how to interpret this information on the Government's website www.communities.gov.uk/epbd.

Energy Performance Asset Rating

More energy efficient
A+
Net zero CO_2 emissions
A 0-25
B 26-50
C 51-75
D 76-100
92 This is how energy efficient the building is.
E 101-125
F 126-150
G Over 150
Less energy efficient

Technical information

Main heating fuel: Gas
Building environment: Air Conditioned
Total useful floor area (m^2): 2927
Building complexity (NOS level): 4

Benchmarks

Buildings similar to this one could have ratings as follows:
58 If newly built
94 If typical of the existing stock

Example of operational rating certificate

Benefits and contribution to compliance and cost effectiveness of Insulated Panels

From their introduction Insulated Panels with PIR insulating cores have offered the designer a guarantee of long-term performance.

Insulated Panels produced as single piece system under factory-controlled conditions ensure that:

- Insulation thickness and performance is calculated, controlled and maintained
- The insulation performance of PIR is one of the most efficient available allowing the dimensions of the wall and roof zone to be kept to a minimum
- The insulation performance remains virtually unchanged throughout the life of the panel due to the encapsulation of the metal facings
- The joints between panels are fully engineered to minimise heat transmittance and ensure that air leakage is minimised after onsite installation.

The complete system including approved details and accessories enable an airtight and energy efficient envelope to be installed by the established cladding installers

Both thermal performance and the airtightness of Insulated Panel systems can be readily controlled, enabling the services engineer to design plant sizes efficiently to maximise capacity and energy efficiency. Under the original 2002 regulations this was of direct benefit to the building user. Under the revised regulations this benefit also translates directly into carbon savings and a positive contribution to the target savings under the SBEM compliance calculations.

2 New build
Insulated Panels – labelling and cost effective compliance

Although the main focus will be how to achieve compliance in meeting the requirements of AD-L2 (2013) for both new build and refurbishment, the continuing rise in the cost of energy has placed renewed emphasis on the thermal performance of building envelopes.

Numerous studies over the past 20+ years, including new research on the 2010 Regulations, have shown the substantial benefits that can be achieved in heating energy costs by moving to an insulated panel clad building. In certain cases payback periods as low as 18 months have been achieved for the re-cladding of buildings.

Cost effective design – new research

A detailed analysis by AECOM on behalf of Kingspan Insulated Panels has been carried out to study the effect of improving insulation levels. The analysis compared the performance of a variety of non-domestic buildings (as detailed in the Building Regulations Part L:2010) under varying circumstances that reflect the practical use of top-lit buildings. This research assessed the energy requirements, carbon emissions, capital costs, net current values and cost effectiveness of the aggregate notional NCM 2010 warehouse buildings, considering four sets of usage options including internal usage types; heating temperature set points; occupancy assumptions; and three insulation levels.

The research study highlights that cost effectiveness of insulation levels is dependent on the building type, temperature set point and occupancy levels. The following general conclusions can be drawn.

- For warehouse storage buildings an improvement of insulation levels – to walls at U-value=0.25 W/m^{2}K and roofs at U-value=0.18 W/m^{2}K – was found to be cost effective for temperature set points and occupancies at the NCM levels
- For retail warehouse buildings the same improvement in insulation levels was found to be cost effective in all cases unless the temperature set point is reduced to 16°C.
- For industrial process buildings the National Calculation Method defines these buildings as having very high internal gains at a level that is not realistic for many industrial process buildings. Against these parameters the result was not cost effective but as there is a potential for change of use of these buildings to a lower internal gain activity it is prudent to maintain good levels of insulation
- The impact of improved values on peak demand was also investigated. Peak demands in some cases reduce by up to 20% with the highest insulation levels. This could have an impact on the cost of the heating systems and would therefore reduce the additional capital costs of the insulation

The cost effectiveness of improving the fabric insulation increases further if DECC Fossil Fuel Price Assumptions are used (Natural Gas at 2.87p/kWh in 2010 rising to 4.06p/kWh by 2020). With only this change in natural gas fuel cost assumptions it is cost effective in nearly all top-lit buildings to insulate to levels of walls at U-value=0.20 W/m^{2}K and roofs at U-value=0.15 W/m^{2}K.

3 New build 2014
Key issues – the SBEM calculation method

3.1 Understanding SBEM – CO_2 contributors

Compliance under AD-L:2013 is demonstrated by proving that the target carbon dioxide emission rate (TER) for the whole building is achieved, as determined by the SBEM or other similar calculation method.

It is electrical, oil or gas energy used by the building services that produces CO_2. The generation of CO_2 in Kg per kW.h for each energy source is shown in Table 2.

Table 2. CO_2 emission factor by energy source

Energy source	CO_2 (kg/kW.h)
Electricity	0.517
Gas	0.198
Oil	0.297

Table 2 lists values taken from the IES calculation model that illustrates clearly that electrical energy used for lighting and the running of services has a considerably greater effect than gas or oil used for heating. Selecting energy efficient plant and equipment that are high users of electrical energy or restricting the use of electrical energy (e.g. lighting controls) produces the largest contribution in SBEM and the other calculation methods. EPIC's recommendations later in this section and in section 4 take this into account.

3.2 Building envelope U-values

U-values (Thermal performance of roofs, walls and floors)

Although the AD does not prescribe U-values, the fact that significantly improved levels have been set into the SBEM notional building means that adopting inferior U-values in the design specification could lead to non-compliance. If worse values are specified then additional major improvements will have to be made in building services, or on-site renewable energy technologies will have to be included to achieve compliance.

As well as being an important factor in achieving compliance, using the 2013 values or better can also be cost effective – see Section 2.

Table 3 shows the U-values used in the 2013 Notional (non-domestic) Buildings together with the backstop values. These are the same as the 2010 levels with the exception of windows U-values. There is no differentiation between heated only and heated and cooled buildings in the notional building.

Table 3. Fabric U-values and backstop levels

Notional building	2013 Notional building values			2013 Backstop values
AD-L2A England	Side-lit/unlit (specification is heating only)	Side-lit/unlit (specification includes cooling)	Top-lit	
Roofs	0.18 W/m²K	0.18 W/m²K	0.18 W/m²K	0.25 W/m²K
Walls	0.26 W/m²K	0.26 W/m²K	0.26 W/m²K	0.35 W/m²K
Floors	0.22 W/m²K	0.22 W/m²K	0.22 W/m²K	0.25 W/m²K
Glazing	1.6 W/m²K	1.6 W/m²K	N/A	2.2 W/m²K
Rooflights	N/A	N/A	1.8 W/m²K	2.2 W/m²K
Rooflight (Max. area)	N/A	N/A	12% area	N/A

EPIC recommends

EPIC recommends designing non-domestic buildings to the 2013 U-values set in the Notional Building or better as a cost effective way to compliance.

3.3 Air permeability

In AD-L2: 2013 for non-domestic buildings air permeability is the only part of the fabric performance that has been improved beyond the 2010 levels. The major change is that air permeability levels are defined according to 'Gross Internal Area' (GIA) becoming lower as the GIA increases. Following the research shown below and representation from EPIC and MCRMA, the levels for smaller top-lit buildings (below 250 m^2) have been relaxed to 7 $m^3/m^2/h$.

Table 4 illustrates the changes which are shown in $m^3/(h.m^2)$ at 50Pa according to GIA. There is a backstop level of 10 $m^3/(h.m^2)$ at 50Pa. The 10 $m^3/(h.m^2)$ limit is a mandatory requirement for all new buildings except those below 500m^2 for which 15 $m^3/(h.m^2)$ can be adopted without testing.

Table 4. Air Permeability levels by Gross Internal Area (GIA)

	2013 Notional building values		
	Side-lit/unlit (specification is heating only)	Side-lit/unlit (specification includes cooling)	Top-lit
GIA ≤250 m^2	5 $m^3/(h.m^2)$	5 $m^3/(h.m^2)$	7 $m^3/(h.m^2)$
250 m^2 < GIA ≤ 3500 m^2	3 $m^3/(h.m^2)$	3 $m^3/(h.m^2)$	7 $m^3/(h.m^2)$
3500 m^2 < GIA ≤ 10000 m^2	3 $m^3/(h.m^2)$	3 $m^3/(h.m^2)$	5 $m^3/(h.m^2)$
10000 m^2 < GIA	3 $m^3/(h.m^2)$	3 $m^3/(h.m^2)$	3 $m^3/(h.m^2)$

Research summary

In September 2010 EPIC commissioned Building Sciences to conduct an analysis of the performance of 245 building reports issued between January 2008 and August 2010. The objective was to obtain an understanding of how actual building performance compared against the 2006 regulatory requirement of 10 $m^3/(h.m^2)$ and in particular whether it is more difficult to achieve lower air permeability values with smaller footprint areas.

- 33% of the buildings tested either failed to comply or only just passed 10 $m^3/(h.m^2)$
- 80% would fail the 2010 benchmark in the SBEM Model of 5 $m^3/(h.m^2)$
- Of buildings with a footprint greater than 4000m^2, 84% achieved a measured air permeability less than 7 $m^3/(h.m^2)$ and 68% achieved a value of 5 $m^3/(h.m^2)$ or better
- Generally the lower the foot print area the worse the air permeability value, especially where the structures are more complex with mixed cladding types

Buildings below 4000m^2 footprint

Research into levels of actual air permeability achieved for buildings with a footprint area under 4000m^2 indicate that improvements from 10 to 5 $m^3/(h.m^2)$ at 50Pa are difficult to achieve unless specific attention is paid to the detailing at both the design and construction stages. Air tightness is very dependent on workmanship however good the joints and details from the manufacturer.

