



# SBEM Elements Adjacent to Unheated Spaces Calculation Tool

October 2013

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## 1 Introduction

This FAQ guidance enables BER Assessors to calculate an area weighted adjusted U value for elements adjacent to unheated spaces for use in the Simplified Building Energy Model (SBEM). The FAQ is appropriate for all software using SBEM as the BER calculation tool.

An unheated space, as outlined in the NEAP Survey Guide, is defined as a space without a HVAC system specified in SBEM or a space that is not normally heated to similar levels to the adjoining zone (i.e. heated to a similar temperature (+/- 5°C) for 90% or more of the duration of the adjoining zone.)

The U-value of elements connecting a conditioned zone in the building being assessed to an "Unheated Adjoining Space" or a "Strongly ventilated adjoining space" must account for the effect of the unheated space. The unheated or strongly ventilated space may be part of the building being assessed or an adjoining building. The procedure and requirement to account for the effect of unheated spaces on heat loss calculations is provided in the Non Domestic Building Regulations Part L Technical Guidance Document (TGD L) Appendix A. TGD L references EN 6946 and BR443:2006 for the approach to be taken in calculating U values. This FAQ follows the guidance in Appendix A of BR443:2006 as based on EN 13789 (as per TGD L) for U-value adjustments for elements adjoining unheated or strongly ventilated spaces:

$$U = \frac{1}{\frac{1}{U_o} + R_u}$$

where:

- U is the resultant adjusted U-value of the element adjacent to unheated space, W/m<sup>2</sup>K;
- U<sub>o</sub> is the U-value of the element between conditioned zones and unheated or strongly ventilated spaces calculated as if there were no unheated space adjacent to the element, W/m<sup>2</sup>K;
- R<sub>u</sub> = effective thermal resistance of unheated space, m<sup>2</sup>K/W.

The R<sub>u</sub> values derivation is detailed in Appendix A of BR443:2006.

$$R_u = \frac{A_i}{\sum (A_e \times U_e) + 0.33nV}$$

where:

- A<sub>i</sub> the area(s) of the element between the conditioned zone and unheated space being calculated, m<sup>2</sup>;
- A<sub>e</sub> is the area of each of the external elements, excluding ground floor, m<sup>2</sup>;
- U<sub>e</sub> is the U value of each of the external elements of the adjoining unheated space, W/m<sup>2</sup>K;
- n is the air change rate (ach) of the unheated space;
- V is the volume of the unheated space, m<sup>3</sup>.

This FAQ has been developed by SEAI to simplify the assessment process while adhering to the relevant U-value calculation standards. Following feedback from assessors, this tool was developed to reduce the workload for the assessor and inputs into iSBEM whilst adhering to the relevant standards.

Alternatively assessors may continue to carry out hand calculations for the U-value adjustment of elements between a zone and unheated space once they follow the methodology in BRE 443.

The FAQ and associated calculation tool:

- Allows Assessors to combine a number of elements adjoining unheated or strongly ventilated spaces within a conditioned zone and enter as a single element in SBEM. For example the assessor can combine a number of internal walls within a conditioned zone adjoining one or more unheated or strongly ventilated spaces.
- Identifies where U-value adjustment is not required in SBEM if the impact of the adjustment is expected to be negligible. SEAI has carried out sensitivity analysis, as outlined in Appendix 1, to show that the following adjustments can be ignored:

Original U-value of element between conditioned zone and unheated or strongly ventilated space (W/m <sup>2</sup> K)	% Difference between Original and Adjusted U value
< 1	Adjustment not made if <= 10%
1 to 3	Adjustment not made if <= 5%
> 3	Adjustment always made.

**Table 1: Application of Ru Adjustment**

For example, a conditioned office zone is adjoining an unheated warehouse. The U value of the element between the office and warehouse has an original U value of 1.7 W/m<sup>2</sup>K. The Assessor carries out an Ru value calculation and determines that the adjusted U value is 1.64 W/m<sup>2</sup>K. As the change in U value is less than 5% the Assessor is not required to create a new element within SBEM with a U value of 1.64 W/m<sup>2</sup>K.

However with a second example, a conditioned office zone is adjoining an unheated internal store. The U value of the element between the office and store has an original U value of 2.1 W/m<sup>2</sup>K. The Assessor carries out an Ru value calculation and determines that the adjusted U value is 1.2 W/m<sup>2</sup>K. As the change in U value is greater than 5% the Assessor is required to create a new element within SBEM with a U value of 1.2 W/m<sup>2</sup>K.

- Follows BRE 443 guide Section 6 and rounds the final result to two significant figures (to two decimal places if the value is less than 1 and one decimal place if more than 1.0) after the Ru adjustment calculation is complete.

## 2 Using the Element Adjacent to Unheated Spaces Tool

The effective thermal resistance of an unheated space ( $R_u$ ) is based on the heat transfer from external elements of the unheated space and the air change rate within the unheated space. The adjusted U-value is based on the original U-value (default or non-default) of the element between the conditioned zone and unheated space and the  $R_u$  value. The  $R_u$  value is determined by measuring the external elements and volume of the unheated spaces and determining the appropriate U-value of the external elements and air change rate within the unheated space.

This data is used by the Microsoft Excel application accompanying this FAQ, "SBEM Elements Adjacent to Unheated Spaces". The application is designed to run in Microsoft Excel 2003 and later versions. **Ensure that macros are enabled in Microsoft Excel when using the application.** Data is entered in the "Zone" tabs.

### 2.1 "Zone" tabs layout

Each "Zone" tab is divided into two sections. Additional conditioned zones adjoining unheated spaces are created as per Figure 8. The header area in Figure 1 contains information relating to the building and conditioned zone being assessed. The detailed table in Figure 2 displays data relating to unheated adjoining spaces.

The header area (Figure 1) is divided into four sections as follows:

Resultant U Value Calculation				Version 1.0				
MPRN:	BER Number:	Zone Name in SBEM:		Number of types of elements in zone adjoining an Unheated Space	Area (m2)	Area Weighted Adjusted U Value (W/m2K)	Area Weighted Km Value (kJ/m2K)	<b>Colour Key</b> <input type="checkbox"/> User Input <input type="checkbox"/> Constant <input type="checkbox"/> Calculated Value
Date of Survey	Address	Year of Construction	Internal Walls		0.00	Incomplete Inputs	Incomplete Inputs	
			Internal Ceiling		0.00	Incomplete Inputs	Incomplete Inputs	
Assessor No	Assessor Name	Comment	Internal Floors	0.00	Incomplete Inputs	Incomplete Inputs		

Figure 1: Zone header area

- 1) The section to the left identifies the building including the MPRN, BER number and address etc. Enter the name of the conditioned zone as used in SBEM (e.g. Z0/03) to which this tab relates.
- 2) The next section contains data entry boxes detailing the number of elements adjoining unheated spaces within the conditioned zone.
- 3) The next section shows the final calculated "Area Weighted Adjusted U value", the "Area Weighted Km value" and the associated area for each element. These are the values entered in SBEM and are generated by this Excel tool.
- 4) The section to the right contains a key for the spreadsheet cells. Only the yellow "User Input" boxes are editable by the user.

