Building Research Establishment Report

Building Regulations : conservation of fuel and power — the 'energy target' method of compliance for dwellings

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A blank copy of Worksheet part A and part B is retained in the back cover flap
This facilitates its being read alongside the text. Further copies for use can be obtained in packages of 50 price £5 (post free) (Reference AP47) from BRE Publications Sales.

SUMMARY

This document sets out, for dwellings, the 'energy target' method of complying with the Building Regulations on conservation of fuel and power due to come into force in 1990, in the form of a 'worksheet' and it also provides the data needed for calculations. For convenience the worksheet has also been implemented for use on a hand-held calculator and on IBM compatible micro-computers.

INTRODUCTION

Following public consultations during 1988, new Building Regulations are soon to take effect in England and Wales and in Scotland. Similar arrangements are being planned for Northern Ireland.

This document is concerned with the regulations as they affect the building fabric for dwellings. Slightly different requirements apply to other types of building and there are also requirements for the provision of controls for heating and hot water systems, and for the insulation of hot water storage tanks and pipes, and warm air ducts.

The details relating to the conservation of fuel and power are set out in Approved Document L for England and Wales, and in Part J of the Technical Memorandum to the Building Standards (Scotland) Regulations. Both of these documents set out the same basic requirements and both refer to this document in the context of the 'energy target' method for dwellings*.

The requirements can be met either by using an *Elemental Approach* or by using *Calculation Procedures.*

ELEMENTAL APPROACH METHOD

Using this method the dwelling is constructed such that:

1 The U-values of walls, floors and roofs do not exceed the following:

Element	U-value W/m²K
Floors next to the ground	0.45
Exposed floors	0.45
Exposed walls	0.45
Semi-exposed walls or floors	0.6
Roofs	0.25

and

2 the total area of glazing openings (including windows and rooflights) does not exceed 15% of the total floor area of the dwelling.

An 'exposed' wall or floor is any wall or floor directly exposed to the external air. A 'semi-exposed' wall or floor is any wall or floor between a heated space and another space having one or more exposed walls not insulated to the required level (usually because this second space is unheated).

The regulatory documents referred to above give details of interpretation, and examples ‡. Guidance on the avoidance of possible side-effects connected with higher insulation levels is given in the *BRE Report* 'Thermal insulation: avoiding risks'[1].

CALCULATION PROCEDURES

Calculation procedures allow, within certain limits, greater flexibility in the design. The maximum U-values of individual elements and the maximum glazed areas do not all have to be complied with, provided there is some compensating factor or factors.

There are two forms of calculation procedures: *calculated trade-off* and *energy target.*

Calculated trade-off

This method allows the U-values and/or glazed areas to be exceeded, provided that the building does not have a greater calculated rate of fabric heat loss as a result.

The method can be used to demonstrate compliance of a design which has, for instance, larger window areas where these are double glazed; less insulation in some elements compensated by more insulation in others; or double glazing compensating for higher U-values of walls or roofs.

Energy target

This method allows the U-values and/or glazed areas to be exceeded, provided that the dwelling does not have a greater calculated net energy consumption (taking into account any useful heat gains) as a result. It can be used for the same purposes as the *calculated trade-off* method, and also to allow for the effect of orientation of windows to increase solar heat gain.

The *energy target* is set up using a notional building of the same size and shape as the actual building, but in which the U-values and glazed areas are those of the *elemental approach method.*

*In England and Wales, Approved Document L provides guidance: 'it has been approved by the Secretary of State as practical guidance to meeting the requirements of the Regulations but there is no obligation to adopt any particular solution in the document if you prefer to meet the requirement in some other way'. In Scotland the Technical Memorandum has statutory backing: 'the requirements of the Regulations shall be satisfied by compliance with the Standards set out in the Technical Memorandum'.

‡ Approved Document L gives, for dwellings, the options of (a) double glazing half the total window area, with wall U-value not exceeding 0.6 W/m²K; (b) double glazing all the windows, with wall U-value not exceeding 0.6 W/m²K, roof U-value not exceeding 0.35 W/m²K and floor uninsulated.

