Glass and Building Regulations: Thermal Insulation and Energy Efficiency.

England and Wales Approved Documents L1 and L2
Scotland Part J
Northern Ireland Part F

PILKINGTON

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THE FOLLOWING BUILDING REGULATIONS set the standards of thermal insulation and energy efficiency for all new buildings and major changes to existing buildings.

The content of the Regulations, the timing of revisions and the regulatory regimes differ throughout the United Kingdom. However, amendments announced in Autumn 2001 have considerably improved the standards required for windows in England & Wales and Scotland. Perhaps the most significant change is that in England & Wales the routine replacement of windows is now covered by the Building Regulations, which effectively means that the U value of replacement windows has to be the same standard which applies to new buildings.

The relevant Regulations are:

England & Wales
The Building Regulations 2000 as amended by the Building (Amendment) Regulations 2001, Part L Conservation of Fuel and Power.

The 2001 editions of Approved Documents L1 and L2 provide guidance on interpreting the Regulation requirements.

Scotland
The Building Standards Amendment (Scotland) Regulations 2001, Part J Conservation of Fuel and Power.

The 2001 'Technical Standards' document provides guidance on meeting the Regulation requirements. Compliance with the document constitutes compliance with the Regulations.

Northern Ireland
The Building Regulations (Northern Ireland) 1994, Part F Conservation of Fuel and Power.

Technical Booklet F, Conservation of Fuel and Power December 1998 provides guidance on the interpretation of the Regulation requirements.

The requirements for each part of the UK are set out in the following sections.

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England and Wales

The 2001 amendment to the Building Regulations, published in October 2001, brought more work relevant to the energy-efficiency of existing buildings into the definition of 'building work' in the Building Regulations. Included in this is the replacement of existing windows. At the same time, Approved Document L was revised and re-issued as two separate documents: Part L1 covering dwellings and Part L2 covering other buildings. The Approved Documents set out the various means of demonstrating compliance with Part L available to building designers and specifiers.

The new Approved Documents include some significant changes compared with the 1995 version. The changes in the Regulations and Approved Documents which affect glazing are:

- Substantially improved U values for all elements, including windows, which means that low emissivity glass is likely to be required in almost every case in order to achieve the elemental U values.

- Replacement windows fall within the scope of the regulations; this effectively requires low emissivity glass to meet the U value requirements.

- The Target U value formula has changed to reflect the new elemental U values. (Target U value is a method of demonstrating compliance for new dwellings by allowing some trade-off of performance between elements).

- For new dwellings, the Carbon Index Method is introduced as an alternative means of demonstrating compliance, replacing the Standard Assessment Procedure (SAP) method of compliance. This calculation of a dwelling's carbon dioxide emissions allows flexibility of design as long as a target Carbon Index value is achieved.

- For new office buildings, an alternative to the Elemental Method is now the Whole Building Method. This allows design flexibility, including trade-off between building envelope and building services performance, as long as a target Carbon Performance Rating level is achieved. Alternatively, for all types of non-housing, a Carbon Emissions Calculation Method can be used, whereby the design complies if it is shown that the emissions of a proposed building are less than if it had been designed to comply with the Elemental Method.

- For buildings other than dwellings the use of daylight is encouraged by relaxing the limitations on installed artificial lighting system efficiency for daylit spaces.

- For buildings other than dwellings there is a requirement to limit solar overheating. Compliance can be demonstrated by keeping window areas within prescribed limits, or by conducting calculations to show that thermal discomfort will not occur with the proposed design.

There are many other detailed changes that are important but do not have a direct bearing on glazing issues.

Building Regulations Part L do not actually make precise performance requirements, they refer to the need for 'reasonable provision' to be made for the conservation of fuel and power in buildings by limiting heat loss through building fabric, providing efficient heating and hot water systems etc. It is the Approved Documents that set out performance levels and methods of demonstrating compliance. The window and glazing requirements of these documents are summarised here.

New dwellings

Demonstration of Compliance

There are three recognised methods of demonstrating compliance given in Approved Document L1:

- The Elemental Method – specifies maximum U values for construction elements: walls, floors, roofs and windows. It places an upper limit on the permitted area of openings, i.e.windows, rooflights and doors.

- The Target U Value Method – utilises a simple formula to establish a Target U value for the whole dwelling envelope. This must then be met by manipulating the performance and areas of the various construction elements. Solar gains through windows can be taken into account.

- The Carbon Index Method – an index of performance is calculated using the government's SAP. The proposed building design must achieve a specified level. The aim is to provide more flexibility of design than the other two methods.

Elemental Method

This is the simplest means of demonstrating compliance. It requires the U value of each element to be no greater than those indicated in *table 1*. For PVC-U and timber windows, rooflights and doors, this is a maximum average U value of 2.0 W/m²K. For aluminium and steel it is 2.2.