The research data suggests that designers should give very careful thought to air permeability values and the design value that is put into the SBEM calculation. In many cases the new AD-L2A: 2010 Notional Building value of 5.0 $m^3/(h.m^2)$ may be difficult to achieve in practice. Failure to achieve the design air permeability value will compromise the ability of the completed building to achieve overall compliance with the Building Regulation. Failure to comply will inevitably involve project delays and additional costs.

Key issues – the SBEM calculation method

The research suggests a conservative value for air permeability should be adopted at design stage, generally above the Notional Building value, to minimise the risk of non-compliance

Buildings above 4000m^2 footprint

In general terms as a building increases in size and volume it will be easier to achieve a low air infiltration value. However, the more complex buildings such as those with a large level of interface details, for example, offices, schools, hospitals and hotels need careful consideration as to whether an air permeability design value of 5 m^3/(h.m^2) at 50Pa is appropriate. Using a higher air permeability design value would lower the risk of failing the final SBEM calculation.

For larger, less complex buildings it may be possible to use an air permeability design value of less than 5 m^3/(h.m^2) at 50Pa however the risk of failing the final SBEM calculation and subsequent cost and program issues needs to be considered.

It is worthwhile remembering that buildings which beat the target carbon emission rate will achieve a better EPC rating and, if BREEAM assessed, will gain additional credits in the energy section.

3.4 Construction details

For DSM software, the non-repeating thermal bridge heat losses for each element (including windows, etc.) must be allowed for by adding 10% to the standard area-weighted average U-values,

In the case of SBEM psi-values (ψ) are entered for the main details calculated using an equivalent method that satisfies BS EN ISO 14683. Insulated Panel Manufacturers' details satisfy these criteria. The psi-values used in the Notional building will be the default values from Table 5 column (a) unless manufacturers' certified details are used in which case the typical values in Table 5 column (b) apply.

The chosen method and values should be consistently applied to both actual and notional buildings.

Steps for entering manufacturers' psi-values in the SBEM Calculation.

- The Ψ-values entered in the calculation should be calculated by a suitably experienced and qualified person
- The Ψ-values supplied either by EPIC panel manufacturers meet this criteria
- Installation should be to a reasonable standard of workmanship including continuity of insulation and air seals. EPIC panel manufacturers provide detailed information on the seven principal details listed in the SBEM dropdown lists
- The installer must provide information on the construction of the details to Building Control

Approved details from the Insulated Panel Manufacturers are generally designed to give lower and more efficient psi-values for most of the common junctions. Use of these details can result in improvements in the TER. Specific values for relevant details should be obtained from the manufacturer.

Table 5 summarises the SBEM default values for junction details listed in SBEM together with example ψ-values values for Insulated Panels. Default values have also been added for junction details not involving metal cladding.

Table 5. Summary of ψ–values found in SBEM compared to manufacturers details

Junction detail	SBEM default values involving metal cladding	ψ–values from Insulated Panel manufacturers	SBEM default values not involving metal cladding
	(a)	(b)	
Roof – wall combined eaves and verge*	0.28	0.10	0.12
Wall – ground floor	1.0	0.34	0.16
Wall – wall corner	0.2	0.01	0.09
Wall – floor not ground	0.0		0.07
Lintel above window or door	1.0	0.48	0.30
Sill below window	0.95	0.06	0.04
Jamb at window or door	0.95	0.04	0.05

* SBEM uses a combined detail to represent both eaves and verge arrangement. The calculation method for this can be found in MCRMA/EPIC TP17.

3.5 Building envelope – Km values

In addition to U-values, the thermal mass of the cladding element (Km in kJ/m²) is now included as part of the SBEM calculation to determine the effects of intermittent heating etc.

The Km value includes an average thermal mass for a steel portal frame and sheeting rails on the heated side of the Insulated Panel.

EPIC recommends

Check that the Km value in the SBEM Calculation is set at 7.0 kJ/m² for the metal panel cladding system. (Some versions of SBEM have different default values and should be corrected).

Table 6. Km values for typical insulated panel systems

	Km value (kJ/m²)
Roof – metal faced insulated panel	7.0
Wall – metal faced insulated panel	7.0

3.6 Building envelope – rooflights and solar gain

The 2013 Building Regulations indicate a minimum U-value requirement of 1.8 W/m^2K, which is used as an area weighted average for profiled in plane rooflights. EPIC recommends that designers use the rooflight manufacturers' values and not the default value in SBEM. Although this may result in a small negative effect within the compliance calculation it has the benefit of being in agreement with the as-built computation.

For normal industrial portal frame, insulated panel clad buildings, the optimum contribution according to SBEM model calculations occurs with about 12% of rooflights. EPIC also recommends that actual light transmission and solar heat gain coefficients are used.

The contribution of rooflights has changed with the varying drafts of the SBEM calculation tool. The amount of roof daylighting directly influences the internal lighting requirements and the potential solar gain.

For AD-L2A:2013, reasonable provision for limiting solar gain is set out in AD-L2A #2.53 according to whether the space is defined in the NCM data base as being:

- Top lit with a zone height below 6m
- Top lit with a zone height greater than 6m
- Side lit

3.7 Lighting and building services

Contributions to the improved targets have substantially changed in AD-L2: 2013. The benefits of improved efficiencies and controls for heating, ventilation and air conditioning services had largely been taken in meeting the requirements for the 2006 and 2010 changes. As a result, greater emphasis has been placed on lighting and controls in the 2013 model.

The less efficient forms of lighting and the least efficient types of plant are penalised in the energy saving calculation. Designers should contact the lighting or services provider to confirm the latest energy efficient technology and its effect on compliance within the SBEM and other calculation tools.

One of the most difficult areas to understand is the way SBEM and similar models have treated lighting, heating, cooling and controls and the inter-relationship between services and controls. One of the principal aims of the model is to encourage the use of automatic controls such as photoelectric dimming and efficient means of providing heating and cooling.

In section 4 EPIC provides guidance on the positive and negative effects of a variety of the most common lighting, heating and HVAC systems. This is critical in some cases because compliance cannot be achieved with some of the older traditional systems and for others there is a significant penalty.

EPIC's experience with the 2013 calculation methods shows that they are very sensitive to changes in services and in particular lighting systems and it is almost impossible to predetermine the effect of any change.

WARNING: Designers are advised not to accept specification or system changes to building services or controls without carrying out a trial check using the calculation tool

4 New build 2014
Key factors to compliance using SBEM

4.1 Introduction

This section of the guide, compiled with the assistance of EPIC's Consultants and technical experts, has been designed:

- To give designers a better understanding of the key variables that control the CO_2 emissions
- To facilitate their path through the SBEM screens
- To optimise the inputs into the calculation tool for Insulated Panel buildings

The information in this EPIC supporting document focuses on metal portal frame buildings constructed with insulated panels as the building envelope. It complements the guidance given in the SBEM tutorial programmes that are downloadable from the BRE website. However the guidance in the tutorials is general in nature and attempts to cover a wide variety of buildings. As a result certain options are not valid for Insulated Panel buildings or if entered may set up a string of irrelevant criteria.

The methodology and data input for insulated panels set out in Section 3 is also valid for alternative metal cladding systems on all building types input. Similarly, the principles apply to other approved compliance calculation tools on the market, which are based on SBEM.

Great care should be taken with the preparation and input of data. Problems are not readily identifiable if unexplained results/non-compliance are produced by the SBEM calculation tool

This section is set out in the same order as the data input into SBEM. However the experts recommend that time should be spent defining a method of working and pre-planning the zoning and data input before embarking on the task of data input (see 4.2).

4.2 Methodology

SBEM is a methodology and it is beneficial to establish a method of working to facilitate the input of data.

Initial steps

1. Determine the building use through the basic building information – menu for end use.
2. Assign each zone to one of the end use categories using the sub-menu.
3. Each zone has to have the activity selected from the sub-menu. This is different for each end use. Care is required because the menu is presented in a different order for each end use and resets to the first line if the zone is changed from say B8 to B2/B7.

Zoning

One of the most important preliminary tasks is to mark out and identify the various distinct zones within a building. SBEM defines zones as spaces that are distinct from adjacent areas in terms of activity, heating/cooling requirement, lighting provided or required, or other services required.

These zones have to be separately identified and may be bounded by physical walls, or 'imaginary' walls to create virtual zones with different heating or lighting requirements to save energy. It is assumed that imaginary walls have a zero transmission where there are similar conditions in the adjacent spaces.

AD-L2A defines daylit space as 'any space within 6 m of a window wall, provided that the glazing area is at least 20% of the internal area of the window wall.' This can be used as a yardstick for zoning as can specific areas under runs of rooflights.