Element Number	Area (m2) of Element	Zone Name/ Description of Unheated Space	External Element in Unheated Space	Area (m2) of External Element	U-Value(W/m <sup>2</sup> K) of External Element	Sum of (A <sub>x</sub> U) for External Element in Unheated Space	Ventilation Rate of Unheated Space (ach)	Volume of Unheated Space (m <sup>3</sup> )	Ru Value	Original U-Value(W/m <sup>2</sup> K) of Element	Adjusted U-Value(W/m <sup>2</sup> K) for Element
Internal Wall Elements Adjoining Unheated Spaces											
	0		Wall	0	2	0	3	0	#DIV/0!	0.00	#DIV/0!
			Roof	0	2					Km Value (kJ/m <sup>2</sup> K) for Element	
			Window	0	2					0.00	
			Other	0	2						

Figure 2: Details for data entry and unheated spaces adjoining walls in this zone

Figure 2 shows where details of the adjoining unheated space are entered, including the area and U values of external elements of the unheated space and the ventilation rate and volume of the unheated space. The area, Km value and original U value of the element between the space being assessed and the adjoining unheated space are also entered.

## 2.2 Adding a New Element

To add an element between the conditioned zone and an adjoining unheated space, select which internal elements are adjoining unheated spaces and the number (ranging from 0 to 4) of each element adjoining unheated spaces as highlighted in Figure 3.

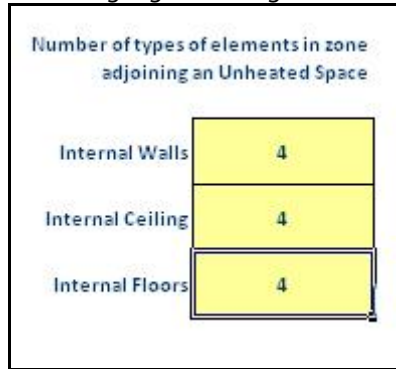


Figure 3: Number of zone elements adjoining unheated space

Based on the selection, the spreadsheet displays the boxes that must be completed as shown in Figure 4. In this example, one of the zone’s bounding walls adjoins an unheated space as highlighted in green below. The tool displays the necessary data entry points for that unheated space so that it can calculate the corresponding adjusted U-value. In the case where there are more than one wall between the conditioned zone and unheated space(s), then the tool automatically displays the required data entry points for those other walls under “Internal Wall Elements Adjoining Unheated Spaces”. The tool provides similar functionality for the ceilings and floors in the zone.

Resultant U Value Calculation										Version 1.0		
MPRN: <input type="text"/> BER Number: <input type="text"/> Zone Name in SBEM: <input type="text"/>			Number of types of elements in zone adjoining an Unheated Space		Area (m2)			Area Weighted Adjusted U Value (W/m2K)		Area Weighted Km Value (kJ/m2K)		Colour Key
Date of Survey: <input type="text"/> Address: <input type="text"/> Year of Construction: <input type="text"/>			Internal Walls: 1		Internal Walls: 0.00			Incomplete Inputs		0.00		User Input
Assessor No: <input type="text"/> Assessor Name: <input type="text"/> Comment: <input type="text"/>			Internal Ceiling: 1		Internal Ceiling: 0.00			Incomplete Inputs		0.00		Constant
			Internal Floors: 0		Internal Floors: 0.00			Not Applicable		Not Applicable		Calculated Value
Element Number	Area (m2) of Element	Zone Name/ Description of Unheated Space	External Element in Unheated Space	Area (m2) of External Element	U-Value (W/m <sup>2</sup> K) of External Element	Sum of (AxU) for External Element in Unheated Space	Ventilation Rate of Unheated Space (ach)	Volume of Unheated Space (m3)	Ru Value	Original U-Value (W/m <sup>2</sup> K) of Element	Adjusted U-Value (W/m <sup>2</sup> K) for Element	
Internal Wall Elements Adjoining Unheated Spaces												
0			Wall	0	2	0	3	0	#DIV/0!	0.00	#DIV/0!	
			Floor	0	2					Km Value (kJ/m <sup>2</sup> K) for Element		
			Window	0	2						0.00	
			Other	0	2							
Internal Ceiling Elements Adjoining Unheated Spaces												
0			Wall	0	2	0	3	1000	0.000	0.00	#DIV/0!	
			Floor	0	2					Km Value (kJ/m <sup>2</sup> K) for Element		
			Window	0	2						0.00	
			Other	0	2							

Figure 4: Specifying the number of elements between the zone and unheated spaces

Complete the yellow “User Input” boxes for each element (e.g. the internal wall and unheated space highlighted in red in Figure 4) including:

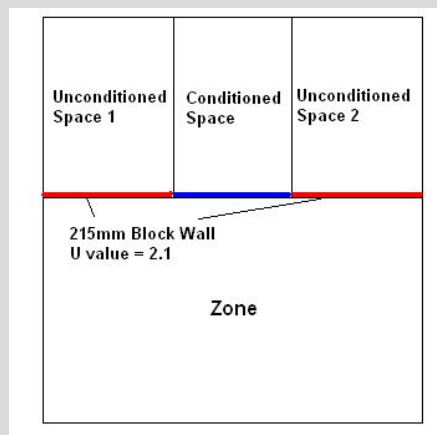
- Element Number: An identifier for the element relating to the drawings/ sketches for the zone.
- Area of Element (m<sup>2</sup>): This is the area of the element between the conditioned zone and the unheated space.
- Description of Unheated Space: This helps identify the unheated space for example, Warehouse or Storeroom.
- Area (m<sup>2</sup>) of External Element: This is the area of the external element(s) in the unheated space for the wall, roof, window etc.
  - The external elements are between the unheated space and outside only. If the unheated space has two or more exposed elements, for example two external walls, enter the total area of the wall (ie Area of Wall 1 + Area of Wall 2.)
  - As per BR 443 ground floors within the unheated space are excluded from this calculation. However if the unheated space has a suspended floor not in contact with the ground, this should be included under "Other".
  - External door elements can be included under "Other".
- U-Value (W/m<sup>2</sup>K) of the External Element: This is the U value of the external element in the unheated space for the wall, roof, window etc.
  - If the unheated space has two or more exposed elements, for example two external walls, enter the area weighted U value of the element. (ie  $(U_1 \times A_1 + U_2 \times A_2) / (A_1 + A_2)$ )
  - The default U value of the external element is always assumed to be 2. This is the default used in the BRE U-value calculator.
- Ventilation Rate of Unheated Space (ach): This is the air change rate within the Unheated Space as per Table A5 of BR 443. The default air change rate is 3, to be used if the airtightness type of the unheated space is not known.

Airtightness type	n (air changes per hour)	Example of unheated space
No doors or windows, all joints between components well-sealed, no ventilation openings provided	0.1	Internal Space with no external elements and no ventilation
All joints between components well-sealed, no ventilation openings provided	0.5	Space with external elements, windows and doors, but well sealed and no ventilation openings.
All joints well-sealed, small openings or permanent ventilation openings	1.0	Space with external elements but well sealed and passive duct with controllable louvers between space and outside
Not airtight due to some localised open joints or permanent ventilation openings	3.0	Space with external elements and wall fan with permanent opening
Not airtight due to numerous open joints, or large or numerous permanent ventilation openings	10.0	Carpark with a number of permanent ventilation openings

- Volume of Unheated Space(m<sup>3</sup>): This is the internal volume of the unheated space.
- Original U Value of Element: This is the unadjusted U value of the element between the conditioned zone and unheated space based on iSBEM defaults or non default U value calculations.
- Km value for Element: This is the Km value of the element between the conditioned zone and the unheated space based on iSBEM defaults or non default Km value calculations.