It is the overall area-weighted average U value of all the dwelling's windows, doors and rooflights that is required to meet the relevant U value in *table 1*. Individual windows, doors and rooflights do not need to achieve a specific U value.

In addition to achieving these U values, the Elemental Method requires that the combined area of windows, doors and rooflights does not exceed 25% of the total floor area.

The U values of the proposed windows, doors or rooflights can be obtained in one of the following three ways:

a) By calculation according to BS EN ISO 10077-1.

b) By measurement in a hot box conforming to BS EN ISO 12567-1, at a suitably accredited facility.

c) By reading the U value from tables in the Approved Document. These are reproduced here as *tables 2 and 3*. *Table 4* gives adjustment factors to apply in the case of metal frames that have thermal breaks other than 4mm.

Table 1

Elemental Method: U values (W/m²K) for construction elements	
Exposed Element	**U value**
Pitched roof with insulation between rafters	0.2
Pitched roof with integral insulation	0.25
Pitched roof with insulation between joists	0.16
Flat roof	0.25
Wall	0.35
Floor	0.25
Windows, doors and rooflights (area-weighted average), glazing in metal frames	2.2
Windows, doors and rooflights (area-weighted average), glazing in wood or PVC-U frames	2.0

Table 2

Indicative U values (W/m²K) for windows and rooflights with wood or PVC-U frames and doors				
	Gap between panes			**Adjustment for rooflights in dwellings[3]**
	6mm	**12mm**	**16mm or more**	
Single glazing		4.8		+0.3
Double glazing (air filled)	3.1	2.8	2.7	
Double glazing (low E, εn = 0.2)[1]	2.7	2.3	2.1	
Double glazing (low E, εn = 0.15)	2.7	2.2	2.0	
Double glazing (low E, εn = 0.1)	2.6	2.1	1.9	
Double glazing (low E, εn = 0.05)	2.6	2.0	1.8	
Double glazing (argon filled)[2]	2.9	2.7	2.6	
Double glazing (low E, εn = 0.2, argon filled)	2.5	2.1	2.0	
Double glazing (low E, εn = 0.1, argon filled)	2.3	1.9	1.8	
Double glazing (low E, εn = 0.05, argon filled)	2.3	1.8	1.7	+0.2
Triple glazing	2.4	2.1	2.0	
Triple glazing (low E, εn = 0.2)	2.1	1.7	1.6	
Triple glazing (low E, εn = 0.1)	2.0	1.6	1.5	
Triple glazing (low E, εn = 0.05)	1.9	1.5	1.4	
Triple glazing (argon filled)	2.2	2.0	1.9	
Triple glazing (low E, εn = 0.2, argon filled)	1.9	1.6	1.5	
Triple glazing (low E, εn = 0.1, argon filled)	1.8	1.4	1.3	
Triple glazing (low E, εn = 0.05, argon filled)	1.7	1.4	1.3	
Solid wooden door[4]		3.0		

[1]The emissivities quoted are normal emissivities. (Corrected emissivity is used in the calculation of glazing U values). Uncoated glass is assumed to have a normal emissivity of 0.89.
[2]The gas mixture is assumed to consist of 90% argon and 10% air.
[3]No correction need be applied to rooflights in buildings other than dwellings.
[4]For doors which are half-glazed the U value of the door is the average of the appropriate window U value and that of the non-glazed part of the door (e.g. 3.0 W/m²K for a wooden door).

Table 3

Indicative U values (W/m²K) for windows with metal frames (4mm thermal break)			
	Gap between panes		
	6mm	**12mm**	**16mm or more**
Single glazing		5.7	
Double glazing (air filled)	3.7	3.4	3.3
Double glazing (low E, εn = 0.2)[1]	3.3	2.8	2.6
Double glazing (low E, εn = 0.1)	3.2	2.6	2.5
Double glazing (low E, εn = 0.05)	3.1	2.5	2.3
Double glazing (argon filled)[2]	3.5	3.3	3.2
Double glazing (low E, εn = 0.2, argon filled)	3.1	2.6	2.5
Double glazing (low E, εn = 0.1, argon filled)	2.9	2.4	2.3
Double glazing (low E, εn = 0.05, argon filled)	2.8	2.3	2.1
Triple glazing	2.9	2.6	2.5
Triple glazing (low E, εn = 0.2)	2.6	2.2	2.0
Triple glazing (low E, εn = 0.1)	2.5	2.0	1.9
Triple glazing (low E, εn = 0.05)	2.4	1.9	1.8
Triple glazing (argon filled)	2.8	2.5	2.4
Triple glazing (low E, εn = 0.2, argon filled)	2.4	2.0	1.9
Triple glazing (low E, εn = 0.1, argon filled)	2.2	1.9	1.8
Triple glazing (low E, εn = 0.05, argon filled)	2.2	1.8	1.7

Table 4

Adjustments to U values in Table 3 for frames with thermal breaks		
Thermal break (mm)	**Window, or rooflight in building other than a dwelling**	**Rooflight in dwellings**
0 (no break)	+0.3	+0.7
4	+0.0	+0.3
8	-0.1	+0.2
12	-0.2	+0.1
16	-0.2	+0.1

The U values given in *tables 2 and 3* tend to be conservative. Experience of the calculation and hot box procedures indicates these are likely to produce better (that is lower) U values than would be obtained by reading from the tables. The Approved Document advises that certified manufacturers' data should be used in preference to the tables.