4.3 Data entry into SBEM

4.3.1 Building type

Building type – options	Notes and recommendations on data entry
The 2013 SBEM model identifies for the first time distinct types of buildings and building activity. [See Section 1]. It is essential that this is correctly entered as it automatically sets some of the energy parameters such as: • The notional hours of building use and therefore the main energy contribution • Types of heating and cooling • Domestic hot water requirements • Daylighting, especially in terms of top-lit or side-lit	Compliance is achieved by comparing the actual building with a Notional Building of the same basic design. If the correct predominant use is not entered this could severely affect the ability to comply and services etc will not be compared on a like-for-like basis. The target improvement is different for each of the new building types In addition there are sub-divisions that are specific to each building type
Speculative buildings Developers have the option of selecting 'shell and core'. The activity e.g. B1, B2/7, B8 has to be selected before the tick box for shell and core. *(See sections 9 and 10 for requirements for Shell and Fit out)*	*Note. Speculative buildings. A full SBEM calculation has to be repeated and compliance proven when the building is brought into use. (See sections 9 and 10)*

4.3.2 Location

Location options	Notes on data entry
Initial selection is to choose the relevant Building Regulations – England, Wales, Northern Ireland or Scotland. The second selection parameter is 'weather [location]' – from a drop-down list of locations.	*It is important to select the correct location because the location automatically sets defaults for weather, heating and lighting and wind exposure.*
Scotland. Selection of Scottish Building Regulations and weather (Scotland) will automatically set defaults for any U-value and other parameters that are different from England, Wales and Northern Ireland.	*Note. Where Scotland/Scottish Building Regulations are selected an additional 'tick-box' appears, to confirm that in the case of naturally ventilated buildings, studies have confirmed that they will not overheat.*

4.3.3 Building fabric

U-value and ψ-value – options	Notes and recommendations on data entry
U-values – roofs and walls Selection options are either to select the generic product type offered or enter the U-value as stated by the Insulated Panel manufacturer.	*EPIC recommends that the U-value stated by the manufacturer for the specified Insulated Panel system be entered. These values are calculated by accredited methods and include allowances for the thermal performance at the joints and fixings used for securement. (see section 3.2)*
Km-values – roofs and walls The SBEM default value should be checked to ensure that the correct value is used for insulated panel roof and wall systems: Roof: Km = 7.0 Wall: Km = 7.0	The Km default value in the calculation models must be checked. (See section 3.5).
U-values and Km-values – internal walls and ceilings U-values and Km values stated by the system manufacturer should be used in the SBEM calculations. In the case of 'imaginary' walls a U-value of '0' should be used.	
U-values – floors The U-value of floors varies with perimeter and any insulation applied to the edges. The U-value used by SBEM for the notional building is now adjusted for size in the calculation for the actual building.	Recommendation. Initially use the default value of 0.22 W/m^{2}K (uncorrected). If the TER result for the building is non-compliant recalculate using the correction factors for perimeter. The method of correction is set out in BR443. The BRE and other software packages for U-value calculations can be used to determine the effective U-value.
ψ–values – roofs and walls Designers should tick the box for QA ACD junctions [see 3.4] and either: • Specify the Insulation Panel manufacturer's approved details and enter the manufacturer's calculated ψ-values for each of the applicable details or • Specify details in accordance with IP 01/06 For any other details not involving metal cladding tick 'robust' if applicable	*EPIC strongly recommends that the Insulated Panel Manufacturer's approved details are always used and the manufacturer's quoted values entered in the calculation. If non-approved details are used the SBEM tool will default to the values for the notional building +50%.* *Note. Only enter ψ-values for the relevant details listed in the SBEM tool.*

4.3.4 Rooflights

Rooflight – options	Important notes on data entry
U-values The 2013 Building Regulations indicate a minimum U-value requirement of 1.8 W/m²K, which is used as an area weighted average for profiled in plane rooflights.	*EPIC recommends that designers use the rooflight manufacturers' values and not the default value in SBEM.*
Percentage of rooflights The amount of roof daylighting directly influences the internal lighting. However this has to be balanced against the increased solar gain.	*For normal industrial portal frame, insulated panel clad buildings the optimum contribution according to SBEM and the other accredited model calculations occurs with about 12% of rooflights.*

4.3.5 Air leakage rate

Air leakage – options	Important notes on data entry
See 3.3 table 4 (England); 5.6 table 8 (Scotland); or 6.6 table 10 (Wales) for values according to footprint area.	
Buildings below 4000m² footprint. Research into levels of actual air permeability achieved for buildings with a footprint area under 4000 m² indicate that improvements from 10 to 5 m³/(h.m²) at 50Pa are difficult to achieve unless specific attention is paid to the detailing.	The research data suggests that designers should give very careful thought to air permeability barriers and the design value that is put into the SBEM calculation. In many cases the values in tables 4, 8 and 10 may be difficult to achieve in practice. [see sections 3.3, 5.6 and 6.6]. The backstop value that has to be achieved for compliance is 10m³/m²/h.
Buildings above 4000m² footprint. In general terms as a building increases in size and volume it will be easier to achieve a low air infiltration value. Using a higher air permeability design value would lower the risk of failing the final SBEM calculation. For larger, less complex buildings it may be possible to use an air permeability design value of less than 5 m³/(h.m²) at 50Pa, however the risk of failing the final SBEM calculation and subsequent cost and program issues needs to be considered.	The more complex buildings such as those with a large level of interface details, for example, offices, schools, hospitals and hotels need careful consideration as to whether an air permeability design value of 5 m³/(h.m²) at 50Pa is appropriate.

4.3.6 Windows and doors

Selection options	Important notes on data entry
It is important within the SBEM and other model calculation methods to select well insulated window glazing and well insulated door units.	Select well insulated window glazing. Select well insulated doors.

4.3.7 Building Services – Lighting and controls

Lighting and control – options	Important notes on data entry
Designs that reduce energy consumption play a key role in achieving compliance. The choice of energy efficient lighting and the optimisation of lighting controls in conjunction with rooflight and glazing areas are critical to achieving compliance in the 2013 model. The use of photoelectric dimming is included in the Notional Building.	Lighting systems and controls have more influence on the energy consumption and therefore compliance than improving the values for the building fabric. Occupancy sensing according to SBEM is very inefficient and increases the kwh. *Note. Care is needed in defining the type of building associated with each zone.*

4.3.8 Building Services – HVAC and controls

HVAC and control – options	Important notes on data entry
Heating systems should be selected that are effective for the type of building and not chosen purely to achieve compliance. An effective heating system will achieve lower CO_2 emissions than an unsuitable system that may have to be run at maximum for long periods.	Efficient heating systems have an influence on the energy consumption and therefore compliance.
The selection menu includes the following systems that are the most frequently used for the larger industrial/warehouse type buildings. • Unflued radiant heater • Flued radiant heater • Multiburner radiant heaters • Flued forced-convection air heaters • Unflued forced-convection air heaters • Single-duct VAV (heating and cooling) • Dual-duct VAV (heating and cooling) The services systems manufacturer should be contacted to obtain the required information for entry into the SBEM calculation.	*EPIC recommends FLUED heater types as the preferred options to avoid potential condensation problems.* Heater systems should be chosen according to the application. Flued forced-convection heaters are more suited for better warm air distribution in high-bay racking applications than radiant heaters and probably in distribution buildings.

5 New build
Scotland New Section 6 Regulations 2015

5.1 Section 6 – 2015

This amendment to the Scotland section 6 Regulations for the conservation of fuel and power came into effect on 1 October 2015. It is the third amendment following the introduction of these mandatory regulations in 2002.

The intention of Section 6 is to ensure that effective measures for the conservation of fuel and power are incorporated in buildings. In addition to limiting energy demand by addressing the performance of the building fabric and fixed building services, a carbon dioxide emissions standard obliges designers of new buildings to consider building design in a holistic way.

Improvements set out within the 2015 Section 6 will result in a greater need to consider the benefits which localised or building-integrated low carbon equipment (LCE) (e.g. photovoltaics, solar water heating, combined heat and power and heat pumps) can make towards meeting standards.

Although the focus is primarily on lowering carbon dioxide emissions from buildings, the measures within Section 6 are intended to reduce energy demand and continue to ensure that, for new buildings and new building work, use of energy and fuel costs arising from this are both minimised.

The standards and guidance given in the 2015 Section 6 are intended to achieve an improvement, for new buildings reducing emissions by approximately 43% compared to the previous 2010 standards (60% compared to the 2007 Standards). However nothing in this Section prevents a non-domestic building from being designed and constructed to be even more energy efficient or make greater use of low carbon equipment (LCE).

5.2 Latest changes

The 2015 edition of Section 6 incorporates a number of changes whilst retaining the existing methodology introduced in 2007. The majority of these changes relate to improvement in specified performance to deliver the intended 43% aggregate reduction in carbon dioxide emissions on the 2010 standards.

Foremost, in guidance to Standard 6.1 is the move to use of a concurrent notional building specification to set the Target Emissions Rate for new buildings. A full summary of changes can be found on the Technical Handbooks [www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/publications/pubtech] page of the Building Standards Division section of the Scottish Government website.

The key changes that have been made to standards and guidance since 1 October 2013 include:

- Standard amended to apply to large extensions (over 100m² and more than 25% of the area of the existing building) – clause 6.1
- SBEM v5 now used to calculate carbon dioxide emissions; both changes to methodology and revised carbon factors for fuels apply – clause 6.1
- Target Emissions Rate for new building now set using a concurrent (2015) notional building specification. Guidance comprehensively amended in support of this new approach (Revised NCM Modelling Guide for Scotland also published) – clause 6.1
- Revisions to calculation options for heat loss from linear thermal bridging – clause 6.2.3
- Revised list of situations where airtightness testing need not be undertaken – clause 6.2.7
- Reference is now made to the Non-domestic Building Services Compliance Guide for Scotland for detailed guidance in support of each standard
- Guidance for new modular and portable buildings update to reflect revised emissions targets; exemption for relocation of buildings under 30m² now expired – Annex 6C
- Annex 6D; incorporates more comprehensive guidance on consequential improvement of fixed building services, taken from the published Direction

5.3 Energy performance as a complete package

Standard 6.1 focuses on the reduction of carbon dioxide emissions arising from the use of heating, hot water, ventilation and lighting in new buildings and large extensions.