Thus two energy calculations are made: one for the intended building and one for the notional building. The requirement of the regulation is met if the net energy consumption of the intended building does not exceed the target, namely the consumption of the notional building.

The calculation method is a subset of BREDEM[2], allocated version number BREDEM-9.2, simplified to the extent that the heating system is not an explicit variable and that the meteorological data relate to average UK conditions*. A ventilation rate of one air change per hour is used in the calculations, both for the actual building and for the notional building. The result is the output needed for space heating expressed in GJ/annum. In the notional building all windows have an average solar gain (corresponding to Easterly or Westerly orientation). The calculations are done for a typical pattern of heating — the living area heated to 21°C and the rest of the house heated to 18°C, for two hours in the morning and seven hours in the evening each day. This enables assessment of the relative merits of different house designs, but it should be borne in mind that actual energy use in any particular house is very dependent on way in which it is heated and ventilated.

Rules in the use of calculation procedures
The following apply when using both types of *calculation procedure*.

- In England and Wales the U-value of an exposed wall or floor should not exceed 0.6 W/m²K and the U-value of a roof should not exceed 0.35 W/m²K; In Scotland the U-value of any part of a floor, wall or roof may not exceed 1.2 W/m²K.
- If the total glazed opening area is less than 15% of the floor area, this in itself cannot be used to relax the U-value requirements of the *elemental approach;*
- If, because of the size of the dwelling, the U-value of the ground floor is less than 0.45 without insulation, this in itself cannot be used to relax the U-value requirements of the *elemental approach;*
- The U-values of glazed openings (windows and rooflights etc) are taken as follows ‡:

Glazing	W/m²K
Single glazed	5.7
Double glazed	2.8
Double glazed with low E coating	2.0
Triple glazed	2.0

*Regional variations are not introduced because there are no such variations in the *elemental approach* method of compliance with the regulations.

‡ These values are to be used for the purposes of the calculation described in this *Report* only, since they do not allow for the effects of curtains or blinds, nor for different types of window framing. In England and Wales other values provided by manufactureres can be used.

WORKSHEET CALCULATIONS
Data are either provided by the user (areas, U-values, References 3 and 4 etc) or are obtained from Tables 1 to 5. The procedure is to work sequentially through the worksheet, entering data in the numbered boxes until the final result is obtained. When the result of a calculation is carried forward to use later in the worksheet, the transfer is indicated by a shaded box.

The worksheet is in two parts : Part A is the calculation for the intended dwelling while Part B is the calculation for the corresponding notional dwelling. For the *calculated trade-off* calculation complete the two parts of the worksheet only as far as Boxes 36a and 36b respectively. The intended construction is acceptable if the fabric heat loss for the intended dwelling, Box 36a, does not exceed that of the notional dwelling, Box 36b.

For an *energy target* calculation, complete the whole worksheet. The intended construction is acceptable if the net space heating energy requirement for the intended dwelling, Box 63a, does not exceed the target, namely that of the notional dwelling, Box 63b.

1 Overall house dimensions. Complete Boxes 1a to 3a and 5a in Part A to provide the total internal floor area (measured between the inside faces of external walls) and house volume. These values, Boxes 4a and 6a, are carried forward to Boxes 4b and 6b in Part B.

2 Ventilation rate. A value of 1.0 air change per hour is used in both parts of the worksheet.

3 Heat loss. This section calculates the rate of heat loss through the fabric, and the total loss including that due to ventilation. Enter the U-values for the intended construction in Part A; the U-values used in Part B are those corresponding to an *Elemental Approach* in compliance with the Regulations. The areas in Part A are carried forward to Part B. For definitions of 'exposed' and 'semi-exposed' see the section *Elemental Approach method.* There is provision for two different types of wall construction, with their corresponding areas. Enter the gross wall and roof areas (including glazed areas) and subtract the glazed areas to give the net wall and roof areas.