This process is repeated for all elements between the conditioned zone and unheated spaces. As each element is added, the Area Weighted Adjusted U-value is calculated for each element.

**Example 1:** The adjusted U-value applied to the wall type "215mm Block Wall" between the zone and the two unheated spaces is calculated along with the associated area.



**Figure 5: Example 1**

The internal walls for this example are then entered in SBEM as follows:

1) Adjusted Internal Wall (highlighted in red):

The area of the element combines the area of the two wall elements between the conditioned zone being assessed and the two unconditioned spaces.

The U value of the element is based on the adjusted U value as calculated using the excel spreadsheet. The Km value is unchanged as there is only a single wall type being adjusted.

2) Internal Wall (highlighted in blue):

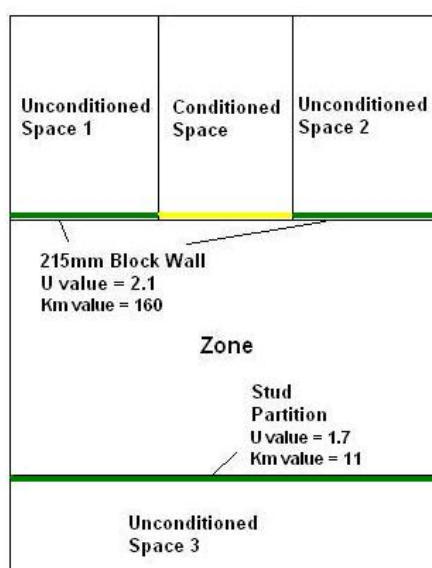
The area of the element is the area of the wall elements between the conditioned zone being assessed and adjoining conditioned space.

The U value of the element is based on the original U value, 2.1 W/m<sup>2</sup>K.

The Km value of the element is based on the original Km value

**Example 2:** Where an element has two separate constructions, the adjusted U-value and area weighted Km value is calculated for the elements adjoining unheated spaces using the Excel tool.

The conditioned zone being assessed is adjoining 3 unheated spaces and the zone tab in the tool will contain 3 wall elements adjoining unheated spaces. As per the sketch below, the 3 wall elements consist of the first wall type, "215mm Block Wall" between the zone and the two unheated spaces 1 and 2, and the second wall type, "stud partition" between the zone and unheated space 3. The tool will calculate the adjusted U value, the area weighted Km value and the associated area.



**Figure 6: Example 2**

The internal walls for this example are then entered in SBEM as follows:

- 1) Adjusted Internal Wall (highlighted in green):  
 The area of the element combines the area of the three wall elements between the conditioned zone being assessed and the three unconditioned spaces.  
 The U value of the element is based on the area weighted adjusted U value as calculated using the excel spreadsheet.  
 The Km value of the element is based on the area weighted Km value as calculated using the excel spreadsheet.
- 2) Internal Wall (highlighted in yellow):  
 The area of the element is the area of the wall element between the conditioned zone being assessed and adjoining conditioned space.  
 The U value of the element is based on the original U value, 2.1 W/m2K.  
 The Km value of the element is based on the original Km value, 160 kJ/m2K

The spreadsheet combines the elements between the conditioned zone being assessed and unheated or strongly ventilated spaces to create an area weighted adjusted U value and an area weighted Km value for a single entry in SBEM per the example in Figure 7. The conditioned zone in Figure 7 has two walls adjoining unheated spaces.

Resultant U Value Calculation										Version 1.0		
MPRN: <input type="text"/> BER Number: <input type="text"/> Zone Name in SBEM: <input type="text"/>			Number of types of elements in zone adjoining an Unheated Space		Area (m2)			Area Weighted Adjusted U Value (W/m2K)		Area Weighted Km Value (kJ/m2K)		<b>Colour Key</b> <input type="checkbox"/> User Input <input type="checkbox"/> Constant <input type="checkbox"/> Calculated Value
Date of Survey: <input type="text"/> Address: <input type="text"/> Year of Construction: <input type="text"/>			Internal Walls: 2		Internal Walls: 15.00			1.00		79.00		
Assessor No: <input type="text"/> Assessor Name: <input type="text"/> Comment: <input type="text"/>			Internal Ceiling: 0		Internal Ceiling: 0.00			Not Applicable		Not Applicable		
			Internal Floors: 0		Internal Floors: 0.00			Not Applicable		Not Applicable		
Element Number	Area (m2) of Element	Zone Name/ Description of Unheated Space	External Element in Unheated Space	Area (m2) of External Element	U-Value(W/m²K) of External Element	Sum of (AxU) for External Element in Unheated Space	Ventilation Rate of Unheated Space (ach)	Volume of Unheated Space (m³)	Ru Value	Original U-Value(W/m²K) of Element	Adjusted U-Value(W/m²K) for Element	
Internal Wall Elements Adjoining Unheated Spaces												
1	6	Z008 Store	Wall	6	0.55	5.55	3	18	0.257	1.70	1.18	
			Roof	9	0.25					Km Value (kJ/m²K) for Element		
			Window	0	2							160.00
			Other	0	2							
2	9	Z008 WC	Wall	9	0.55	4.95	1	27	0.648	2.10	0.89	
			Roof	0	2					Km Value (kJ/m²K) for Element		
			Window	0	2							25.00
			Other	0	2							

Figure 7: Combining two walls between zone and unheated spaces

Each tab in the tool caters for assessment of one zone adjoining unheated spaces. To assess additional zones adjoining unheated spaces, copy the zone sheet and apply a unique name to the new tab. The sheet is copied by right clicking on the "Zone" sheet title and select "Move or Copy" as per Figure 8.

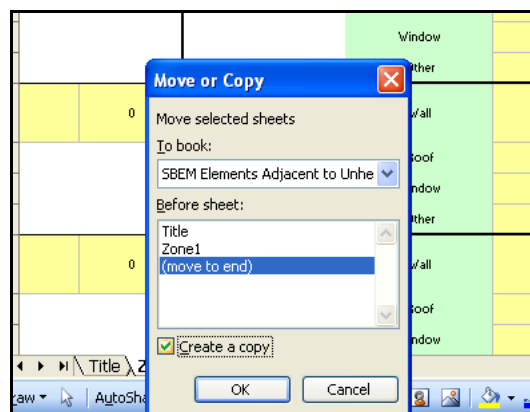


Figure 8: Creating a new tab for an additional zone



### 2.3 Results

Figure 9 shows the results from the tool for a single conditioned zone. Results consist of a single area weighted adjusted U-value for any internal walls, ceilings or floors between the conditioned zone and unheated spaces:

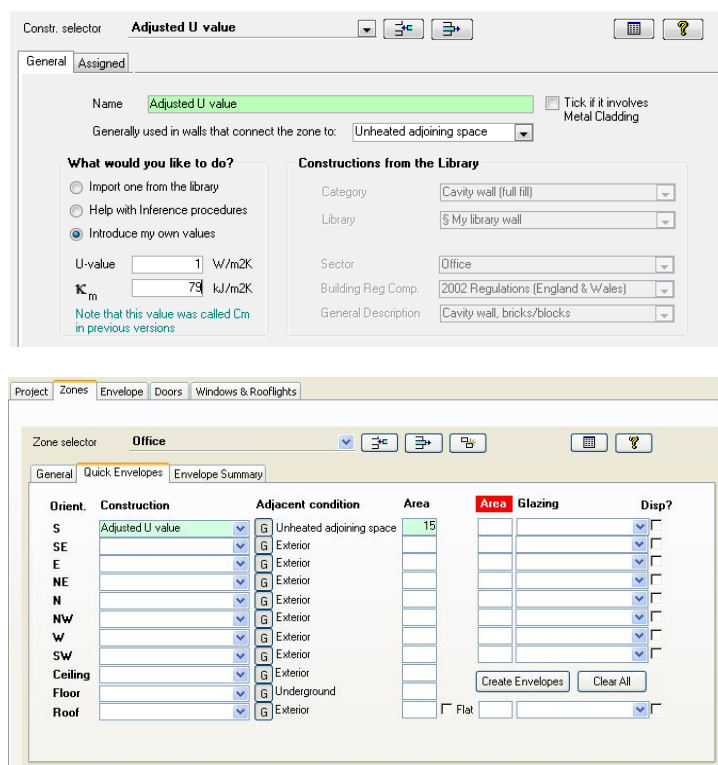
	Area (m <sup>2</sup> )	Area Weighted Adjusted U Value (W/m <sup>2</sup> K)	Area Weighted Km Value (kJ/m <sup>2</sup> K)
Internal Walls	15.00	1.00	79.00
Internal Ceiling	0.00	Not Applicable	Not Applicable
Internal Floors	0.00	Not Applicable	Not Applicable

	Area (m <sup>2</sup> )	Area Weighted Adjusted U Value (W/m <sup>2</sup> K)	Area Weighted Km Value (kJ/m <sup>2</sup> K)
Internal Walls	1.00	Adjustment not Required	Adjustment not Required
Internal Ceiling	0.00	Incomplete Inputs	0.00
Internal Floors	0.00	Incomplete Inputs	0.00

Figure 9: Adjusted U-value results examples

- Adjusted U-value and Area Weighted Km Value: This is the Area Weighted Adjusted U-value, Area Weighted Km value and area of the internal element that is entered into SBEM as follows:



- “Incomplete Inputs”: This highlights where insufficient data has been entered into the spreadsheet to calculate the Area Weighted Adjusted U-value or Area Weighted Km value.
- “Not Applicable”: This highlights that “0” has been selected for “Number of types of elements in zone adjoining an unheated space”.
- “Adjustment not Required”: This highlights where the change in U-value is within the tolerances detailed in Section 1. In this case the U-value of the element need not be adjusted in SBEM. The guidelines from the SBEM User Guide are followed for entering internal elements.

## Appendix 1: Sensitivity Analysis

SEAI carried out a sensitivity analysis to look at the impact of adjusting the U value of an element adjoining an unheated space.

The analysis looked at a number of building types and HVAC systems. The building types included office buildings and retail buildings, whereas the HVAC systems included a radiator heating system, a split air conditioning system and an electric heating system.

The analysis also looked at a number of varying adjoining conditioning including the following:

- Small Room with no external elements
- Large Single Storey Room with external elements and an air change rate of 1
- Large Single Storey Room with external elements and an air change rate of 3
- Large Double Height Room with permanent vents.

The sensitivity analysis also considered the area of the internal element adjoining an unheated space and a number of types of construction for the elements adjoining the unheated spaces. These included:

- Lightweight partition U value greater than 3
- Solid Concrete Wall U value between 1 and 3
- Insulated Wall U value less than 1.

The sensitivity analysis considered the impact on the change in BER grade, change in energy ratio and change in energy use for the actual building.

The results showed that the impacts of adjusting the U value vary depending on the original U value of the element between the zone and the adjoining unheated space. These results are reflected in Table 1 and are automatically taken into account by the Ru value calculation spreadsheet.

### **Sensitivity analysis results**

- Where the original U value was less than 1, the sensitivity analysis found that there needs to be a significant change in the U value (greater than 10%) for it to impact on the results. To achieve this type of change in the U value, the adjoining space would have very little fabric and ventilation heat loss. In otherwords, the unheated space provides a significant barrier to heat loss.
- Where the original U value was from 1 to 3, the sensitivity analysis found that there needs to be a less significant change in the U value (greater than 5%) for it to impact on the results. To achieve this type of change in the U value, the adjoining space would have more significant fabric and/or ventilation heat loss. In otherwords, the unheated space provides a less significant barrier to heat loss.
- Where the original U value was greater than 3, the sensitivity analysis found that any change in the original U value can impact on the results. Therefore even a high rate of fabric and ventilation heat loss from the adjoining space would require a U value adjustment in the element adjoining the conditioned zone.

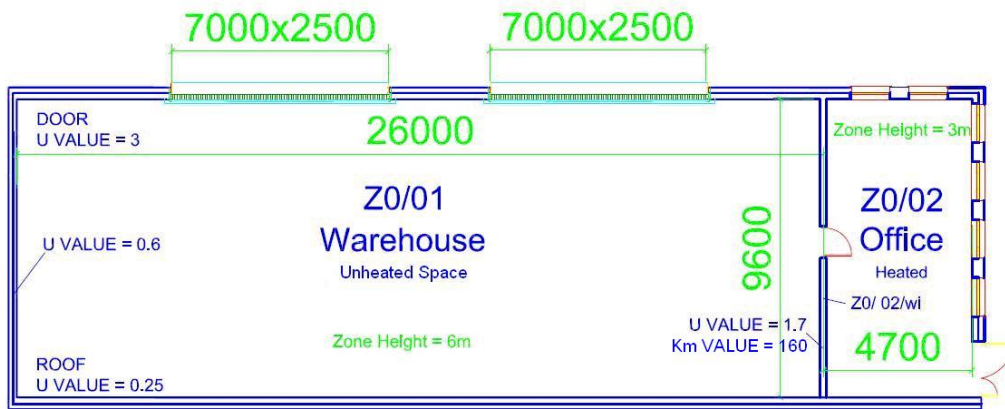
## Appendix 2: Examples of Adjusted U-values

### Example 1: Element Adjacent to Large Unheated Volume

This example adjusts the U-value of an office wall adjacent to an unheated warehouse.

The diagram below shows a conditioned zone Z0/02 with an adjoining unheated zone Z0/01. The wall element between the two zones has an unadjusted U-value of 1.7 W/m<sup>2</sup>K. The door element between the two zones has an unadjusted U value of 3 W/m<sup>2</sup>K and an area of 2.8m<sup>2</sup>.

As part of the BER assessment the Assessor has obtained the required documentary evidence to support the U-values of the building elements. The unheated warehouse has a number of large permanent ventilation openings.