The guidance sets an overall level for maximum carbon dioxide emissions in buildings by use of a methodology which incorporates a range of parameters that influence energy use. This means a designer is obliged to consider energy performance as a complete package rather than looking only at individual elements such as insulation or boiler efficiency – a 'whole building approach' to energy, which offers a significant degree of design flexibility.

For the majority of new buildings, Standard 6.1 has the greatest influence on design for energy performance. Standards 6.2 to 6.6 and 6.10, in the main, recommend benchmark and backstop levels to be achieved for individual elements or systems. To achieve compliance with Standard 6.1, it will be necessary to improve upon some or all of these backstop levels, or incorporate additional energy performance measures, such as low carbon equipment (LCE).

Renewable technologies – The EC Directive promotes the use of energy from renewable sources. Where a building design will include use of renewable energy for heating, Article 13 of the Directive recommends, amongst other measures, consideration of use of the following:

- for biomass equipment, conversion efficiencies of 85%
- for heat pumps, those that fulfil the minimum requirements of eco-labelling establishing the ecological criteria for the award of the Community eco-label to electrically driven, gas driven or gas absorption heat pumps and
- for solar thermal systems, those that are subject to EU standards, including eco-labels and other technical reference systems established by the European standardisation bodies.

High-efficiency alternative systems – The Directive requires that, for all new buildings, the technical, environmental and economic feasibility of high-efficiency alternative systems (such as decentralised energy supply systems using renewable energy, co-generation, district or block heating/cooling and heat pumps) are considered and taken into account in developing proposals. This should be documented and available for verification purposes and a statement should therefore accompany the building warrant application.

5.4 Calculation methods – Scotland

The data defining the actual building is input into an approved software tool and the notional building is generated automatically by applying the National Calculation Methodology (NCM) for Scotland, which includes Scottish compliance parameters for use with this guidance. The notional building has the same size, shape, orientation, conditioning strategy and zone activities as the actual building.

The Target Emissions Rate (TER) for the actual building is generated automatically, with SBEM applying prescribed fabric and services specifications to the notional building. These are applied to the individual building zones that make up the notional building. Values are assigned automatically based upon both the activity and the conditioning strategy for each zone of the actual building, as input by the designer.

Application of these specifications defines a 'concurrent notional building', i.e. one from which a calculated emissions rate is deemed to meet the requirements of this standard. This calculated figure is the TER for the actual building.

The Building Emissions Rate (BER) is generated by applying the designer's chosen fabric and services specifications for the actual building on a zone by zone basis within the NCM for Scotland. In determining this specification, the fabric and services specifications for the actual building should meet or improve upon the benchmark and backstop levels identified in guidance to Standards 6.2 to 6.6.

If, following full specification of the actual building, the BER is not more than the TER, then compliance with this standard is achieved.

5.5 New prescriptive building types – Scotland

In common with England, a major change for non-domestic buildings is that they have been divided into nine different building types (Table 7) to conform to the national building specifications. A specific Notional Building has been calculated for each within the SBEM model.

The listed building types have been allocated a target energy/carbon emissions saving over 2010 levels that is considered achievable, incorporating improvements to the fabric and services in the notional building and with the addition of PV, with PV acting a proxy for a contribution from renewables. This approach represents an average saving over all building types of 43%.

The target savings are different for each type of building and have been programmed into SBEM or the equivalent compliance models.

Table 7. New notional building types – Scotland*

Non-domestic building type	Build Mix (%)	Resultant target reduction over 2010
Primary school	10%	27%
Hotel	5%	24%
Retail	5%	40%
Supermarket	20%	48%
Shallow-plan Office AC	5%	48%
Shallow-plan Office NV	5%	37%
Deep-plan Office AC	20%	42%
Warehouse (with rooflights)	20%	46%
Warehouse (without rooflights)	10%	47%
Aggregate total	**–**	**43%**

Note: AC = Air conditioned. NV = Naturally ventilated.
* Data obtained from the Scottish Impact Document for the proposed changes 2015.

5.6 Building envelope Elemental Specifications – Fabric values – Scotland

The U-values in the notional building are as specified in Table 8. The U-values calculation methods are inclusive of repeating thermal bridges.

The U-values for the heated and naturally ventilated zones within the notional building are less challenging than for the heated and mechanically ventilated / heated and cooled zones. This is in recognition of the fact that heated only zones are less energy intensive than heavily serviced ones. Zones that use mechanical ventilation only to limit overheating in peak summer conditions and ventilation is provided naturally under normal conditions are modelled using the heated and naturally ventilated specification.

Zones in the notional building will use the air permeability values from Table 8, provided that zones whose activity types are flagged as involving metal cladding in the NCM Activity database will use the values in the 'Top-lit' column of Table 4.

Table 8. Elemental Specification values and backstop levels – Scotland

Notional building	2015 Notional building values			2015 Limiting values
Scotland	Zone heated and naturally ventilated (a)	Zone heated and mechanically ventilated/cooled (b)	Top-lit (U-values according to (a) or (b))	
U-value (W/m².K)				
Roofs(1)	0.18 W/m²K	0.18 W/m²K		0.20 W/m²K
Walls(1)	0.23 W/m²K	0.20 W/m²K		0.27 W/m²K
Floors(1)	0.22 W/m²K	0.20 W/m²K		0.22 W/m²K
Glazing(1)	1.8 W/m²K	1.6 W/m²K	N/A	2.0 W/m²K
Rooflights(1)	N/A	N/A	1.8 W/m²K	2.0 W/m²K
Rooflight (Max. area)	N/A	N/A	12% area	N/A
Air-permeability (m³/m²/hour), note GIA = Gross Internal Area				
GIA ≤ 3500m²	5	3(2)	7(2)	10(3)
3500m² < GIA ≤ 10000m²	5	3(2)	5(2)	10(3)
10000m² < GIA	5	3(2)	3(2)	10(3)
Renewables contribution				
Monocrystalline PV with an efficiency of 15%.	4.5% of gross internal area (Active area of south facing panels (120kWh/m²/year output) equivalent to stated % of gross floor area but limited to 50% of roof area).			

(1) Area weighted average value for all types of that element
(2) Top-lit values are used in the notional building **for buildings using metal cladding**
(3) Recommended backstop value

5.7 Building envelope Elemental Specifications – Psi values – Scotland

For SBEM and DSM software, the non-repeating thermal bridge heat losses for each element (including windows, etc.) must be allowed for by adding 10% to the standard area-weighted average U-values, or by an equivalent method that satisfies BS EN ISO 14683, and be consistently applied to both Actual and Notional buildings.

In the case of SBEM psi-values are entered for the main details calculated using an equivalent method that satisfies BS EN ISO 14683. Insulated Panel Manufacturers' details satisfy these criteria.

The psi-values for the Notional Building are the same as those for England – see section 3.4, Table 5. The default values from Table 5 column (a) will be used unless manufacturers' certified details are entered in which case the typical values in Table 5 column (b) apply.

The chosen method and values should be consistently applied to both actual and notional buildings

6 New build
Wales – L2A Regulations 2014

6.1 Major changes

This latest amendment to the Wales L2 Regulations for the conservation of fuel and power (2014) came into effect on 31 July 2014. It is the third amendment following the introduction of these mandatory regulations in 2002.

The Regulations for Wales (L2A), England (AD-L2A) and Scotland (Section 6) follow a common approach to the Conservation of Fuel and Power [See Section 1]. The Welsh Government has however made two significant changes.

1. A 20% average improvement in savings over the level set in the 2010 regulations compared to a 9% target improvement in the English Regulations

2. Measures have been included to safeguard the projected energy savings by including additional criteria for compliance covering 'Primary Energy Consumption'.

These two changes have a major affect on the performance of the building fabric and the fixed building services requiring minimum energy efficiency standards to be achieved. The implications of these enhanced requirements are set out in 6.2 and 6.3 below together with other material differences compared to England and Scotland and information on a number of minor variations that affect the compliance calculations.

6.2 Implications of 20% target improvement

L2A 2014 specifications have been strengthened to deliver 20% carbon dioxide savings across the new non domestic build mix relative to Part L 2010. Whereas the 9% improvement set in the new English regulations may be achieved by fabric improvements and further efficiencies in lighting, controls and building services, additional measures will be necessary to comply with the 20% target level for Wales.

Improved levels are expected in all areas of the construction of the building covering fabric envelope, lighting and building services. These are defined in the specification for the Notional Building (Approved document L2A – Appendix B) – see Section 6.6 of this EPIC Guide. In addition the Regulation assumes that Renewable Energy sources will be used. This is expressed in the Notional Building as 5.3% of gross internal area and the National Calculation Model used for compliance assumes that this proportion of PV (or equivalent renewable) will be used.

6.3 New requirement on Primary Energy Consumption

The Wales Regulation L2A introduces for the first time a criteria for compliance covering Primary Energy Consumption, where the building has to achieve better than the target value defined by the Notional Building (TPEC).