The Pilkington range of low E glass

Pilkington has a range of low E glass products, whose normal emissivities are shown in *table 5.* These figures can be used to obtain indicative window U value from *tables 2 & 3.* For example, Pilkington **K Glass**™ in a double glazed unit with 16mm airspace, fitted in a PVC-U window, is shown to have a U value of 2.0 W/m²K.

Table 5

Emissivities of different types of Pilkington low E glass	
Product	**Normal emissivity**
Pilkington **K Glass**™	0.15
Pilkington **Optitherm**™	0.09
Pilkington **Optitherm**™ SN	0.04
Pilkington **Optitherm**™ S2	0.02

Target U Value Method

One of the alternative methods to demonstrate compliance for new dwellings is the Target U value Method. The use of this approach offers more design freedom than the Elemental Method, for example enabling window areas greater than 25% to be used.

The method requires a Target U value to be calculated for the dwelling first. This is calculated according to a formula in the Approved Document, and takes into account factors such as the surface areas of the building envelope, and the distribution of glazing between north- and south-facing façades. The second stage is to calculate the area-weighted average U value for the building envelope. If this is equal to, or lower than the Target U value, the design complies.

The Target U value, U_{Target}, is obtained as follows:

$$U_{Target} = \frac{SEDBUK_{PROP}}{SEDBUK_{Ref}} \times \left(0.35 - \frac{0.19A_R}{A_T} - \frac{0.10A_{GF}}{A_T} + 0.413\frac{A_F}{A_T} - \right)$$

where

A_R is the exposed roof area

A_{GF} is the ground floor area

A_F is the total floor area (all storeys)

A_T is the total exposed surface area (including ground floor)

$SEDBUK_{PROP}$ is the SEDBUK efficiency of the proposed boiler

$SEDBUK_{REF}$ is the Reference Standard SEDBUK boiler efficiency *(see table 6)*

(Note: if the heating system is not a gas or oil boiler, heat pump, CHP, biogas or biomass, the Target U value has to be further divided by 1.15).

When using metal frame windows, the Target U value can be increased by multiplying by a factor of 1.03 (due to the greater glazed proportion with metal frames).

If the area of windows facing south (+/-30º) exceeds that facing north (+/-30º), the Target U value can be increased by adding

$$0.04\ \frac{(A_S - A_N)}{A_{TG}}$$

where

A_S is the area of windows facing South (+/-30º)

A_N is the area of windows facing North (+/-30º)

A_{TG} is the total area of windows

Although the Target U value Method introduces flexibility, there are still upper limits on the U values permitted for roofs (0.35 W/m²K), walls and floors (0.70 W/m²K).

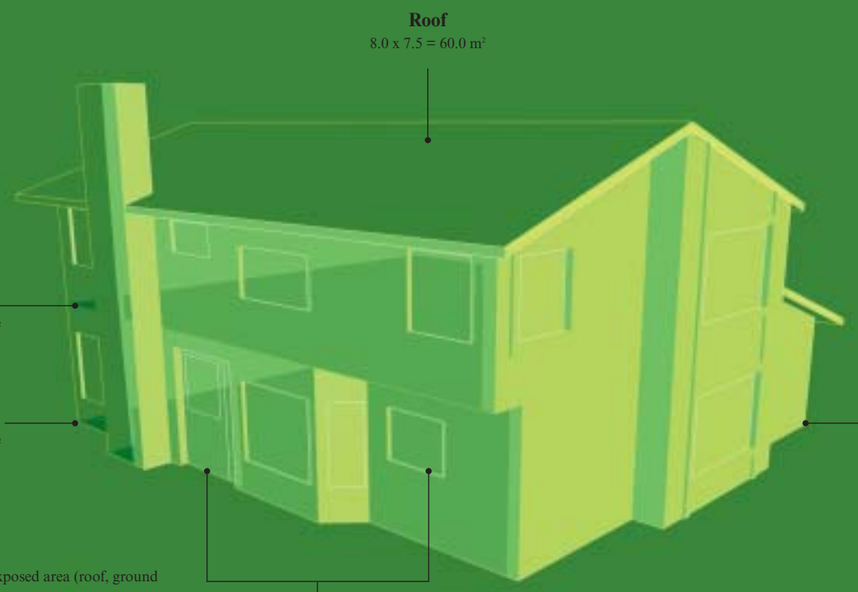
The examples on pages 10 to 13 show how the Target U value formula can be used to achieve solutions that would not conform to the limitations prescribed in the Elemental Method. This particular example is based on a detached house, with the following basic details:

Table 6

Minimum boiler SEDBUK to enable adoption of the U values in *table 1*, and reference boiler SEDBUK for use in the Target U value Method	
Central heating system fuel	**SEDBUK %**
Mains natural gas	78
LPG	80
Oil	85

Diagram 1

DWELLING DIMENSIONS



U values

Element	U value (W/m²K)
Ground floor	0.25
Roof	0.16
Opaque walls	0.35
Windows and doors	2.00*

Boiler

Central heating system fuel	SEDBUK efficiency
Mains natural gas	78%

**This is the area-weighted average U value of all windows and external doors. The 2.00 U value could of course be achieved by all windows and doors having that particular U value; alternatively, individual components can vary. For example in this house, if the windows had a U value of 1.9, and the doors a U value of 2.7, the area-weighted average U value would also be 2.00 W/m²K.*

The house described above in *Diagram 1*, just complies with the U value, boiler efficiency and window/door area requirements of the Elemental Method. However, employing the Target U value Method gives greater flexibility, so that some of the components can underperform some requirements of the Elemental Method, provided that others achieve a suitably improved performance.

Here are some examples:

EXAMPLE 1

How can I increase my window area by 4m²?

There are three possible options:

Option A – Improve window U value

First calculate the Target U value for the basic house. By inserting the relevant figures from *diagram 1* into the Target U value equation we get

$$U_{Target} = \frac{78}{78} \times \left(0.35 - \frac{0.19 \times 60}{275} - \frac{0.10 \times 60}{275} + \frac{0.413 \times 120}{275} \right)$$

U_{Target} = 0.467 W/m²K (which is the same as the average U value for the basic house)

If we increase window area by 4 m², to 30.2 m², and improve window U value to 1.75 W/m²K, data for the revised design are as shown in *table 7*.

Exposed element	Exposed surface area	U value	Rate of heat loss per degree (surface area x U value)
Opaque wall	121	0.35	42.35
Roof	60	0.16	9.60
Ground floor	60	0.25	15.00
Windows	30.2	1.75	52.85
Doors	3.8	2.00	7.60
TOTAL	**275**	**-**	**127.40**

Table 7

The average U value for the revised design is

$$\frac{\text{Total rate of heat loss per degree}}{\text{Total exposed surface area}} = \frac{127.40}{275} = 0.463$$

Therefore the average U value is lower than the Target U value, and the revised design complies.

SOLUTION: Improve window U value to 1.75

Option B – Install a boiler of higher efficiency

The Target U value in this case will be the same as for the previous option, but multiplied by the SEDBUK efficiency of the proposed boiler, divided by 78%. If a boiler of SEDBUK 82% is selected, the new Target U value therefore becomes

$$\frac{82}{78} \times 0.467 = 0.491 \text{ W/m}^2\text{K}$$

The revised data under option B are shown in *table 8*:

Exposed element	Exposed surface area	U value	Rate of heat loss per degree (surface area x U value)
Opaque wall	121	0.35	42.35
Roof	60	0.16	9.60
Ground floor	60	0.25	15.00
Windows	30.2	2.00	60.40
Doors	3.8	2.00	7.60
TOTAL	**275**	**-**	**134.95**

Table 8

The average U value for the revised design is

$$\frac{\text{Total rate of heat loss per degree}}{\text{Total exposed surface area}} = \frac{134.95}{275} = 0.491$$

Therefore the average U value equals the Target U value, and the revised design complies.

SOLUTION: Retain window U value at 2.0, and increase boiler efficiency to 82%

Option C – Improve wall insulation performance

The Target U value will be the same as in option A (namely 0.467).

Table 9 overleaf shows the data for a revised design where a wall with U value 0.31 W/m²K is selected.

Table 9

Exposed element	Exposed surface area	U value	Rate of heat loss per degree (surface area x U value)
Opaque wall	121	0.31	37.51
Roof	60	0.16	9.60
Ground floor	60	0.25	15.00
Windows	30.2	2.00	60.40
Doors	3.8	2.00	7.60
TOTAL	**275**	**-**	**130.11**

The average U value for the revised design is

$$\frac{\text{Total rate of heat loss per degree}}{\text{Total exposed surface area}} = \frac{130.11}{275} = 0.473$$

This is higher than the Target U value, so the proposal would not comply. However, if the glazing is arranged so that there is more facing south than north, the Target U value can be increased by the factor

$$0.04\ \frac{(A_s - A_n)}{A_{FG}}$$

If the proposed design has 13m² of south facing glazing, and 8m² of north facing glazing, the adjustment is 0.007, which means that the Target U value is increased to

$0.467 + 0.007 = 0.474\ W/m^2K$

This revised Target U value is now greater than the average U value of the proposed design, which therefore complies.