4 Mean internal temperature. In Table 1* use the heat loss parameter (Box 39) to obtain the mean temperature of the living area, and the temperature difference between zones which are entered in Boxes 39 and 40 respectively (both parts of the worksheet). The 'living area fraction' is the proportion of the total floor area (between 0 and 1) that is heated to a higher temperature standard than the rest of the house. It will normally include any lounge, living room, sitting room or dining room.

***General note on the use of Tables 1, 2, 4 and 5.**
For better accuracy, expecially when using Table 1 interpolate (in linear proportion) as necessary between the values given in these tables.

Table 1 Mean internal temperature of living area, and temperature difference between living area and rest of house

HLP	Living area (°C)	Temperature difference (°C)
1.0	20.01	0.40
1.5	19.64	0.60
2.0	19.35	0.79
2.5	19.11	0.97
3.0	18.89	1.15
3.5	18.68	1.32
4.0	18.48	1.48
4.5	18.26	1.63
5.0	18.04	1.76

Note: Interpolate as necessary between the values in this Table. Often it will be sufficient to use internal temperatures to one decimal place but that may introduce inconsistencies in the results due to rounding errors. When examining the effect of small changes or when the net energy use with the designed U-values and with the prescribed U-values are similar, work with temperatures correct to two decimal places.

Table 2 Internal gains

Floor area (m^2)	Gains (W)	Floor area (m^2)	Gains (W)	Floor area (m^2)	Gains (W)	Floor area (m^2)	Gains (W)
30	400	90	770	150	1110	200	1365
40	465	100	830	160	1165	210	1410
50	530	110	890	170	1215	220	1455
60	590	120	945	180	1265	230	1500
70	650	130	1000	190	1315	240	1545
80	710	140	1055				

Note: Interpolate as necessary between the values in this Table. The gains include metabolic gains and those from cooking, the hot water system, lights and appliances.

Table 3 Solar flux through glazing (W/m^2)

Orientation:	Horizontal	Vertical		
		Northerly	Southerly	Other
Single glazed	31.0	10.0	30.4	18.1
Double glazed	26.1	8.4	25.6	15.2
Double glazed with low-E coating	24.5	7.9	24.0	14.3
Triple glazed	22.0	7.1	21.6	12.8

Note: For windows facing up to 30° either side of North use the value under 'Northerly'; for windows facing up to 30° either side of South use the value under 'Southerly'; for all other windows use the value under 'Other'. For rooflights in pitched roofs with a pitch of up to 70°, use the value under 'Northerly' for orientations up to 30° of North and the value under 'Horizontal' for all other orientations. (If the pitch is greater than 70° it should be treated as a vertical window).

Table 4 Utilisation factors as a function of gain/loss ratio (G/L)

G/L	Utilisation factor	G/L	Utilisation factor	G/L	Utilisation factor
1	1.00	11	0.81	21	0.58
2	1.00	12	0.78	22	0.56
3	1.00	13	0.75	23	0.54
4	0.99	14	0.72	24	0.53
5	0.97	15	0.70	25	0.51
6	0.95	16	0.68	30	0.45
7	0.92	17	0.65	35	0.40
8	0.89	18	0.63	40	0.36
9	0.86	19	0.61	45	0.33
10	0.83	20	0.59	50	0.30

Note: Interpolate as necessary between the values in this Table

Table 5 Degree-days as a function of base temperature

Base temperature	Degree-days	Base temperature	Degree-days
1.0	0	11.0	1140
1.5	30	11.5	1240
2.0	60	12.0	1345
2.5	95	12.5	1450
3.0	125	13.0	1560
3.5	150	13.5	1670
4.0	185	14.0	1780
4.5	220	14.5	1900
5.0	265	15.0	2015
5.5	310	15.5	2130
6.0	360	16.0	2250
6.5	420	16.5	2370
7.0	480	17.0	2490
7.5	550	17.5	2610
8.0	620	18.0	2730
8.5	695	18.5	2850
9.0	775	19.0	2970
9.5	860	19.5	3090
10.0	950	20.0	3210
10.5	1045		

Note: Interpolate as necessary between the values in this Table.