The TPEC limits fabric heat gains and losses and energy consumption from fixed building services. However, achieving the TPEC could be dependent on very good performance of one specific feature of the design with poorer performance elsewhere. If this key element of the design was to fail, or perform less well than expected, this would have a significant impact on performance. Hence minimum energy efficiency standards for building fabric and service elements have been retained.

Document L2A states that the standards set in Appendix B of the Approved Documents, for building fabric and fixed services, should be considered a starting point towards achieving the TPEC and TER. It is likely that the design standards will need to be considerably better than the stated values in more than one aspect. The fabric and airtightness values are set out in 6.6 (Table 10) of this guide.

6.4 Calculation methods – Wales

Compliance is demonstrated by using the Simplified Building Energy Model (SBEM) for those buildings whose design features are capable of being adequately modelled by SBEM or other approved software tools.

The Target Primary Energy Consumption (TPEC) and the Target CO2 Emission Rate (TER) are the minimum energy performance requirements for a new building.

The TPEC is calculated by determining the primary energy consumption from a building of the same size and shape as the actual building and which is constructed according to the elemental specification set out in the 2013 Wales NCM Modelling Guide19 using one of the approved software tools. The key fabric components are shown in 6.6 below. Other key components of this specification are detailed in Appendix B of the Approved Document, with the exception that all electrical demand is assumed to be supplied from the grid (i.e. energy generated by the PV system is disregarded) so that the TPEC is based only on the fabric and building services performance.

The TER is calculated by determining the CO_2 emissions from a building of the same size and shape as the actual building and which is constructed according to the elemental specification set out in the 2013 Wales NCM Modelling Guide using one of the approved software tools. The key fabric components of this specification are shown in 6.6 (Table 10).

NOTE. The 2014 update to the Approved Document maintains the approach to setting the TER adopted in 2010 whereby the TER is based on an elemental set of specifications to which no additional improvement factor is applied. The specifications now include an area of roof mounted photovoltaic panels.

6.5 New prescriptive building types – Wales

In common with England, a major change for non-domestic buildings is that they have been divided into different building types (Table 9) to conform to the national building specifications. A specific Notional Building has been calculated for each within the SBEM model. The list of building types is different to that chosen for England and reflects the division of building types in Wales.

The listed building types have been allocated a target energy/carbon emissions saving over 2010 levels that is considered achievable, incorporating improvements to the fabric and services in the notional building and with the addition of PV, with PV acting a proxy for a contribution from renewables. This approach represents an average saving over all building types of 20%.

The target savings are different for each type of building and have been programmed into SBEM or the equivalent compliance models.

Table 9. New notional building types for 2014

Non-domestic building type	Notional Building	Resultant target reduction over 2010
Primary school	SL-HO	20.9%
Office	SL-H&C	27.1%
Hotel	SL-HO	10.6%
Community Hospital	SL-HO	21.9%
Multi-Residential	SL-HO	20.5%
Retail	SL-H&C	18.9%
Small Warehouse	TL	15.2%
Warehouse	TL	23.9%
Large Warehouse	TL	20.1%
Aggregate total		**20%**

Note: SL = Side-lit. TL = Top-lit. HO = Heating only. H&C = Heating & Cooling

6.6 Building envelope Elemental Specifications – Fabric values – Wales

L2A Wales sets out the elemental specifications which 'must be used to calculate the TPEC and TER. The U-values and air-permeability levels are set out in Table 10.

These significantly improved values together with the higher target reductions (see Table 9) have been set into the Wales NCM Modelling Tool, which means that adopting inferior U-values or backstop values could lead to non-compliance. This is further emphasized by the TPEC requirement that the fixed building elements should be to the best specification.

Table 10. Elemental Specification values and backstop levels – Wales

Notional building	2014 Notional building values			2014 Backstop values
Wales	**Side-lit/unlit (specification is heating only)**	**Side-lit/unlit (specification includes cooling)**	**Top-lit**	
U-value (W/m².K)				
Roofs[1]	0.18 W/m²K	0.18 W/m²K	0.18 W/m²K	0.25 W/m²K
Walls[1]	0.26 W/m²K	0.26 W/m²K	0.26 W/m²K	0.35 W/m²K
Floors[1]	0.22 W/m²K	0.22 W/m²K	0.22 W/m²K	0.25 W/m²K
Glazing[1]	1.6 W/m²K	1.8 W/m²K	N/A	2.2 W/m²K
Rooflights[1]	N/A	N/A	1.8 W/m²K	2.2 W/m²K
Rooflight (Max. area)	N/A	N/A	12% area	N/A
Air-permeability (m³/m²/hour), note GIA = Gross Internal Area				
GIA ≤ 250m²	5	5	7[3]	10
250m² < GIA ≤ 3500m²	3	5[2]	7[3]	10
3500m² < GIA ≤ 10000m²	3	5[2]	5[3]	10
10000m² < GIA	3	5[2]	3[3]	10
Renewables contribution				
Monocrystalline PV with an efficiency of 15%.	5.3% of gross internal area (Active area of south facing panels (120kWh/m²/year output) equivalent to stated % of gross floor area but limited to 50% of roof area).			

(1) Area weighted average value for all types of that element

(2) Note. These values are relaxed from 3 to 5(m³/m²/hour) compared to AD-L2:2013 (England)

(3) Top-lit values are used in the notional building **for buildings using metal cladding**

6.7 Building envelope Elemental Specifications – Psi values – Wales

For DSM software, the non-repeating thermal bridge heat losses for each element (including windows, etc.) must be allowed for by adding 10% to the standard area-weighted average U-values,

In the case of SBEM psi-values are entered for the main details calculated using an equivalent method that satisfies BS EN ISO 14683. Insulated Panel Manufacturers' details satisfy these criteria.

The psi-values for the Notional Building are the same as those for England – see section 3.4, Table 5. The default values from Table 5 column (a) will be used unless manufacturers' certified details are entered in which case the typical values in Table 5 column (b) apply.

The chosen method and values should be consistently applied to both actual and notional buildings.

7 Refurbishment AD-L2B [England] and Part F2 [Northern Ireland]
Overview and implications of the requirements

7.1 Introduction

AD-L2B gives guidance on "what, in ordinary circumstances, will meet the requirements of Part L when carrying out work on buildings that are not dwellings". The requirements set out in Part F2: Section 3 for Northern Ireland: L2B for Wales: and Section 6 for Scotland for refurbishment work are broadly similar. Specific requirements for Scotland and Wales are set out in Sections 8 and 9.

AD-L2B 2013 amendments present some minor changes in the technical guidance. "The guidance is generally based on an elemental approach, with additional guidance that provides greater flexibility. The main technical changes comprise a strengthening of energy efficiency standards that are considered reasonable for work on thermal elements, controlled fittings and controlled services in existing buildings."

The two main areas for improvement during refurbishment works concern

- The building fabric and
- The building services and controls

This section of the EPIC Guide concentrates on those requirements that relate to the building fabric including roof daylighting and the rules for compliance.

The requirements in AD-L2B (2013) do not require the use of the SBEM calculation model unless the designer wishes to illustrate that performance will be better than the original building.

7.2 Insulated Panels and refurbishment works

Insulated panels by the nature of their single piece construction are ideal for re-cladding walls and roofs and have been used extensively on refurbishment projects for over 30 years. Panels offer real practical benefits in terms of speed, minimum disruption, use of existing structure (in most cases), improved external and internal environment, low maintenance and increased security.

PIR cored panels have the best insulation performance for lowest thickness and weight and can transform the energy efficiency of a building to AD-L2B (2013) standards with immediate payback on investment. In addition to improved thermal performance, which is guaranteed by the factory controlled production, insulated panel systems also meet the AD-L2B requirements for maintaining continuous insulation and minimising the effect on useable floor area.

See www.epic.uk.com/refurbishment.jsp

7.3 Types of work covered by 'Refurbishment'

Five main types of refurbishment activity are subject to the requirements of AD-L2B:2013 and the other National Regulations:

- Construction of an extension
- Material change of use or a change to the building's energy status
- Consequential improvements
- The provision or extension of a controlled service or fitting (not covered by this guide)
- The replacement or renovation of a thermal element

Each of the above activities may trigger an automatic appraisal of the fabric, either in respect of the new thermal elements, i.e. used in an extension, or the existing thermal elements. The specific requirements for each type of refurbishment activity are set out in the following paragraphs and may involve the replacement and/or upgrading of the elements.

7.4 Extensions

A. Large extensions:

The regulations relating to 'large extensions' apply where the proposed extension has a total useful floor area that is both

a. greater than 100m^2; and
b. greater than 25% of the total useful floor area of the existing building

In these cases the work should be regarded as a new building and the guidance in AD-L2A followed (see sections 1 to 4 of this EPIC guide).

In buildings with a 'total useful floor area' greater than 1000m^2 it is possible for the construction of an extension to trigger the requirement for consequential improvements. In such cases the guidance in 6.6 should be followed.

B. Other extensions

Reasonable provision would be for the proposed extension to meet the following performance standards: (relevant to refurbishment projects using insulated panels.)

- New thermal elements shall meet the standards of 0.18 W/m^{2}K for roofs and 0.28 W/m^{2}K for walls
- Existing opaque fabric that becomes part of the thermal envelope whereas previously it was not, should be improved to 0.1.8 W/m^{2}K for roofs and 0.30 W/m^{2}K for walls. If this is not feasible a minimum threshold performance value should be met – see section 7.7. Retained thermal elements.
- Areas of windows and rooflights should not exceed the values given in table 11 unless a proportion of glazing is present in the part of the building to which the extension is attached. In such cases, reasonable provision would be to limit the proportion of glazing in the extension so that it is no greater than the proportion that exists in the building to which it is attached.