The areas are calculated as follows:

- Following the methodology outlined in iSBEM User Guide, the wall area entered in iSBEM is inclusive of window and door areas, and internal windows and doors are ignored.
- Area of Wall between Zone and Unheated Space:  $9.6 \times 3 = 28.8\text{m}^2$
- Area of External Walls in Unheated Space:  $(61.6 \times 6) - (7 \times 2.5 \times 2) = 334.6$
- Area of Doors in Unheated Space:  $7 \times 2.5 \times 2 = 35$
- Area of Roof in Unheated Space:  $26 \times 9.6 = 249.6$
- Ground floors in the unheated space are not considered (as per BRE 443)

Entering in the tool:

Resultant U Value Calculation										Version 1.0								
MPRI: <input type="text"/> BER Number: <input type="text"/> Zone Name in SBEM: <input type="text"/>			Number of types of elements in zone adjoining an Unheated Space		Area (m <sup>2</sup> )			Area Weighted Adjusted U Value (W/m <sup>2</sup> K)		Area Weighted Km Value (kJ/m <sup>2</sup> K)		Colour Key						
Date of Survey: <input type="text"/> Address: <input type="text"/> Year of Construction: <input type="text"/>			Internal Walls: 1		Internal Walls: 28.00			Adjustment not Required		Adjustment not Required		User Input						
Assessor No: <input type="text"/> Assessor Name: <input type="text"/> Comment: <input type="text"/>			Internal Ceiling: 0		Internal Ceiling: 0.00			Not Applicable		Not Applicable		Constant						
			Internal Floors: 0		Internal Floors: 0.00			Not Applicable		Not Applicable		Calculated Value						
Element Number	Area (m <sup>2</sup> ) of Element	Zone Name/ Description of Unheated Space	External Element in Unheated Space	Area (m <sup>2</sup> ) of External Element	U-Value(W/m <sup>2</sup> K) of External Element	Sum of (AxU) for External Element in Unheated Space	Ventilation Rate of Unheated Space (sch)	Volume of Unheated Space (m <sup>3</sup> )	Ru Value	Original U-Value(W/m <sup>2</sup> K) of Element	Adjusted U-Value(W/m <sup>2</sup> K) for Element							
Internal Wall Elements Adjoining Unheated Spaces																		
1	28.8	Z0/01 Warehouse	Wall	334.6	0.6	368.16	10	1497.6	0.005	1.70	1.88							
			Roof	249.6	0.25													Km Value (kJ/m <sup>2</sup> K) for Element
			Window	0	2													
			Other	35	3													160.00

The results show that the adjustments are not required for the adjoining wall because the Ru values are within the acceptable tolerances. The wall is entered in iSBEM with an unadjusted U value.

**Example 2: Element Adjacent to Small Unheated Volume**

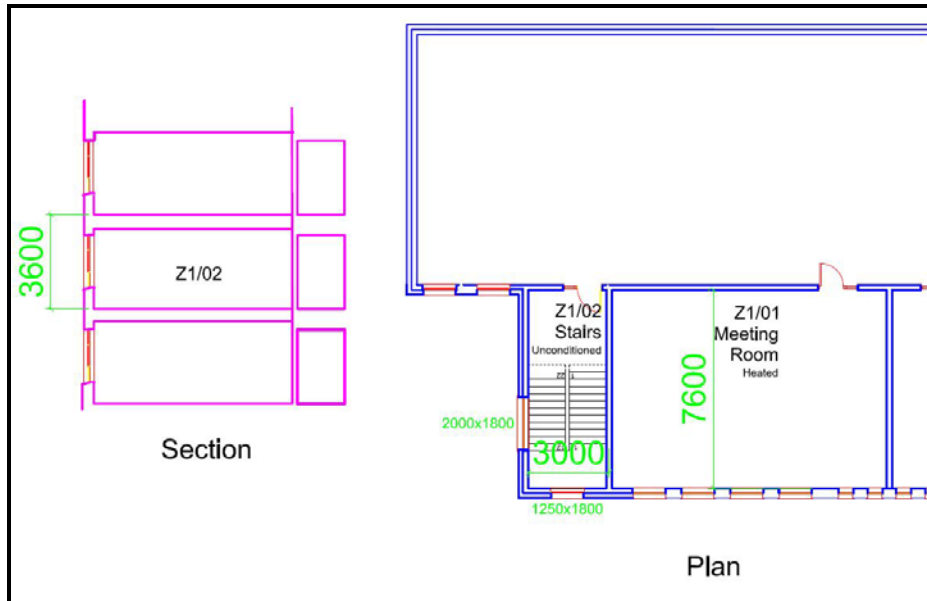
The following example adjusts the U-value of a meeting room wall adjacent to an unheated staircore:

The diagram below shows a conditioned zone Z1/01 Meeting Room with an adjoining unheated zone Z1/02 Stairs.

The building was built in 2008 and there is insufficient evidence available to substantiate non-default U-values. Therefore default U-values are used for the building based on the NEAP Survey Guide A4.2. The External and Internal Wall U values are obtained using the inference method in iSBEM. The Window U-Values are obtained using the library database.

- External Wall U-value: 0.27 W/m<sup>2</sup>K
- Window U-value: 2.8 W/m<sup>2</sup>K
- Internal Wall U-value: 2.1 W/m<sup>2</sup>K, Km Value 135 kJ/m<sup>2</sup>K

The building is air tight with all joints well sealed. Small openings are provided for ventilation within the stairs.



The areas are calculated as follows:

- Area of Wall between Zone and Unheated Space:  $7.6 \times 3.6 = 27.36\text{m}^2$
- Area of External Walls in Unheated Space:  $(10.6 \times 3.6) - (5.85) = 32.31$
- Area of External Windows in Unheated Space:  $2 \times 1.8 + 1.25 \times 1.8 = 5.85$

Entering in the tool:

Resultant U Value Calculation										Version 1.0											
IPRN: <input type="text"/> BER Number: <input type="text"/> Zone Name in SBEM: <input type="text"/> Date of Survey: <input type="text"/> Address: <input type="text"/> Year of Construction: <input type="text"/> Assessor No: <input type="text"/> Assessor Name: <input type="text"/> Comment: <input type="text"/>			Number of types of elements in zone adjoining an Unheated Space Internal Walls: 1 Internal Ceiling: 0 Internal Floors: 0		<table border="1"> <tr> <th>Area (m<sup>2</sup>)</th> <th>Area Weighted Adjusted U Value (W/m<sup>2</sup>K)</th> <th>Area Weighted Km Value (kJ/m<sup>2</sup>K)</th> </tr> <tr> <td>Internal Walls</td> <td>27.36</td> <td>1.00</td> </tr> <tr> <td>Internal Ceiling</td> <td>0.00</td> <td>Not Applicable</td> </tr> <tr> <td>Internal Floors</td> <td>0.00</td> <td>Not Applicable</td> </tr> </table>			Area (m <sup>2</sup> )	Area Weighted Adjusted U Value (W/m <sup>2</sup> K)	Area Weighted Km Value (kJ/m <sup>2</sup> K)	Internal Walls	27.36	1.00	Internal Ceiling	0.00	Not Applicable	Internal Floors	0.00	Not Applicable	Colour Key <input type="checkbox"/> User Input <input type="checkbox"/> Constant <input type="checkbox"/> Calculated Value	
Area (m <sup>2</sup> )	Area Weighted Adjusted U Value (W/m <sup>2</sup> K)	Area Weighted Km Value (kJ/m <sup>2</sup> K)																			
Internal Walls	27.36	1.00																			
Internal Ceiling	0.00	Not Applicable																			
Internal Floors	0.00	Not Applicable																			
Element Number	Area (m <sup>2</sup> ) of Element	Zone Name/ Description of Unheated Space	External Element in Unheated Space	Area (m <sup>2</sup> ) of External Element	U-Value (W/m <sup>2</sup> K) of External Element	Sum of (AxU) for External Element in Unheated Space	Ventilation Rate of Unheated Space (ach)	Volume of Unheated Space (m <sup>3</sup> )	Ru Value	Original U-Value (W/m <sup>2</sup> K) of Element	Adjusted U-Value (W/m <sup>2</sup> K) for Element										
Internal Wall Elements Adjoining Unheated Spaces																					
1	27.36	Z1/02 Stairs	Wall	32.31	0.27	25.1037	1	82.08	0.524	2.10	1.00										
			Floor	0	2					Km Value (kJ/m <sup>2</sup> K) for Element											
			Window	5.85	2.8						135.00										
			Other	0	2																

An adjusted U value is applied in this case as the tool has identified that the Ru value has exceeded the tolerances.