5 Internal gains. Obtain a value from Table 2 according to the floor area. The same value is used in both parts of the worksheet.

6 Solar gains. Enter the area of window at each orientation in Part A of the worksheet : these are the same areas that were entered against each elevation in Section 3. There is provision for a mixture of single and multiple glazing. In Part B of the worksheet only the total glazed area is needed. Obtain solar flux values according to glazing type and orientation from Table 3. Note that the values given in Table 3 are to be used with the whole window area (including the frame). A frame factor of 30% has been assumed.

7 Degree-days. Use the gains and the specific heat loss to calculate the temperature rise due to the gains and subtract this from the mean internal temperature to obtain the base temperature. Obtain the degree-days from Table 5 interpolating between the entries in the table if necessary. Carry out this procedure in both parts of the worksheet.

8 Space heating. The space heating energy requirements is the output needed from the space heaters, expressed in GJ.

CALCULATION AND COMPUTER IMPLEMENTATIONS

In the calculator and computer implementations of the worksheet all the tabular data are stored in the machine and called automatically when needed.

The Psion calculator has a two-line alphanumeric display which prompts the user for each input. After data entry there is the facility to alter any data item and recalculate.

The computer implementation displays the worksheet on the screen. After data entry any item can be amended and the display, including the final result, is immediately updated.

Software to run BREDEM-9.2 on IBM-compatible computers and the Psion calculator is available (under licence to BRE) from Energy Advisory Services Limited, The Old Manor House, The Green, Hanslope, Milton Keynes, MK19 7LS. Telephone (0908) 510596.

REFERENCES

1 **Building Research Establishment.** Thermal insulation: avoiding risks. *BRE Report* BR 143. BRE 1989.

2 **Anderson B R.** Energy assessment for dwellings using BREDEM Worksheets. *BRE Information Paper* IP 13/88.

3 **Building Research Establishment.** Standard U-values . *BRE Digest* 108. Revised 1984.

4 **Chartered Institution of Building Services Engineers** (CIBSE) 1980. *CIBSE Guide* Section A3 — Thermal properties of building structures.

APPENDIX 1 Parts A and B

WORKED EXAMPLE

It is proposed to build a semi-detached house with U-values as follows:

exposed walls: 0.6 W/m²K
exposed roof: 0.25 W/m²K
ground floor: 0.45 W/m²K

with window openings totalling 8.7 m². The plan dimensions are 6 m × 5 m (between external walls) and there are two storeys each of height 2.4 m.

To compensate for having exposed walls with a U-value greater than 0.45 W/m²K, it is proposed to double glaze 3.2 m² of window. Is this acceptable?

Calculated trade-off

For the *calculated trade-off* method the worksheet (Appendix 1) is completed as far as Boxes 36a and 36b.

The total rate of heat loss (Boxes 36a and 36b of the worksheet) are:

for the intended construction: 102.4 W/K
for the notional dwelling: 101.2 W/K

The rate of fabric heat loss for the intended construction exceeds that of the notional dwelling. The proposed house does not therefore meet the requirements of the regulation on this basis.

Energy target

For the *energy target* method the whole worksheet is completed. The orientation of the dwelling is to be such that the windows are arranged predominantly south-facing. The net space-heating energy requirement (Boxes 63a and 63b of the worksheet) is:

for the intended construction: 21.4 GJ/annum
for the notional dwelling: 21.7 GJ/annum

The net space-heating energy requirement for the intended dwelling does not exceed that of the notional dwelling. The construction is acceptable at the specified orientation and disposition of windows. (It would not necessarily be acceptable at another orientation).

BREDEM WORKSHEET (Version-BREDEM-9.2)

To be used with BRE Report BR150 'Building Regulations : conservation of fuel and power — the 'energy target' method of compliance for dwellings'.