Table 11. Opening areas in an extension

Building type	Rooflights as % of area of roof	Windows and personnel doors as % of exposed wall
Industrial and storage buildings	20%	15%
Places of assembly, offices and shops	20%	40%
Residential buildings where people temporarily or permanently reside	20%	30%
Vehicle access doors and display windows and similar glazing	N/A	As required
Smoke vents	As required	N/A

Notes on the requirements for 'other extensions'

1: AD-L2B also gives a formula for greater design flexibility by recalculating the area-weighted value of the respective U-values and rooflight area (AD-L2B #4.7).

2: AD-L2B also allows the facility to use SBEM or an approved calculation tool to show that the calculated CO_2 emissions for the building plus proposed extension is no greater than for the building plus a notional extension complying with note 1 above (AD-L2B #4.9).

7.5 Material change of use and change of energy status

Two changes are covered by this provision:

- A material change of use as defined in AD-L2B #4.15
- Where a building changes its energy status #4.16 to #4.18 (including where a previously unheated building were to be heated in the future.
- Under these changes a reasonable provision would be to meet the following performance standards: (relevant to refurbishment projects using insulated panels.)
- Where the work involves the provision of a new or replacement element, the thermal elements shall meet the standards of 0.18 W/m^{2}K for roofs and 0.28 W/m^{2}K for walls
- Where the thermal element is to be renovated or retained the thermal element should be improved to 0.18 W/m^{2}K for roofs and 0.30 W/m^{2}K for walls. If this is not feasible a minimum threshold performance value should be met – see section 7.7 Retained thermal elements
- Any existing window, including roof window or rooflight, or door which separates a conditioned space from an unconditioned space or the external environment and which has a U-value worse than 3.3 W/m^{2}K should be replaced (AD-L2B #4.23 to #4.28).

7.6 Consequential improvements

Consequential improvements means those energy efficiency improvements required when an existing building is extended or renovated.

Consequential improvements apply to existing buildings over 1000m^2 where the work consists of:

a. an extension
b. the initial provision of a fixed building service or
c. an increase to the installed capacity of any fixed building service

Consequential improvements are in addition to the proposed building works and should be made to ensure that the building complies with Part L provided that any such improvements are technically, functionally and economically feasible.

The following improvements relating to the building fabric are considered to be practical and economically feasible in ordinary circumstances e.g. if the remaining life of a building is less than 15 years it would be economic to carry out improvements with payback periods within that life:

1. Upgrading thermal elements which have U-values worse than 0.70 W/m^{2}K for walls and 0.35 W/m^{2}K for roofs

2. Replacing existing windows, roof windows or rooflights or doors which have a U-value worse than 3.3 W/m^{2}K (AD-L2B #4.23 to #4.28)

Where the installed capacity per unit area of a cooling system is increased the following improvements relating to the building fabric are considered to be practical and economically feasible in ordinary circumstances:

- To upgrade or replace the thermal elements within the heated areas which have a U-value worse than 0.7 W/m^{2}K (to 0.35 W/m^{2}K) for walls and 0.35 W/m^{2}K (to 0.25 W/m^{2}K) for roofs
- If the windows, roof windows within the area served exceed 40% of the façade area, or the area of the rooflights exceeds 20% of the area of the roof and the design solar load exceeds 25W/m^2, then the solar control provisions should be upgraded (see AD-L2B #6.11)
- Any lighting system within the area served with a lamp efficacy of less than 45 lamp-lumens per circuit watt shall be upgraded with new luminaries and/or controls (AD-L2B #6.11).

7.7 Guidance on thermal elements

This section summarises the requirements listed above under various refurbishment categories.

Newly constructed or replacement elements.

Reasonable provision is given as follows in AD-L2B:

- For newly constructed thermal elements such as those constructed as part of an extension – Table 12(a)
- For those thermal elements constructed as replacements – Table 12(b)
- No individual element should have a U-value worse than those set out in – Table 12(c).

Table 12. Standard for use of new insulated panels in refurbishment

Element	(a) Standard for new thermal elements	(b) Standard for replacement thermal elements	(c) Limiting U-value for existing elements – not worse than
Walls	0.28	0.28	0.70
Roofs (with integral insulation)	0.18	0.18	0.35

Continuity of insulation and air tightness

The building fabric should be constructed so that there are no reasonably avoidable thermal bridges in the insulation layers caused by gaps within the various elements, at the joints between elements, and at the edges of elements such as those around windows and door openings. Reasonable provision should be made to reduce unwanted air leakage through the new envelope parts AD-L2B #5.5 to #5.7

Renovation (replacement) of thermal elements

AD-L2B states that reasonable provision would be to achieve the standard set out in Table 13(b) provided the area to be renovated is greater than 50% of the surface of the individual element or 25% of the total building envelope AD-L2B #5.8 to #5.9.

If such an upgrade is not technically or functionally feasible or would not achieve a payback of 15 years or less, the element should be upgraded to the best standard that is technically or functionally feasible and which can be achieved within a simple payback no greater than 15 years.

Retained thermal elements

Retained thermal elements refers to the following circumstances:

- Where an existing element is part of a building subject to a material change of use
- Where an existing element is to become part of the thermal envelope and is to be upgraded
- Where an existing element is being upgraded as a consequential improvement

AD-L2B states that reasonable provision would be to upgrade those thermal elements whose U-value is worse than the threshold value in Table 13 column (a) to achieve the U-value given in column (b) providing this is technically and economically feasible.

A reasonable test of economic feasibility is to achieve a simple payback of 15 years or less. Where the standard given in column (b) is not technically or functionally feasible, then the element should be upgraded to the best standard that is technically or functionally feasible and which can be achieved within a simple payback no greater than 15 years.

Overview and implications of the requirements

Table 13. Replacement and upgrading retained thermal elements

Element	(a) Threshold U-value	(b) Improved U-value
Walls	0.70	0.30
Roofs (with integral insulation)	0.35	0.18

8 Refurbishment – Scotland
Overview of the requirements

8.1 Requirements

Guidance on refurbishment is set out in Section 6.2 of the Technical Handbook (2010) as follows.

6.2.8 Conversions

6.2.11 Extensions

6.2.13 Alterations

This section of the EPIC Guide summarises the basic requirements in terms of the building element. Although many of the values for insulating elements are similar to those set for England, Wales and Northern Ireland, Section 6 for Scotland aims to set higher basic levels for Extensions to heated buildings especially for walls.

There is also a strong emphasis on the need to upgrade to the highest standards and Section 6 recommends consultation with the verifier of the relevant local authority on refurbishment issues at an early stage of the works.

8.2 Conversions

Section 6.2.8 states that in the case of the conversion of an unheated building it is appropriate to treat the building as if it were an extension – see 8.3 below. In certain instances it may be more worthwhile to demolish these buildings and rebuild to the latest standards.

In the case of a building that was previously designed to be heated, it is appropriate to examine the insulation envelope and upgrade, if necessary, following table 14.

Table 14. Conversion of a heated building that remains heated after conversion (Scotland)

Maximum U-values (W/m²K) for building elements of the insulation envelope		
Type of element (excluding separating walls and separating floors)	**(a) Area weighted average U-value for elements of the same type**	**(b) Individual element U-value**
Wall(1)	0.30	0.7
Roof [Insulated Panels](1)	0.25	0.35
Floor(1)	0.25	0.7
Windows, doors, roof windows and rooflights	1.6	3.3

(1) Where upgrading work is necessary to achieve the U-values, reference should be made to 'Reconstruction of elements (clause 6.2.13) and more demanding U-values achieved where reasonably practicable.

Overview of the requirements

8.3 Extensions

Section 6 anticipates that in the case of extensions to the building envelope, the majority of the construction will be 'new-build' and seldom will there be a need to construct to a lesser specification.

Where the insulation envelope of a building is extended, the new building fabric should be designed (or upgraded) in accordance with Table 15 below.

The extended part of an insulation envelope or the unheated to heated category of an extension should be constructed in such a way that there are no substantial thermal bridges or gaps where the layers of insulation occur.

Table 15. Extensions to the insulation envelope of buildings [Scotland]

Maximum U-values (W/m²K) for building elements of the insulation envelope		
Type of element (excluding separating walls and separating floors)	**(a) Area weighted average U-value for elements of the same type**	**(b) Individual element U-value**
Wall	0.25	0.7
Roof [Insulated Panels]	0.15	0.35
Floor	0.20	0.7
Windows, doors, roof windows and rooflights	1.6	3.3

Where the insulation envelope of a building is extended, the new opening areas should be designed in accordance with Table 16.

Table 16. Maximum window and rooflight areas for extensions [Scotland]

Building type	Rooflights as % of area of roof	Windows and doors as % of exposed wall
Industrial and storage buildings	20%	15%
Residential buildings, offices and shops and buildings for entertainment and assembly purposes	20%	40%

Compensatory arrangements – area weighted average U-values

Table 15 illustrates that the Building (Scotland) Regulations – Section 6 sets tighter (lower) values for the thermal elements in Refurbishment than for new constructions. This also applies for Shell and fit-out (see section 11 of this guide).