The results are entered into SBEM as follows:

The original U value of the semi exposed wall was determined using the Inference method as follows:

The screenshot shows a dialog box titled "Constr. selector" with two main sections:

- What would you like to do?**
  - Import one from the library
  - Help with Inference procedures
  - Introduce my own values
- Constructions from the Library**
  - Category: Solid (masonry) wall
  - Library: Solid brick wall, 225 mm, uninsulated
  - Sector: Office
  - Building Reg Comp.: no date, uninsulated
  - General Description: Solid brick or block wall on in-situ concrete

Below the "What would you like to do?" section, the following values are displayed:

- U-value: 2.1 W/m<sup>2</sup>K
- K<sub>m</sub>: 135 kJ/m<sup>2</sup>K

A note states: "Note that this value was called Cm in previous versions".

Once the adjusted U value is calculated by the tool, the assessor now selects "Introduce my own values" and enter the Km value and the U-value based on the SBEM Elements Adjacent to Unheated Spaces tool:

The screenshot shows the "Constr. selector" dialog box with the "Assigned" tab selected. The "Name" field is set to "Adjusted U value". The "Generally used in walls that connect the zone to:" dropdown is set to "Unheated adjoining space".

The "What would you like to do?" section now has:

- Import one from the library
- Help with Inference procedures
- Introduce my own values

The input fields are:

- U-value: 1.0 W/m<sup>2</sup>K
- K<sub>m</sub>: 135 kJ/m<sup>2</sup>K

The "Constructions from the Library" section remains the same as in the previous screenshot.

A note states: "Note that this value was called Cm in previous versions".

**Example 3: Element Adjacent to Unheated Adjoining Building**

The following example adjusts the U-value for an element adjacent to an unheated adjoining building.

The unit being assessed below is part of a building constructed in 1950 and sits between two identical units. The walls were constructed of cavity blockwork with no insulation. The roof is metal clad with no insulation.

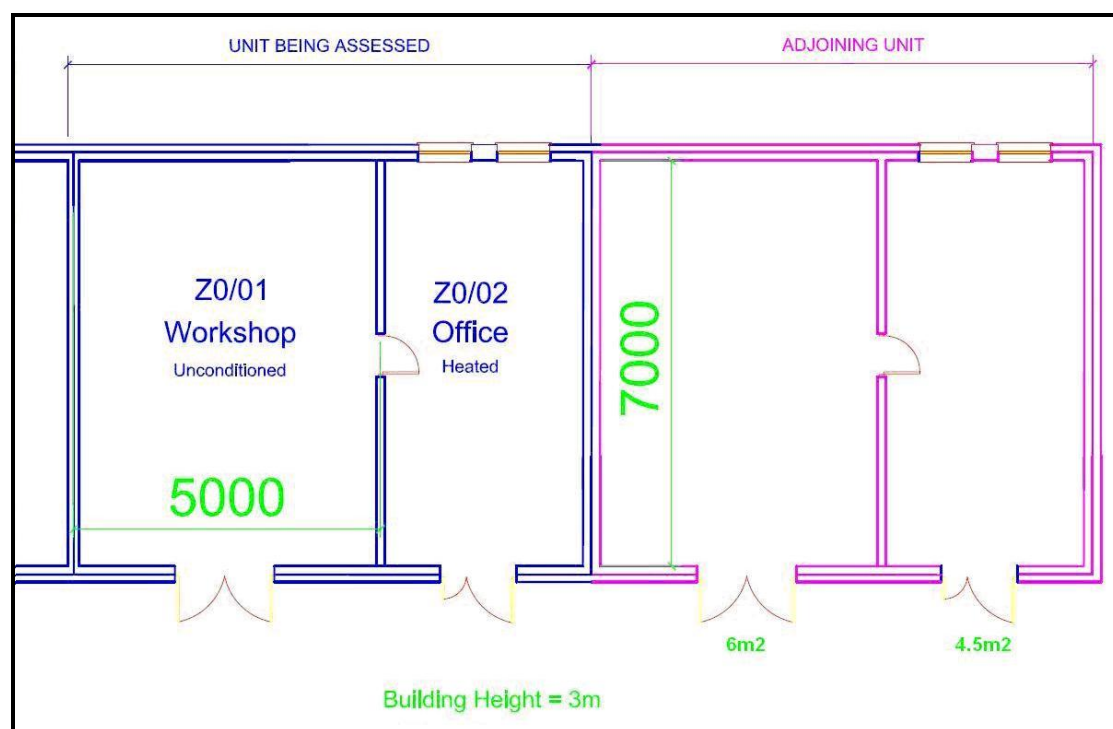
All the units within the building consist of unheated workshops and conditioned offices.

In order to determine the U-value of the wall between the office and adjoining unheated spaces, the Assessor must determine the default U-values for the building age:

As the building was constructed in 1950 with no insulation, the default U-values as based on the NEAP Survey Guide A4.2 are:

- External Wall U-value: 1.6 W/m<sup>2</sup>K
- Roof U-value: 7.14 W/m<sup>2</sup>K
- Door U-value: 3 W/m<sup>2</sup>K
- Internal Wall U-value: 1.7 W/m<sup>2</sup>K

The adjoining unit is the same height as the unit being assessed. The external dimensions of the adjoining unit are the same of the unit being assessed. Therefore it is acceptable to use the dimensions from the unit being assessed.



The office is adjoining two unheated spaces, Z0/01 and the adjoining buildings warehouse.