Part A *Calculation for the intended construction*

1 Overall house dimensions

Ground floor area (m^2)	=	30.0 (1a)				
First floor area (m^2)	=	30.0 (2a)				
Second and other floors (m^2)	=	(3a)	Average storey height (m)	=	2.4	(5a)
Total floor area	=	60.0 (4a)	House volume (4a) × (5a)	=	144.0	(6a)

2 Air-change rate

Air fixed rate (air changes per hour) (fixed value) = 1.0 (7a)

3 Heat loss

Element		Gross Area (m^2)	Glazed openings (m^2)	Net Area (A) (W/m^2K)	U-value (W/K)	A × U (W/K)
Glazed openings (single glazed)	– elevation 1	1.5 (8a)		×	5.7	= 8.6 (19a)
	– elevation 2	1.5 (9a)		×	5.7	= 8.6 (20a)
	– elevation 3	2.5 (10a)		×	5.7	= 14.3 (21a)
	– elevation 4	(11a)		×	5.7	= (22a)
	– roof	(12a)		×	5.7	= (23a)
Glazed openings (multiple glazed) (U = 2.8 or 2.0)	– elevation 1	1.0 (13a)		×	2.8	= 2.8 (24a)
	– elevation 2	(14a)		×		= (25a)
	– elevation 3	2.2 (15a)		×	2.8	= 6.2 (26a)
	– elevation 4	(16a)		×		= (27a)
	– roof	(17a)		×		= (28a)
Total glazed opening area:		8.7 (18a)	(Carry 18a to 18b)			
Floors	Ground	30.0 (1a)		×	0.45	= 13.5 (29a)
	Exposed			×		= (30a)
Walls	Exposed — type 1	76.8	– 8.7 *	68.1	× 0.6	= 40.9 (31a)
	— type 2		– *		×	= (32a)
	Semi-exposed				×	= (33a)
Roofs	Exposed — type 1	30.0	– *	30.0	× 0.25	= 7.5 (34a)
	— type 2		– *		×	= (35a)

**The sum of the values in these four boxes must equal the value in Box 18a.*

Total fabric loss: = (19a) + (20a) + ... (35a) = 102.4 (36a)

Ventilation loss: = 144.0 (6a) × 0.33 × 1.0 (7a) = 47.5 (37a)

Total specific heat loss (W/K): = (36a) + (37a) = 149.9 (38a)

The Heat Loss Parameter is the specific heat loss divided by the floor area:

Heat Loss Parameter (HLP): = 149.9 (38a) ÷ 60.0 (4a) = 2.50 (39a)

4 The Mean Internal Temperature

Use the Heat Loss Parameter (HLP) of Box 39a in Table 1 to obtain the mean temperature of the living area, and the temperature difference between living area and the rest of the house.

Mean temperature of living area		=	19.11 (40a)
Temperature difference		=	0.97 (41a)

Enter the fraction of the total internal floor area assigned to living areas (including any lounge, living room, sitting room or dining room):

Living area fraction (0.0 to 1.0):		=	0.3 (42a)
Rest of house fractional area:	= 1.0 − (42a)	=	0.7 (43a)
Mean internal temperature:	= (40a) − ((41a) × (43a))	=	18.43 (44a)

5 Internal gains

Use the total floor area in Box 4a to obtain a value for the internal heat gains from Table 2.

Internal gains (from Table 2) = 590 (45a)

Solar gains

Enter the area (m²) of the whole glazing including frame and the value for solar flux for single and/or multiple glazing from Table 3. See note to Table 3 concerning orientations.

			Area (m²)		Solar Flux (W/m²)		Gains (W)
Glazed openings (single glazed)	− Northerly	=	1.5	×	10.0	=	15.0 (46a)
	− Easterly	=	1.5	×	18.1	=	27.2 (47a)
	− Southerly	=	2.5	×	30.4	=	76.0 (48a)
	− Westerly	=		×	18.1	=	(49a)
	− Rooflights	=		×	31.0	=	(50a)
Glazed openings (Multiple glazed)	− Northerly	=	1.0	×	8.4	=	8.4 (51a)
	− Easterly	=		×		=	(52a)
	− Southerly	=	2.2	×	25.6	=	56.3 (53a)
	− Westerly	=		×		=	(54a)
	− Rooflights	=		×		=	(55a)