SOLUTION: Reduce wall U value to 0.31, and ensure south facing glazing area exceeds north facing by 5m²

Table 10

Exposed element	Exposed surface area	U value	Rate of heat loss per degree (surface area x U value)
Opaque wall	125	0.43	53.75
Roof	60	0.16	9.60
Ground floor	60	0.25	15.00
Windows	26.2	1.60	41.92
Doors	3.8	2.00	7.60
TOTAL	**275**	**-**	**127.87**

EXAMPLE 2

How can I use less wall insulation and therefore reduce wall thickness?

Improve window U value

Assuming there is no greater area of glazing facing south than north, the Target U value for the basic house of *diagram 1* would remain at 0.467.

If wall U value is relaxed to 0.43 and window U value improved to 1.60, data for the revised design are shown in *table 10*.

The average U value for the revised design is

$$\frac{\text{Total rate of heat loss per degree}}{\text{Total exposed surface area}} = \frac{127.87}{275} = 0.465$$

This is lower than the Target U value, and the revised design therefore complies.

SOLUTION: Reduce window U value to 1.60

EXAMPLE 3

How can I use a metal window with only a 4mm thermal break?

If there is no certified manufacturers' U value available for the window, the appropriate indicative U value *(taken from table 3)* must be used. For a metal window incorporating a double glazed unit having a 16mm airspace and one pane of low E glass ($\varepsilon_n = 0.2$), the indicative U value is 2.6. Therefore measures to compensate must be applied elsewhere:

Install a boiler of higher efficiency and improve the wall U value

With metal window frames, the Target U value can be multiplied by 1.03. If a boiler of SEDBUK efficiency 82% is also used, the Target U value can therefore be increased to

$$\frac{82}{78} \times 1.03 \times 0.467 = 0.506$$

If a wall U value of 0.30 W/m²K is selected, data for the design are shown in *table 11*.

Table 11

Exposed element	Exposed surface area	U value	Rate of heat loss per degree (surface area x U value)
Opaque wall	125	0.30	37.50
Roof	60	0.16	9.60
Ground floor	60	0.25	15.00
Windows	26.2	2.60	68.12
Doors	3.8	2.00	7.60
TOTAL	**275**	**-**	**137.82**

The average U value for the revised design is

$$\frac{\text{Total rate of heat loss per degree}}{\text{Total exposed surface area}} = \frac{137.82}{275} = 0.501$$

The average U value is therefore lower than the new Target U value: the design complies.

SOLUTION: Improve boiler efficiency to 82%, and wall U value to 0.30

Carbon Index Method

This third method of demonstrating compliance provides most design flexibility. It uses the government SAP (1998 version) to calculate the Carbon Index of the dwelling. The Carbon Index is a measure of the CO_2 emissions, adjusted for floor area. It is expressed on a 0 to 10 scale, and the higher the number the better the performance.

The data required to generate the Carbon Index are exactly the same as that needed to perform a calculation of the SAP rating. No additional data are required. The methodology is given in Approved Document L1.

In order to comply using this method the dwelling must be shown to have a Carbon Index of at least 8.0.

Although the Carbon Index method offers a higher degree of flexibility, there are upper limits on the U values of elements. These are the same as those that apply under the Target U value Method.

Extensions to dwellings

In extensions with a greater than 6m² floor area, the average U value of windows, doors and rooflights should not exceed the Elemental U values *(shown in table 1)*. The maximum areas of windows, doors and rooflights in the extension should be 25% of the extension floor area. Alternatively, the total area of openings in the enlarged dwelling should not exceed 25% of the floor area of the enlarged dwelling.

It is however also permitted to vary the U values and areas by using a 'trade-off' calculation, to show that the total rate of heat loss from the extension is no greater than if the elemental U values and areas had individually been achieved.

Replacement windows in dwellings

For the first time replacement windows, doors and rooflights are covered by Part L. When any of these elements are being replaced, they must now comply with the same Elemental U values as apply to new dwellings – namely 2.0 W/m²K for PVC-U and timber windows, and 2.2 for aluminium and steel windows. Alternatively, the requirement can be satisfied by a maximum centre-pane U value of 1.2 W/m²K for the glazing alone.

Replacement doors that are more than 50% glazed must also comply.

The U values can be demonstrated by calculation, by measurement or by reading from the tables in the Approved Document *(see tables 2 and 3)*.

Exceptions can only be made in the case of historic buildings, where necessary to conserve their special characteristics. However, the Approved Document makes it clear that they should be brought up to the highest standards of energy-efficiency that do not compromise the building's character.

The Approved Document also points out that replacement windows and doors should comply with the requirements of Part N, and should not detrimentally affect building performance in respect of Parts B, F and J.

(Note: when it is only the glass or glazing unit that is being replaced, rather than the whole window, there is no specific performance requirement).