However Table 16, taken from Section 6.2.11 of the Standard, also contains a table of maximum opening areas for windows, doors and rooflights and SBSA have confirmed that it is permissible to trade off between panel and opening areas to achieve the required area weighted average U-values for the whole roof or wall construction, based on the values in Table 15 column (a).

This ability to make compensatory arrangements by reducing the opening areas allows panels of the standard thickness required for new constructions to be used, i.e. 0.20 W/m²K for roofs and 0.27 W/m²K for walls.

Example calculation

Roof refurbishment project – example of compensatory arrangement between roof panel and rooflights using heat loss calculation.

Note. A similar calculation can be extended for the whole building to include the walls and window openings.

A. Building to be refurbished/extended – footprint area 1000m². Using a proposed standard panel U-value of 0.25 W/m².K

Exposed element	Exposed surface area (m²)	U-value (W/m²K)	Rate of heat loss (W/K)
Roof	905 (90.5%)	x 0.25 (U-value of standard panel)	226.2
Rooflight [1]	95 (9.5%)	x 2.20 (most common rooflight value)	209.0
Total rate of heat loss			435.2

(1) reduced percentage area from 20% maximum level in Notional Building calculation.

B. Notional refurbishment/extension – footprint area 1000m²

Exposed element	Exposed surface area (m²)	U-value (W/m²K)	Rate of heat loss (W/K)
Roof	800	x 0.15	120
Rooflight	200	x 1.60	320
Total rate of heat loss			440

8.4 Alterations

Reconstruction of elements

Section 6.2.13 states that where the element forming part of the insulation envelope is to be altered or replaced the opportunity should be taken to improve the level of thermal insulation. Column (a) of Table 15 gives 'benchmark' U-values that in many cases can be achieved without technical risk, within the constraints of the existing construction.

The Standard recognises that there are certain constructions that lend themselves better than others as candidates for upgrading. Where it is inappropriate for these changes to be made, due to reductions of internal space or by causing excessive enabling alterations, or impact on other building standards worse levels may be acceptable. The Standard states that 'there are not many cases however, where after an alteration to the insulation envelope, a roof or wall cannot achieve the values given in column (b) of Table 15'.

When an alteration is carried out, attention should be paid to limiting thermal bridging at junctions and around openings and also limiting air infiltration.

Infill of openings

Where the opening is less than 4m², the infill should match the thermal performance of the surrounding fabric and not be worse than 0.35W/m²K for a roof and 0.7 W/m²K for a wall.

In the case of larger openings the infill should achieve the values in column (a) of Table 15, or by compensating for the energy efficiency deficit by improving the overall U-value of other parts of the envelope.

8 Refurbishment – Scotland
Overview of the requirements

Additional guidance

Section 6.2.13 also gives guidance on the creation or replacement of windows, doors and rooflights and where internal parts or elements become part of the insulating envelope.

9 Refurbishment L2B WALES
Overview of the requirements – Wales

9.1 Introduction

This section of the EPIC Guide summarises the main requirements of the L2B Wales Regulations for the refurbishment or renovation of a building in so far as they apply to the fabric of the building and Insulated Panels in particular. The L2B Regulation document should be referred to for separate requirements concerning windows, doors, openings and services.

L2B Wales gives guidance on "what will meet the requirements of Part L when carrying out work on buildings that are not dwellings".

L2B 2014 amendments present some changes in the technical guidance. "The guidance is generally based on an elemental approach, with additional guidance that provides greater flexibility. The main technical changes comprise a strengthening of energy efficiency standards that are considered reasonable for work on thermal elements, controlled fittings and controlled services in existing buildings."

The two main areas for improvement during refurbishment works concern

- The building fabric and
- The building services and controls

and specifically the following:

- Consequential improvements can require additional energy efficiency measures when undertaking applicable building work. The previous 1000m^2 threshold has been removed for extensions and where fixed heating is provided into a previously unheated space. Guidance on consequential improvements is provided in Section 9.5 of this EPIC Guide.
- U-values for new thermal elements have been revised, and the U value threshold for retained and refurbished thermal elements has been removed
- For first fit-out works in buildings such as shell and core office buildings or business park units, the guidance in L2A Wales for new non-domestic buildings covering first fit-out should be followed. For any subsequent fit-out works the appropriate guidance is contained in L2B Wales.

This section of the EPIC Guide concentrates on those requirements that relate to the building fabric including roof daylighting and the rules for compliance.

The requirements in L2B 2014 do not require the use of the SBEM calculation model unless the designer wishes to demonstrate compliance where certain elements have been relaxed and are compensated for elsewhere (the U-value trade off approach) – Reference L2B Section 11 and 9.6.2 of this EPIC Guide.

9.2 Types of work covered by 'Refurbishment'

Five main types of refurbishment activity are subject to the requirements of L2B:2014 and the other National Regulations:

- Construction of an extension
- Conversions – Material change of use or a change to the building's energy status
- Consequential improvements
- The provision or extension of a controlled service or fitting (not covered by this guide)
- The replacement or renovation of a thermal element

Each of the above activities may trigger an automatic appraisal of the fabric, either in respect of the new thermal elements, i.e. used in an extension, or the existing thermal elements. The specific requirements for each type of refurbishment activity are set out in the following paragraphs and may involve the replacement and/or upgrading of the elements.

9.3 Extensions

9.3.1. Large extensions:

Large extensions are defined as having a total useful floor area that is both greater than 100m², and greater than 25 per cent of the total useful floor area of the existing building and should be carried out in accordance with the guidance in L2A – see section 6. The requirement for consequential improvements, if appropriate, should also be met by following the guidance in L2B Section 11 (9.5 of this EPIC Guide).

9.3.2. Other extensions

Reasonable provision would be for the proposed extension to meet the following performance standards: (relevant to refurbishment projects using insulated panels.)

New thermal elements

New thermal elements constructed as part of an extension should achieve or better the U-values set out in Table 17.

Table 17. U-values (W/m².K) for new thermal elements

Elements (1)	Maximum U-values for new fabric	
	Buildings that are essentially domestic in character (2)	All other buildings
Wall	0.21	0.26
Floor (3)	0.18	0.22
Pitched roof – insulation at rafter level	0.15	0.18
Flat roof or roof with integral insulation	0.15	0.18

(1) Roof includes the roof parts of dormer windows, and 'wall' includes the wall parts (cheeks) of dormer windows.
(2) For example, student accommodation, care homes and similar uses where the occupancy levels and internal gains are essentially domestic in character.
(3) A lesser provision may be appropriate where meeting such a standard would create significant problems in relation to adjoining floor levels. The U-value of the floor of an extension can be calculated using the exposed perimeter and floor area of the whole enlarged building.

If an extension incorporates a part of the existing structure, which previously was not subject to the energy efficiency requirements, for example if the extension is built against a garage, this part should be treated as a retained thermal element and follow the guidance set out in Section 9.4.

In buildings with high internal heat gains, a less demanding U-value for glazing may be an appropriate way of reducing CO_2 emissions. If this case can be made, then the average U-value for windows, door and rooflights can be relaxed from the values in L2B, Table 2, but the value should not exceed 2.7 W/m².K.

Windows, doors and rooflights

The area of windows, doors and rooflights in the extension should generally not exceed the values given in Table 18. However, where a greater proportion of glazing is present in the part of the building to which the extension is attached, the proportion of glazing in the extension should be no greater than the proportion that exists in the part of the building to which it is attached.

Table 18. Opening areas in an extension

Building type	Rooflights as % of area of roof	Windows and personnel doors as % of exposed wall
Industrial and storage buildings	20%	15%
Places of assembly, offices and shops	20%	40%
Residential buildings where people temporarily or permanently reside	20%	30%
Vehicle access doors and display windows and similar glazing	N/A	As required
Smoke vents	As required	N/A

9.4 Conversions – Material change of use and change of energy status

9.4.1 Introduction

In L2B Wales, conversion describes when part of a building, which previously was not subject to the energy efficiency requirements (see regulation 21 in Appendix B), is converted into a conditioned space, for example an unheated warehouse conversion to offices, where the space is now to be heated and/or cooled. This is described as a change in energy status (see regulation 22 in Appendix B) in the Building Regulations.

In the case of a conversion, a retained thermal element is an existing element that becomes a thermal element where previously it was not, for example where an internal wall is removed so that a previously unconditioned store room with an external wall becomes a cellular office.

Converting part of an existing building to increase the conditioned volume triggers a requirement for additional energy efficiency improvements – Consequential improvements (see Section 9.5.)

Compliance of the building fabric may be demonstrated by meeting the U values set out in Table 17. Alternative optional approaches that offer more design flexibility by allowing some elements of the design to be relaxed if compensated for elsewhere are set out in L2B Section 11 and 9.6.2 of this EPIC Guide.

Overview of the requirements – Wales

9.4.2 Building Fabric

Retained thermal elements should be upgraded to achieve or better U-values set out in column (a) of Table 19.

Table 19: U-values (W/m^2K) for RETAINED thermal elements in Conversions

Elements	a) Maximum U-values for retained fabric	b) Limiting U-values for reatined fabric
Wall	0.30	0.70
Floor	0.25	0.70
Pitched roof – insulation at rafter level	0.18	0.35
Flat roof or roof with integral insulation	0.18	0.35

Where the U-value set out in column (a) of Table 19 is not economically, functionally or technically feasible, the thermal element should be upgraded to as close to the maximum U-value as is practicably possible. Generally, the U-value of the thermal element should not be worse than the limiting U-values set out in column (b) of Table 19 to minimise the risk of surface condensation and mould growth.