Total solar gain	= (46a) + (47a) + ... + (55a)				=	183 (56a)
Total gains	= 590 (45a)	+	183 (56a)		=	773 (57a)
Gain/Load ratio (G/L)	= 773 (57a)	÷	149.9 (38a)		=	5.2 (58a)

Useful gains: *Get utilisation factor from Table 4 using Box 58a for value of G/L*

Useful gains = (Utilisation factor) 0.97 × 773 (57a) = 750 (59a)

6 Degree-days

Use the useful gains in Box 59a and the specific heat loss in Box 38a to calculate the temperature rise due to the internal and solar gains. Subtract this from the mean internal temperature to obtain the base temperature.

Temperature rise from gains	= 750 (59a)	÷	149.9 (38a)		=	5.00 (60a)
Base temperature	= 18.43 (44a)	−	5.00 (60a)		=	13.43 (61a)

Use Table 5 to obtain the degree-days from the base temperature:

Degree-days (use Box 61a in Table 5) 1655 (62a)

7 Net space heating energy requirement

Calculate the net space heating energy requirement (GJ/annum) from the specific loss Box 38a and the degree-days Box 61a. Express the result to one place of decimals.

Space heating 0.0000864 × 149.9 (38a) × 1655 (62a) = 21.4 (63a)

Part B *Calculation for notional building (with prescribed U-values etc)*

1 Overall house dimensions

Total floor area	=	60.0 (4a)	=	60.0 (4b)
House volume	=	144.0 (6a)	=	144.0 (6b)

2 Air change rate

Air change rate (air changes per hour) (fixed value) = 1.0 (7b)

3 Heat loss

Total glazed opening area in actual design	=	8.7 (18a)	=	8.7 (18b)
15% of floor area:	= 0.15 x	60.0 (4b)	=	9.0 (19b)
Enter the smaller of Boxes 18b and 19b:			=	8.7 (20b)
U-value of floor without insulation:			=	0.9 (21b)
Enter the smaller of 0.45 and Box 21b			=	0.45 (22b)

Element		Gross Area (m^2)	Glazed openings (m^2)	Net Area (A) (N^2)	U-value (W/m^2K)	A x U (W/K)
Glazed openings		= 8.7 (20b)			x 5.7	= 49.6 (28b)
Floors	Ground	= 30.0			x 0.45 (22b)	= 13.5 (29b)
	Exposed	=			x 0.45	= (30b)
Walls	Exposed	= 76.8	− 8.7 (20b)	= 68.1	x 0.45	= 30.6 (31b)
	Semi-exposed	=			x 0.6	= (33b)
Roofs	Exposed	= 30.0			x 0.25	= 7.5 (34b)

Total fabric loss: (28b) + (29b) + (30b) + (31b) + (33b) + (34b) = 101.2 (36a)

Ventilation loss: = 144.0 (6b) x 0.33 x 1.0 (7b) = 47.5 (37b)

Total specific heat loss (W/K): (36b) + (37b) = 148.7 (38b)

Heat Loss Parameter (HLP): = 148.7 (38b) ÷ 60.0 (4b) = 2.48 (39b)

4 Mean internal temperature

Use the Heat Loss Parameter (HLP) of Box 39b in Table 1 to obtain the mean temperature of the living area, and the temperature difference between living area and the rest of the house.

Mean temperature of living area (Table 1)			=	19.12 (40b)
Temperature difference (Table 1)			=	0.96 (41b)
Living area fraction	=	0.3 (42a)	=	0.3 (42b)
Rest of house fractional area		= 1.0 − (42b)	=	0.7 (43b)
Mean internal temperature	= (40b) −	((41b) x (43b))	=	18.45 (44b)

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BREDEM WORKSHEET (Version-BREDEM-9.2)

To be used with BRE Report BR150 'Building Regulations : conservation of fuel and power — the 'energy target' method of compliance for dwellings'.