Conservatories

The new Approved Document makes no significant changes to the 1995 version in respect of conservatories. However, ODPM have signalled their intention to introduce improved energy-efficiency requirements for conservatories in the future.

At present the Approved Document states the following:

A conservatory is defined as having not less than three quarters of its roof area and not less than half of the external wall area glazed with a translucent material.

When a conservatory is attached to or built as part of a new dwelling the following requirements apply:

- Where there is no separation between the conservatory and the dwelling, the conservatory must be treated as an integral part of the dwelling.

- Where there is separation between the conservatory and the dwelling, energy savings can be achieved if the conservatory is not heated. If fixed heating installations are proposed, the conservatory should have its own temperature and on/off controls.

'Separation' means that the conservatory and the dwelling have separating walls and floors insulated at least to the same degree as the exposed walls and floors, and that separating windows and doors have the same U values and provisions for draught stripping as the exposed windows and doors in the rest of the dwelling.

When a conservatory is attached to an existing dwelling the existing separation should be retained or, when enlarged, have an average U value the same as the elemental U value required for windows in *table 1*.

The safety requirements set out in Part N of the Building Regulations must be achieved.

New non-domestic buildings

Approved Document L2 gives three alternative methods of demonstrating compliance. They are:

- Elemental Method – specifies maximum U values for construction elements – walls, floors, roofs and windows. It operates in a similar way to that for dwellings, except that rooflights are considered separately from doors and windows. It should be noted that the permitted percentage of doors and windows is based on the exposed wall area and the permitted area of rooflights is a percentage of the roof area. Trade-off is permitted within the Elemental Method, which also contains requirements for air leakage, hot water systems, lighting efficiency and avoiding solar overheating.

- Whole Building Method – applies principally to office buildings. This is a method of estimating the 'Carbon Performance Rating' of a proposed office building, and a specific target level must be achieved.

- Carbon Emissions Calculation Method – a proposed building is acceptable if it is shown that its calculated carbon emissions are less than those that would have occurred with a similar building designed according to the Elemental Method.

Elemental Method

Upper limits are placed on the U values of elements. These are the same as for dwellings *(see table 1)* with the exception that rooflights are permitted a maximum U value of 2.2 W/m²K, irrespective of frame material.

Display windows, shop entrance doors and similar glazing however do not have to meet any specific U value standard, and therefore may be single glazed.

The maximum permitted window, door and rooflight areas depend on the building type, and are given in *table 12*.

The Elemental Method permits trade-off between U values and areas of construction elements, and between construction elements and heating system efficiency. To comply, it has to be demonstrated that the rate of heat loss from the proposed building does not exceed that of an equivalent building meeting the criteria in *tables 1 and 12*. The permitted rate of heat loss can be increased if a heating system is included with a higher efficiency than a reference standard.

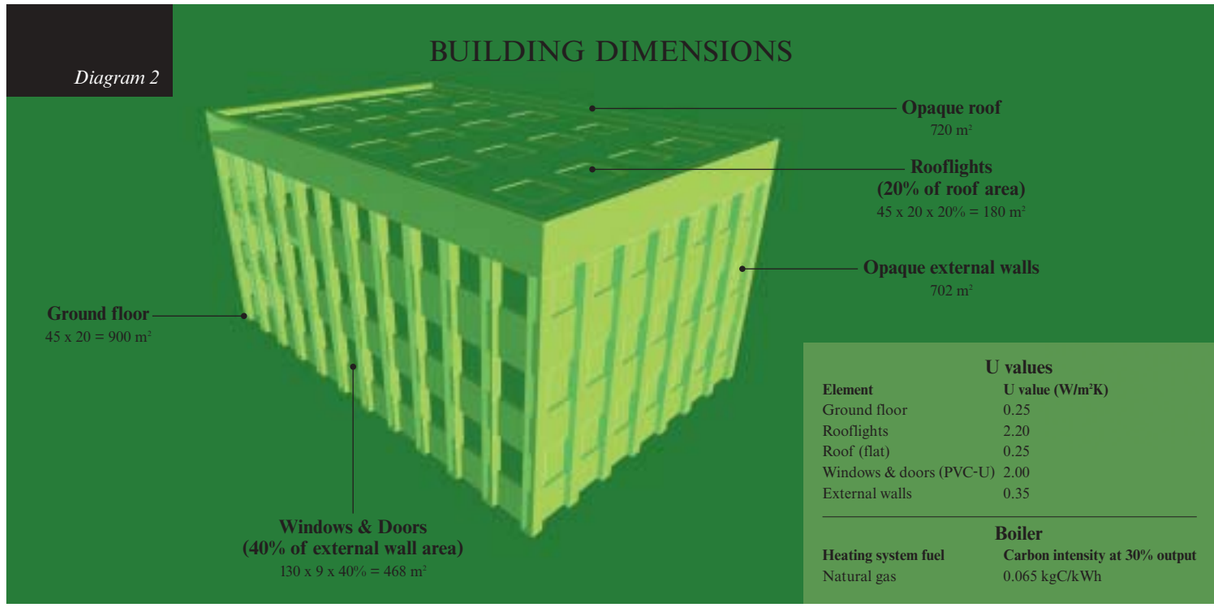
Table 12

Maximum area of openings unless compensating measures are taken

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

Diagram 2 below gives details of a basic office building designed to comply with the maximum U value, window area and heating system carbon intensity requirements.