An energy efficiency measure is not deemed to be functionally or technically feasible if the thickness of insulation needed to achieve the U-values set out in column (a) of Table 19 would:

a. reduce the internal floor area of a room by more than 5 per cent; or
b. cause significant problems with adjoining floor levels; or
c. create insufficient headroom; or
d. could not be supported by the existing structure.

In such cases, the choice of insulant should be based on the best thermal performance that is practicable to achieve a U-value as close as possible to the U-values given in column (a). In cases of insufficient headroom, the depth of the insulation plus any required air gap should be at least equal to the depth of the rafters.

If any new or replacement thermal elements are constructed as part of a conversion, the guidance for new thermal elements set out in 9.3.2, should be followed.

9.5 Consequential improvements

Consequential improvements describe additional energy efficiency improvements that should be undertaken when the following buildings works are undertaken during the extension or renovation of an existing building:

a. The existing building is extended or part of the building is converted to provide fixed heating in a previously unheated space, increasing the conditioned volume

or where an existing building has a useful floor area over $1000m^2$

b. the initial provision of any fixed building service i.e. the initial installation of heating, hot water, air conditioning or mechanical ventilation, or internal or external lighting (not including emergency escape lighting or specialist process lighting), or
c. an increase in the installed capacity of any fixed building service (other than renewable energy generators)

Consequential improvements are in addition to the proposed building works and should be made to ensure that the building complies with Part L provided that any such improvements are technically, functionally and economically feasible.

Fabric improvements are required for space heating and cooling systems as indicated below. This is to make cost-effective improvements to the performance of the fabric so that the installed capacity (and initial cost) of these fixed building services and their subsequent energy consumption is not excessive.

Consequential improvements to the fabric are required where:

a. there is an initial provision, or an increase in the installed capacity, of a space heating system

b. there is an initial provision, or an increase in the installed capacity, of a space cooling system

The thermal elements within the area served by the space heating system which have U-values worse than those set out in column (b) of Table 19 (see 9.4.2 above) should be improved to achieve or better the U-values set out in column (a) where economically, functionally or technically feasible.

9.6 Renovation of thermal elements

9.6.1 Introduction

Where a thermal element is subject to a renovation, the performance of the whole of the thermal element should be improved provided the area to be renovated is greater than 50% of the surface of the individual thermal element or constitutes a major renovation where more than 25% of the surface area of the building envelope undergoes renovation.

When assessing the proportion of the area to be renovated, the area of the element to be renovated should be taken as that of the individual element, not all the elements of that type in the building. For example, if stripping down the roof of an extension the area of the element is the area of the extension roof, not the total roof area of the building.

Two alternative optional approaches to the guidance are provided below, that offer more design flexibility by allowing some elements of the design to be relaxed if compensated for elsewhere, are set out in Section 11 of L2B.

9.6.2 Building Fabric

Where a thermal element is renovated the performance of the whole element should be improved to achieve or better the U-values set out in column (a) of Table 19 (see 9.4.2 above).

Where the U-value set out in column (a) of Table 19 is not economically, functionally or technically feasible, then the thermal element should be upgraded to as close to the maximum U-value as is practicably possible. Generally, the U-value of the thermal element should not be worse than the limiting U-values set out in column (b) of Table 19 to minimise the risk of surface condensation and mould growth.

The test of the economic feasibility of an energy efficiency measure is to calculate if the measure achieves a payback of the initial cost within 15 years through energy savings. This is calculated by dividing the cost of implementing the measure (not the whole cost of the project) by the annual energy saving achieved by that measure, estimated using the latest version of the National Calculation Methodology, taking account of VAT in both the cost and the saving.

10 Shell and fit out buildings
Requirements – England and Wales

The following guidance has been taken from AD-L2A:2013 # 2.34 and L2A: 2014 # 3.8 [Wales]

If a building is offered to the market as a shell for specific fit-out work by the incoming occupier, the developer should demonstrate via the design stage TER/BER and TPEC/BPEC [Wales] submission, how the building shell as offered could meet the energy efficiency requirements.

For those parts of the building where certain systems are not installed at the point the building is to be offered to the market, the model that is used to derive the BER and BPEC [Wales] should assume efficiencies for those services that will be installed as part of the first fit-out work. The specification provided to Building Control [BCB] should identify which services have not been provided in the base build and the efficiency values assumed for each system. This should enable the BCB to ensure that the necessary infrastructure needed to deliver the assumed fit-out specification is provided as part of the base build.

At practical completion of the base building the as-built TER/BER and TPEC/BPEC [Wales] calculation should be based only on the building and systems actually constructed: the fit-out areas should be assumed to be conditioned to temperatures appropriate for their designated use, but no associated energy demand included. A formal EPC is not required at this stage.

When an incoming occupier does first fit-out work on all or part of the building, then the TER/BER and TPEC/BPEC [Wales] submission should be made to Building Control after completion to demonstrate compliance for the part of the building covered by the fit-out work. This submission should be based on the building shell as constructed and the fixed building services actually installed. If the fit-out work does not include the provision or extension of any of the fixed services then reasonable provision would be to demonstrate that any lighting systems that are installed are at least as efficient as those assumed in the developer's initial submission.

A new EPC is required for that part of the physical building covered by the fit-out.

11 Shell and fit out buildings
Requirements – Scotland

Shell and fit out projects may be treated in two ways when applying for a building warrant.

a. As a staged application with the internal fit out being at a final stage.

b. With separate warrants for the shell and fit out.

A. Staged applications

The staged application approach can be of benefit when the eventual building occupier and building use are not known.

Under staged applications the building design and construction should meet the requirements for 'New Build' set out in Section 6 of the Technical Standard (2010) including satisfying the compliance calculation method, (SBEM or equivalent – see sections 3 and 4 of this Guide) at the final stage.

Internal fit out is the final stage of the shell and fit out. A Completion Certificate can only be submitted/ accepted once all the works have been completed.

Note. Section 6 of the Standard recommends consultation with the verifier of the relevant local authority on shell and fit out issues at the time of application for the initial building warrant.

B. Separate warrants for shell and fit out

Under the separate warrant approach the building design and construction for the shell should meet the requirements for the building envelope set out in # 6.2.4 (U-values), # 6.2.5 (thermal bridging) and # 6.2.6 (air infiltration) of Section 6 of the Technical Standard (2010), the details of which are set out below.

Completion Certificates are submitted for both the shell and the fit out warrants, with the shell being subject to a continuing requirement confirming that the building may not be used until the Completion Certificate for the fit out has been accepted. No Completion Certificate or authorisation of temporary use certificate can be accepted/issued at the completion of the shell.

Building element requirements under shell and fit out – separate warrants

New buildings which have been constructed as a shell for later fit out that are not the subject of a staged building warrant should meet the maximum U-values for building elements of the insulation envelope as given in Table 20 column (a) and also should meet the air permeability requirements.

The values are lower (better) than the requirements set for new build.

Localised areas of the same type of element may be designed to give a poorer performance. These in turn will need to be compensated for by the rest of the element being designed and built to a more demanding level. These areas should be better than the figures given in Table 20 column (b).

No compensatory arrangements, such as those allowed for refurbishment projects, are allowed for shell and fit out projects.

Requirements – Scotland

Table 20. U-values and air permeability for shell and fit out buildings

Maximum U-values (W/m²K) for building elements of the insulation envelope		
Type of element (excluding separating walls and separating floors)	**(a) Area weighted average value for elements of the same type**	**(b) Individual element U-value**
Wall	0.23	0.7
Roof [Insulated Panels]	0.15	0.35
Floor	0.20	0.7
Windows, doors, roof windows and rooflights	1.6	3.3
Air permeability	$7 m^3/(h.m^2)$	

Thermal bridging. For shell buildings thermal bridging should meet or improve upon the values for the notional building given in # 6.2.5.

Where a building warrant is made for the building shell only, air permeability should not exceed $7\ m^3/(h.m^2)$ and testing should be carried out both at completion of the shell and again when fit-out is completed.

Note. Section 6 recommends consultation with the verifier of the relevant local authority on shell and fit out issues at an early stage of the development.

ENGINEERED PANELS IN CONSTRUCTION

EPIC was set up in 1991 to promote quality roofing and cladding systems through the use of factory-engineered panels. Insulated panels maximise thermal efficiency whilst reducing the risk and effects of condensation and significant energy loss through air leakage.

The new building regulations and today's cost competitive and quality conscious environment require that industrial and commercial buildings are high performance designs working with maximum efficiency and minimum running costs. PIR insulated panels allow designers to achieve these goals with confidence and minimum risk.

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Download information from the EPIC website

This guide on the compliance of buildings in accordance with the 2013 (England) and 2014 (Wales) Energy Conservation Regulations can be downloaded from the EPIC website at **www.epic.uk.com**

EPIC has also published a series of other Guides including:

– Fire safety, Specification and Installation of Insulated Panels
– Insulated Panels, The Fire Safety Order (2005)*
– Insulated Panels. Identification and disposal*

*These guides are available in hard copy form through the website.

Information on CD Rom

EPIC has produced a Guide to the performance of insulated cladding systems in fire. This can be ordered directly from EPIC or through the EPIC website.

– Insulated cladding systems – performance in fire: The CD provides essential data about the fire performance of external cladding panels based on extensive research programmes.

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