Part A *Calculation for the intended construction*

1 Overall house dimensions

Ground floor area (m^2)	=	(1a)				
First floor area (m^2)	=	(2a)				
Second and other floors (m^2)	=	(3a)	Average storey height (m)	=		(5a)
Total floor area	=	(4a)	House volume (4a) × (5a)	=		(6a)

2 Air-change rate

Air fixed rate (air changes per hour) (fixed value) = 1.0 (7a)

3 Heat loss

Element		Gross Area (m^2)	Glazed openings (m^2)	Net Area (A) (W/m^2K)		U-value (W/K)		A x U (W/K)
Glazed openings	– elevation 1 =		(8a)		×	5.7	=	(19a)
(single glazed)	– elevation 2 =		(9a)		×	5.7	=	(20a)
	– elevation 3 =		(10a)		×	5.7	=	(21a)
	– elevation 4 =		(11a)		×	5.7	=	(22a)
	– roof =		(12a)		×	5.7	=	(23a)
Glazed openings	– elevation 1 =		(13a)		×		=	(24a)
(multiple glazed)	– elevation 2 =		(14a)		×		=	(25a)
(U = 2.8 or 2.0)	– elevation 3 =		(15a)		×		=	(26a)
	– elevation 4 =		(16a)		×		=	(27a)
	– roof =		(17a)		×		=	(28a)
Total glazed opening area:	=		(18a)	(Carry 18a to 18b)				
Floors	Ground		(1a)		×		=	(29a)
	Exposed				×		=	(30a)
Walls	Exposed — type 1 =		–	* =	×		=	(31a)
	— type 2 =		–	* =	×		=	(32a)
	Semi-exposed =				×		=	(33a)
Roofs	Exposed — type 1 =		–	* =	×		=	(34a)
	— type 2 =		–	* =	×		=	(35a)

**The sum of the values in these four boxes must equal the value in Box 18a.*

Total fabric loss: = (19a) + (20a) + ... (35a) = (36a)

Ventilation loss: = (6a) × 0.33 × 1.0 (7a) = (37a)

Total specific heat loss (W/K): = (36a) + (37a) = (38a)

The Heat Loss Parameter is the specific heat loss divided by the floor area:

Heat Loss Parameter (HLP): = (38a) ÷ (4a) = (39a)

4 The Mean Internal Temperature

Use the Heat Loss Parameter (HLP) of Box 39a in Table 1 to obtain the mean temperature of the living area, and the temperature difference between living area and the rest of the house.

Mean temperature of living area = [ ] (40a)

Temperature difference = [ ] (41a)

Enter the fraction of the total internal floor area assigned to living areas (including any lounge, living room, sitting room or dining room):

Living area fraction (0.0 to 1.0): = [ ] (42a)

Rest of house fractional area: = 1.0 − (42a) = [ ] (43a)

Mean internal temperature: = (40a) − ((41a) × (43a)) = [ ] (44a)

5 Internal gains

Use the total floor area in Box 4a to obtain a value for the internal heat gains from Table 2.

Internal gains (from Table 2) = [ ] (45a)

Solar gains

Enter the area (m²) of the whole glazing including frame and the value for solar flux for single and/or multiple glazing from Table 3. See note to Table 3 concerning orientations.

			Area (m²)		Solar Flux (W/m²)		Gains (W)
Glazed openings (single glazed)	– Northerly	=	[ ]	×	10.0	=	[ ] (46a)
	– Easterly	=	[ ]	×	18.1	=	[ ] (47a)
	– Southerly	=	[ ]	×	30.4	=	[ ] (48a)
	– Westerly	=	[ ]	×	18.1	=	[ ] (49a)
	– Rooflights	=	[ ]	×	31.0	=	[ ] (50a)
Glazed openings (Multiple glazed)	– Northerly	=	[ ]	×	[ ]	=	[ ] (51a)
	– Easterly	=	[ ]	×	[ ]	=	[ ] (52a)
	– Southerly	=	[ ]	×	[ ]	=	[ ] (53a)
	– Westerly	=	[ ]	×	[ ]	=	[ ] (54a)
	– Rooflights	=	[ ]	×	[ ]	=	[ ] (55a)