The areas are calculated as follows:

- Area of Wall between Zone and each Unheated Space:  $7 \times 3 = 21\text{m}^2$
- Area of External Walls in each Unheated Space:  $(10 \times 3) - (6) = 24\text{m}^2$
- Area of Doors in each Unheated Space:  $6\text{m}^2$
- Area of Roof in each Unheated Space:  $7 \times 5 = 35\text{m}^2$

*Entering in the tool:*

**Resultant U Value Calculation**

Version 1.0

MPRI:	BER Number:	Zone Name in SBEM:	Number of types of elements in zone adjoining an Unheated Space	Internal Walls: 2 Internal Ceiling: 0 Internal Floors: 0	Area (m2)	Area Weighted Adjusted U Value (W/m2K)	Area Weighted Km Value (kJ/m2K)	<b>Colour Key</b> User Input Constant Calculated Value	
Date of Survey	Address	Year of Construction			Internal Walls	42.00	1.60		75.00
Assessor No	Assessor Name	Comment			Internal Ceiling	0.00	Not Applicable		Not Applicable
					Internal Floors	0.00	Not Applicable		Not Applicable

Element Number	Area (m2) of Element	Zone Name/Description of Unheated Space	External Element in Unheated Space	Area (m2) of External Element	U-Value(W/m <sup>2</sup> K) of External Element	Sum of (AxU) for External Element in Unheated Space	Ventilation Rate of Unheated Space (ach)	Volume of Unheated Space (m3)	Ru Value	Original U-Value(W/m <sup>2</sup> K) of Element	Adjusted U-Value(W/m <sup>2</sup> K) for Element
<b>Internal Wall Elements Adjoining Unheated Spaces</b>											
1	21	Adjoining Warehouse	Wall	24	1.6	306.3	3	105	0.051	1.70	1.56
			Floor	35	7.14					Km Value (kJ/m <sup>2</sup> K) for Element	
			Window	0	0					75.00	
			Other	6	3						
2	21	20/01	Wall	24	1.6	306.3	3	105	0.051	1.70	1.56
			Floor	35	7.14					Km Value (kJ/m <sup>2</sup> K) for Element	
			Window	0	0					75.00	
			Other	6	3						

The two adjusted walls are then combined in iSBEM with an Area Weighted Adjusted U value (1.6) and area (42m<sup>2</sup>) as per the screenshot above.

**Example 4: Ceiling Above an Unheated Store**

The following example adjusts the U-value for a ceiling element above an unheated store.

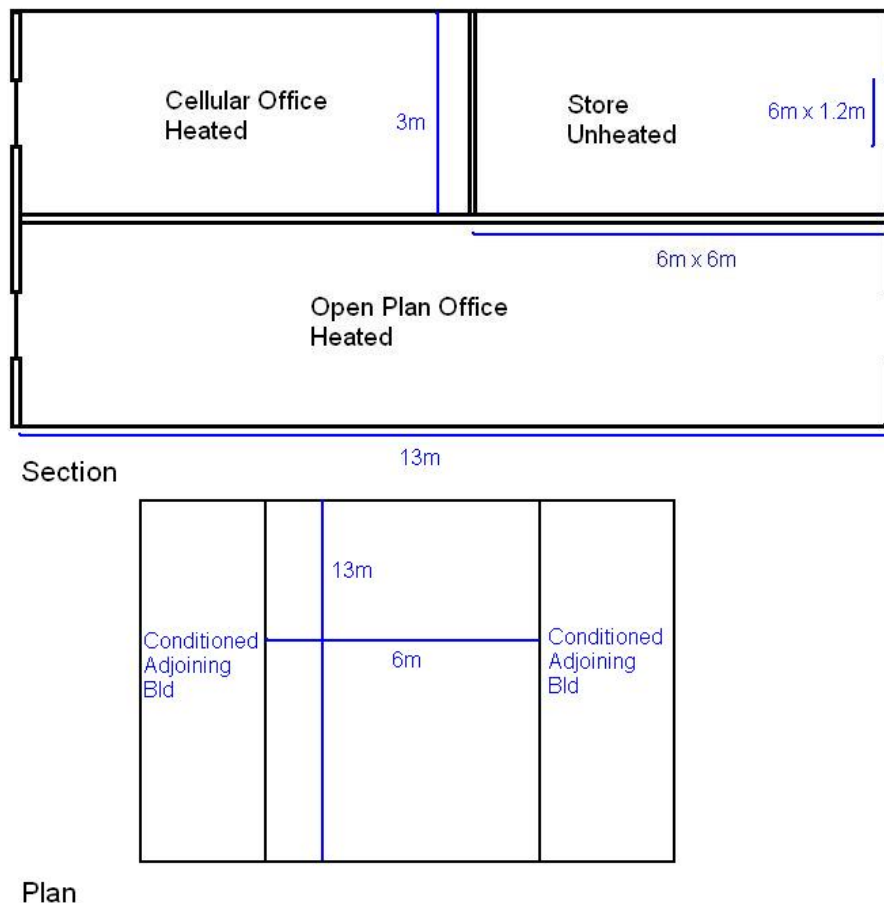
The unit being assessed below is part of a building constructed in 1930. The walls were constructed of cavity blockwork with no insulation. The roof is a flat roof with no insulation. Double Glazing is installed.

In order to determine the U-value of the ceiling between the open plan office and adjoining store, the Assessor must determine the default U-values for the building age as non-defaults are not available:

As the building was constructed in 1930 with no insulation, the default U-values as based on the NEAP Survey Guide A4.2 are:

- External Wall U-value: 1.6 W/m<sup>2</sup>K
- Roof U-value: 2.8 W/m<sup>2</sup>K
- Glazing U value: 2.8 W/m<sup>2</sup>K
- Internal Ceiling U-value: 1.4 W/m<sup>2</sup>K, Km Value 12 kJ/m<sup>2</sup>K (from Library)

The building is air tight with all joints well sealed. Small openings are provided for ventilation within the store.



The areas are calculated as follows:

- Area of Ceiling between Zone and Unheated Space:  $6 \times 6 = 36\text{m}^2$
- Area of External Walls in Unheated Space:  $(6 \times 3) - (7.2) = 10.8\text{m}^2$
- Area of Windows in Unheated Space:  $6 \times 1.2 = 7.2\text{m}^2$
- Area of Roof in Unheated Space:  $6 \times 6 = 36\text{m}^2$

Entering in the tool:



Resultant U Value Calculation										Version 1.0				
MPRN: <input type="text"/> BER Number: <input type="text"/> Zone Name in SBEM: <input type="text"/>			Number of types of elements in zone adjoining an Unheated Space			Area (m2)			Area Weighted Adjusted U Value (W/m <sup>2</sup> K)		Area Weighted Km Value (kJ/m <sup>2</sup> K)		Colour Key	
Date of Survey <input type="text"/> Address <input type="text"/> Year of Construction <input type="text"/>			Internal Walls: 0			Internal Walls: 0.00			Not Applicable		Not Applicable		User Input	
Assessor No <input type="text"/> Assessor Name <input type="text"/> Comment <input type="text"/>			Internal Ceiling: 1			Internal Ceiling: 36.00			1.10		12.00		Constant	
			Internal Floors: 0			Internal Floors: 0.00			Not Applicable		Not Applicable		Calculated Value	
Element Number	Area (m2) of Element	Zone Name/ Description of Unheated Space	External Element in Unheated Space	Area (m2) of External Element	U-Value(W/m <sup>2</sup> K) of External Element	Sum of (AxU) for External Element in Unheated Space	Ventilation Rate of Unheated Space (ach)	Volume of Unheated Space (m3)	Ru Value	Original U-Value(W/m <sup>2</sup> K) of Element	Adjusted U-Value(W/m <sup>2</sup> K) for Element			
<b>Internal Ceiling Elements Adjoining Unheated Spaces</b>														
1	36	Store	Wall	10.8	1.6	138.24	1	108	0.207	1.40	1.09			
			Floor	36	2.8					Km Value (kJ/m <sup>2</sup> K) for Element				
			Window	7.2	2.8									
			Other	0	2					12.00				

**Example 5: More than 4 Unheated Adjoining Spaces**

The number of element types adjoining an unheated space are entered. Select the number of element types (to a maximum of 4) and enter the data for each element in the yellow boxes displayed.