Diagram 2



Heat loss data for the basic design are:

Table 13

Exposed element	Exposed surface area	U value	Rate of heat loss per degree (surface area x U value)
Ground floor	900	0.25	225
Rooflights	180	2.20	396
Opaque roof	720	0.25	180
Windows and doors	468	2.00	936
Opaque external walls	702	0.35	245.7
TOTAL	**2970**	**-**	**1982.7**

Average heat loss is therefore

$$\frac{\text{Total rate of heat loss per degree}}{\text{Total exposed surface area}} = \frac{1982.7}{2970} = 0.668$$

Permitted heat loss is therefore

$$0.668 \times \frac{0.065}{0.063} = 0.689$$

The heat loss of the revised design is lower than the permitted heat loss, and therefore the revised design complies.

How can I increase my window/door area to 65%?

Theoretically there are infinite numbers of permutations. In the example below we improve window/door U value to 1.70, wall U value to 0.30, heating system carbon intensity at 30% output to 0.063, and reduce rooflight area to 10%.

The Elemental Method also has an 'Avoiding Solar Overheating' section. The Approved Document gives a number of ways in which satisfactory performance can be achieved. The performance of solar control glass is acknowledged and taken into account.

Heat loss data for the revised design are:

Table 14

Exposed element	Exposed surface area	U value	Rate of heat loss per degree (surface area x U value)
Ground floor	900	0.25	225
Rooflights	90	2.20	198
Opaque roof	810	0.25	202.5
Windows and doors	760.5	1.70	1292.9
Opaque external walls	409.5	0.30	122.9
TOTAL	**2970**	**-**	**2041.3**

Average heat loss of the revised design is therefore

$$\frac{2041.3}{2970} = 0.687$$

The permitted heat loss is the average heat loss of the basic design, multiplied by the carbon intensity of the heating system in the reference design (0.065) divided by that for the revised design (0.063).

The above design would therefore comply with the requirement to avoid overheating, using the appropriate distribution of glazing and glass specification and/or shading. Appendix H in Approved Document L2 gives worked examples of how the requirement can be achieved, taking into account the areas and shading coefficients of the glazing.

Whole Building Method

This requires the carbon emissions or primary energy consumption of the building to be 'reasonable'. For office buildings, this is met by demonstrating that the Whole-Office Carbon Performance Rating achieves a target level determined by the office type. This approach therefore allows much more flexibility than the Elemental Method. For schools and hospitals, compliance is demonstrated by showing that the relevant DfEE or NHS Estates guides on energy-efficiency have been followed.

Carbon Emissions Calculation Method

Compliance is demonstrated if the calculated carbon emissions of the proposed building are no greater than those of a similar building designed to comply with the Elemental Method. It allows a very high degree of flexibility in design and fully takes into account all energy saving features – such as passive solar gains. The calculation method must be acceptable to building control bodies. One such method referred to in the Approved Document is CIBSE AM11; Building Energy and Environmental Modelling. The Carbon Emissions Calculation Method, and also the Whole Building Method, would enable façades with very high proportions of (correctly specified) glazing to be used.

Replacement windows in non-domestic buildings

There is a new requirement that any window (or rooflight) being replaced must comply with the same Elemental U values as those for new buildings – 2.0 W/m²K for PVC-U and timber windows, and 2.2 for aluminium and steel windows.

Alternatively, the requirement can be satisfied by a maximum centre-pane U value of 1.2 W/m²K for the glazing alone.

Any replacement door which is more than 50% glazed must also meet this standard.

Exceptions can only be made in the case of historic buildings, where necessary to conserve their special characteristics. However, the Approved Document makes it clear that they should be brought up to the highest standards of energy-efficiency that do not prejudice the building's character.

The Approved Document also points out that replacement windows and doors should comply with the requirements of Part N, and should not detrimentally affect building performance in respect of Parts B, F and J.

Conservatories, atria and sunspaces

When attached to non-dwellings, these are brought within the scope of the Approved Document for the first time. The definitions and requirements are the same as those that apply to conservatories attached to dwellings (see page 15).

Scotland

The 2001 amendments to the Building Standards (Scotland) Regulations, published in September 2001, increased the standards of energy-efficiency required for all new buildings, including a significant improvement in window U values. It also brought conservatories within the scope of Part J. The improved standards also apply to replacement windows, as stated in Part A.

As with England and Wales, for both dwellings and other buildings, there is an Elemental Method and two other methods offering greater design flexibility. The remainder of this section highlights where Scottish requirements differ from those detailed for England and Wales.