Total solar gain = (46a) + (47a) + ... + (55a) = [ ] (56a)

Total gains = [ ] (45a) + [ ] (56a) = [ ] (57a)

Gain/Load ratio (G/L) = [ ] (57a) ÷ [ ] (38a) = [ ] (58a)

Useful gains: *Get utilisation factor from Table 4 using Box 58a for value of G/L*

Useful gains = (Utilisation factor) [ ] × [ ] (57a) = [ ] (59a)

6 Degree-days

Use the useful gains in Box 59a and the specific heat loss in Box 38a to calculate the temperature rise due to the internal and solar gains. Subtract this from the mean internal temperature to obtain the base temperature.

Temperature rise from gains = [ ] (59a) ÷ [ ] (38a) = [ ] (60a)

Base temperature = [ ] (44a) − [ ] (60a) = [ ] (61a)

Use Table 5 to obtain the degree-days from the base temperature:

Degree-days (use Box 61a in Table 5) [ ] (62a)

7 Net space heating energy requirement

Calculate the net space heating energy requirement (GJ/annum) from the specific loss Box 38a and the degree-days Box 61a. Express the result to one place of decimals.

Space heating 0.0000864 × [ ] (38a) × [ ] (62a) = [ ] (63a)

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Part B *Calculation for notional building (with prescribed U-values etc)*

1 Overall house dimensions

Total floor area = (4a) = (4b)

House volume = (6a) = (6b)

2 Air change rate

Air change rate (air changes per hour) (fixed value) = 1.0 (7b)

3 Heat loss

Total glazed opening area in actual design = (18a) = (18b)

15% of floor area: = 0.15 x (4b) = (19b)

Enter the smaller of Boxes 18b and 19b: = (20b)

U-value of floor without insulation: = (21b)

Enter the smaller of 0.45 and Box 21b = (22b)

Element		Gross Area (m^2)	Glazed openings (m^2)	Net Area (A) (N^2)	U-value (W/m^2K)	A × U (W/K)
Glazed openings		= (20b)			× 5.7	= (28b)
Floors	Ground	=			× (22b)	= (29b)
	Exposed	=			× 0.45	= (30b)
Walls	Exposed	=	− (20b) =		× 0.45	= (31b)
	Semi-exposed	=			× 0.6	= (33b)
Roofs	Exposed	=			× 0.25	= (34b)

Total fabric loss: (28b) + (29b) + (30b) + (31b) + (33b) + (34b) = (36a)

Ventilation loss: = (6b) × 0.33 × 1.0 (7b) = (37b)

Total specific heat loss (W/K): (36b) + (37b) = (38b)

Heat Loss Parameter (HLP): = (38b) ÷ (4b) = (39b)

4 Mean internal temperature

Use the Heat Loss Parameter (HLP) of Box 39b in Table 1 to obtain the mean temperature of the living area, and the temperature difference between living area and the rest of the house.

Mean temperature of living area (Table 1) = (40b)

Temperature difference (Table 1) = (41b)

Living area fraction = (42a) = (42b)

Rest of house fractional area = 1.0 − (42b) = (43b)

Mean internal temperature = (40b) − ((41b) × (43b)) = (44b)

5 Internal and solar gains

Internal gains, same value as Box 45a:							(45b)
Solar gains	=		(20b)	×	18.1	=	(56b)
Total gains	=		(45b)	+		(56b) =	(57b)
Gain/load ratio (G/L)	=		(57b)	÷		(38b) =	(58b)

Get utilisation factor from Table 4 using Box(58b) for value of (G/L)

Useful gains = (utilisation factor) × (57b) = (59b)

6 Degree-days

temperature rise from gains	=		(59b)	÷		(38b) =	(60b)
Base temperature	=		(44b)	−		(60b) =	(61b)

Degree-days (use Box 61b in Table 5) = (62b)

7 Net space heating energy requirement

Space heating = 0.0000864 × (38b) × (62b) = (63b)

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