If the element is adjoining more than 4 unheated spaces, there is potential to combine the unheated spaces or if this is not possible the element is split.

If the adjoining unheated spaces are adjacent to each other and have the same ventilation rate it is acceptable to combine these unheated spaces.

Unconditioned Space 1	Unconditioned Space 2	Unconditioned Space 3	Unconditioned Space 4	Unconditioned Space 5
ach - 3	ach - 0.5	ach - 0.5	ach - 0.5	ach - 3

For example, in the scenario above the building is entered into the tool as follows:

- Green Element: Details of the Unheated Space are based on Unconditioned Space 1
- Red Element: Unconditioned spaces 2, 3 and 4 can be combined and entered in the tool as one unconditioned space.
  - The volume of the space is the sum of the volumes for each of the unconditioned spaces 2, 3, and 4.
  - Similarly the external elements shall be the sum of the external elements for each of the unconditioned spaces 2, 3 and 4. If the U values of the external walls differ, their area weighted average is used as per Section 2.2.
- Blue Element: Details of the Unheated Space are based on Unconditioned Space 5

If the element is between the conditioned zone and 5 unheated spaces where it is not possible to combine the spaces because of the ventilation rates, the element is entered twice into SBEM.

Unconditioned Space 1	Unconditioned Space 2	Unconditioned Space 3	Unconditioned Space 4	Unconditioned Space 5
ach - 3	ach - 0.1	ach - 0.5	ach - 1	ach - 10

In Zone Tab 1 in the Excel sheet, the elements adjoining unconditioned space 1, 2 and 3 (highlighted in red) are entered. The following diagrams show each of Zone tab 1 and 2 before details of the areas and U values have been entered.

**Resultant U Value Calculation** Version 1.0

MPRI: <input type="text"/> BER Number: <input type="text"/> Zone Name in SBEM: <input type="text"/>			Number of types of elements in zone adjoining an Unheated Space	Area (m2)			Area Weighted Adjusted U Value (W/m2K)			Area Weighted Km Value (kJ/m2K)			<b>Colour Key</b> <input type="checkbox"/> User Input <input type="checkbox"/> Constant <input type="checkbox"/> Calculated Value
Date of Survey: <input type="text"/> Address: <input type="text"/> Year of Construction: <input type="text"/>				Internal Walls: <input type="text" value="3"/>	Internal Walls	0.00	Incomplete Inputs	Incomplete Inputs	Internal Ceiling	0.00	Not Applicable	Not Applicable	
Assessor No: <input type="text"/> Assessor Name: <input type="text"/> Comment: <input type="text"/>				Internal Ceiling: <input type="text" value="0"/>	Internal Ceiling	0.00	Not Applicable	Not Applicable	Internal Floors	0.00	Not Applicable	Not Applicable	
				Internal Floors: <input type="text" value="0"/>	Internal Floors	0.00	Not Applicable	Not Applicable					

Element Number	Area (m2) of Element	Zone Name/ Description of Unheated Space	External Element in Unheated Space	Area (m2) of External Element	U-Value(W/m <sup>2</sup> K) of External Element	Sum of (AxU) for External Element in Unheated Space	Ventilation Rate of Unheated Space (ach)	Volume of Unheated Space (m3)	Ru Value	Original U-Value(W/m <sup>2</sup> K) of Element	Adjusted U-Value(W/m <sup>2</sup> K) for Element
<b>Internal Wall Elements Adjoining Unheated Spaces</b>											
1	0	Unconditioned Space 1	Wall	0	2	0	3	0	#DIV/0!	0.00	#DIV/0!
			Roof	0	2						
			Window	0	2						
			Other	0	2						
										Km Value (kJ/m <sup>2</sup> K) for Element	0.00
2	0	Unconditioned Space 2	Wall	0	2	0	0.1	0	#DIV/0!	0.00	#DIV/0!
			Roof	0	2						
			Window	0	2						
			Other	0	2						
										Km Value (kJ/m <sup>2</sup> K) for Element	0.00
3	0	Unconditioned Space 3	Wall	0	2	0	0.5	0	#DIV/0!	0.00	#DIV/0!
			Roof	0	2						
			Window	0	2						
			Other	0	2						
										Km Value (kJ/m <sup>2</sup> K) for Element	0.00

Zone Tab 1 will include the first element, between the zone and the first three unheated spaces 1, 2 and 3 and the tool will calculate the adjusted U value, Km value and the associated area.

This figure is entered into SBEM as the first adjusted U value.

In Zone Tab 2, the elements adjoining unconditioned space 4 and 5 (highlighted in blue) are entered

**Resultant U Value Calculation** Version 1.0

MPRI: <input type="text"/> BER Number: <input type="text"/> Zone Name in SBEM: <input type="text"/>			Number of types of elements in zone adjoining an Unheated Space	Area (m2)			Area Weighted Adjusted U Value (W/m2K)			Area Weighted Km Value (kJ/m2K)			<b>Colour Key</b> <input type="checkbox"/> User Input <input type="checkbox"/> Constant <input type="checkbox"/> Calculated Value
Date of Survey: <input type="text"/> Address: <input type="text"/> Year of Construction: <input type="text"/>				Internal Walls: <input type="text" value="2"/>	Internal Walls	0.00	Incomplete Inputs	Incomplete Inputs	Internal Ceiling	0.00	Not Applicable	Not Applicable	
Assessor No: <input type="text"/> Assessor Name: <input type="text"/> Comment: <input type="text"/>				Internal Ceiling: <input type="text" value="0"/>	Internal Ceiling	0.00	Not Applicable	Not Applicable	Internal Floors	0.00	Not Applicable	Not Applicable	
				Internal Floors: <input type="text" value="0"/>	Internal Floors	0.00	Not Applicable	Not Applicable					

Element Number	Area (m2) of Element	Zone Name/ Description of Unheated Space	External Element in Unheated Space	Area (m2) of External Element	U-Value(W/m <sup>2</sup> K) of External Element	Sum of (AxU) for External Element in Unheated Space	Ventilation Rate of Unheated Space (ach)	Volume of Unheated Space (m3)	Ru Value	Original U-Value(W/m <sup>2</sup> K) of Element	Adjusted U-Value(W/m <sup>2</sup> K) for Element
<b>Internal Wall Elements Adjoining Unheated Spaces</b>											
1	0	Unconditioned Space 4	Wall	0	2	0	1	0	#DIV/0!	0.00	#DIV/0!
			Roof	0	2						
			Window	0	2						
			Other	0	2						
										Km Value (kJ/m <sup>2</sup> K) for Element	0.00
2	0	Unconditioned Space 5	Wall	0	2	0	10	0	#DIV/0!	0.00	#DIV/0!
			Roof	0	2						
			Window	0	2						
			Other	0	2						
										Km Value (kJ/m <sup>2</sup> K) for Element	0.00

Zone Tab 2 will include the second element, between the zone and the remaining unheated spaces 4 and 5. The tool will calculate the adjusted U value, Km value and the associated area.

This figure is entered into SBEM as the second adjusted U value.