New dwellings

There are three alternative ways of demonstrating compliance with Part J:

Elemental Method

The maximum permitted U value for windows, doors and rooflights is dependent on the heating system fuel and boiler efficiency. With the fuels and minimum SEDBUK boiler efficiencies shown in *table 6* the maximum U values are 2.0 W/m²K for PVC-U and timber windows, and 2.2 for aluminium and steel windows. However, with boilers that do not meet these performance figures, or for any electric or solid fuel system, the maximum U values are tightened to 1.8 W/m²K for PVC-U and timber windows, and 2.0 for aluminium and steel. *Table 15* gives the maximum U values permitted for all elements.

As for England and Wales, manufacturers' declared U values, certified by a notified body, should be given as evidence of performance. U values from *tables 2, 3 and 4* may be used as an alternative. However, these are likely to underestimate the performance of the window.

Table 15

Maximum U values for dwellings – Elemental Method			
Exposed building element		Gas or oil central heating with boiler SEDBUK not less than the relevant entry in *table 6*	Other gas or oil central heating, or any electric system or solid fuel central heating or undecided
		U values (W/m²K)	
Pitched roof – with insulation between rafters		0.20	0.18
Pitched roof – with insulation between joists		0.16	0.16
Flat roof		0.25	0.22
Wall		0.30	0.27
Floor		0.25	0.22
Windows, doors and rooflights (overall average)	PVC-U or timber	2.0	1.8
	Aluminium or steel	2.2	2.0

Target U Value Method

This permits some trade-off between the thermal performance of elements and heating system efficiency, and enables the benefit of solar gain to be taken into account. The formula to determine the Target U value is similar to that for England and Wales Part L, but with different constants. The formula in Part J is

$$U_{target} = \frac{SEDBUK_{new}}{SEDBUK_{ref}} \times \left(0.60 - 0.14\frac{A_g}{A_T} - 0.05\frac{A_{cg}}{A_T} + 0.425\frac{A_r}{A_T} \right)$$

The worked examples on pages 10-13 show how the formula could be used.

Carbon Index Method

As for England and Wales, compliance can be demonstrated by achieving a calculated Carbon Index of at least 8.0 for the dwelling.

Conservatories

Conservatories of 30m² or less have in the past been exempt from the need to have a Building Warrant prior to construction. This has now changed. In order to comply with Part J, the glazing of all conservatories between 8 and 30m² floor area has to achieve a U value of 3.3 W/m²K or lower. In practice this means that single glazing will not be permitted.

New non-domestic buildings

There are three ways of demonstrating compliance. These are similar to the three methods that apply in England and Wales Part L, but with a few significant differences:

Elemental Method

The same maximum U values for windows, doors and rooflights apply *(see table 1)*, as do the same maximum window areas *(see table 12)*. However, there is no trade-off allowed between the performances of individual elements or with the heating system performance.

Heat Loss Method

This method does allow trade-off between the areas and U values of elements. The requirement is satisfied where the calculated total rate of heat loss through the envelope of the proposed building is no greater than if it had been designed to comply with the U value and window area limits of the Elemental Method.

Carbon Emissions Calculation Method

This demonstrates compliance by showing that annual carbon emissions from the proposed building are no greater than if it were designed to comply with the Elemental Method. It allows a very high degree of design flexibility, and could be used, for example, to enable larger areas of glazing to be used.

Replacement windows

Part A of the Building Regulations states that the replacement of windows in existing buildings does not require a building warrant. However, it also states that such windows shall meet the standards set out in Part J. This means that although a building warrant is not needed, replacement windows must achieve the same elemental U values as apply to new buildings in Part J.

Northern Ireland

Unlike the Regulations for England & Wales and Scotland, there have been no recent revisions to those for Northern Ireland. The requirements are therefore similar to those that used to apply elsewhere in the UK prior to revision.

New dwellings

The Elemental and Target U value Methods are used to demonstrate compliance. In the Elemental Method, the maximum permitted U value for windows, doors and rooflights is 3.0 W/m^{2}K (if the dwelling has a SAP rating of 60 or less), and 3.3 if its SAP is more than 60. The maximum permitted area of glazing and doors is 22.5% of the floor area. This maximum area can be increased provided the window U value improves proportionally. The Target U value Method offers greater flexibility through a formula that enables the performances of different elements to be traded-off against one another. It also allows the benefit of solar gains through south facing glazing to be taken into account.

New non-domestic buildings

Three alternative methods are given. The Elemental Method prescribes a maximum U value of 3.3 W/m^{2}K for windows, doors and rooflights. There are also maximum permitted glazed areas for different Purpose Groups, but these can be increased with improved window thermal performance. Greater flexibility on window area can be achieved using either the Calculation Method or the Energy Use Method; both of which allow trade-off of performance between the different components of the building.