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Proven Performance.

Calculation of Thermal Transmittance

Report in Accordance with BS EN ISO 10077-1:2017

Thermal Performance of Windows, Doors & Shutters

CONFIDENTIAL

Report reference:	3-027-1
Prepared for:	Alunet Systems Low Mill Lane, Havelock Street Ravensthorpe Industrial Estate Ravensthorpe, Dewsbury, WF13 3LN
Project:	BF73 aluminium bi-fold doorset
Prepared by:	Sue Peatey
Issue date:	13 October 2023

1 Introduction

This document details the thermal performance calculation of the doorset configuration as detailed below.

The results in this report relate only to the simulated specimen using the drawings and specification received.

The frame profile results detailed below are provided by computer simulation using Physibel software program BISCO and validated against proofs in Annex H (H1 to H11) of BS EN ISO 10077-2:2017.

The frame profile results detailed below are provided from methods contained in BS EN ISO 10077-1:2017 and in accordance with thermal transmittance requirements detailed in BS EN 14351-1:2006 +A1:2010. Cavities are calculated in accordance with BS EN ISO 10077-2 section 6.4.2 Treatment of cavities using the radiosity method.

2.0 Authorisation

Report Issued By:	Sue Peatey Technical Officer	
Report Checked By:	Richard Bate Technical Director	

3 Results

3.1 U-Value

The thermal performance of the doorset (U_W) in accordance with EN ISO 10077-1:2017 is:

1.4 W/m²K

3.2 Frame thermal transmittance (in accordance with BS EN ISO 10077-1: 2017)

Frame Profile	Frame Thermal Transmittance (U_f)
Head	2.8 W/m²K
Left Jamb	2.7 W/m²K
Right Jamb	2.9 W/m²K
Threshold	2.9 W/m²K
Meeting Stile	1.4 W/m²K

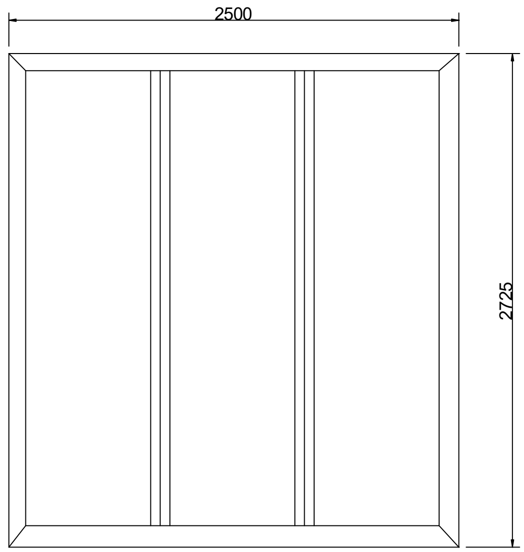
3.3 Linear thermal transmittance (in accordance with BS EN ISO 10077-1: 2017)

Frame Profile	Linear Thermal Transmittance (ψ)
Head	0.043 W/m.K
Left Jamb	0.044 W/m.K
Right Jamb	0.042 W/m.K
Threshold	0.042 W/m.K
Meeting Stile	0.10 W/m.K

3.4 Centre pane U-Value of glazing calculated in accordance with BS EN 673: 2011

Glazing unit	Centre pane U-value (U_g)
Nominal dimensions 4-16-4 90% argon 10% air filled, normal emissivity 0.01 and 0.14 (4mm Pilkington Optitherm S1 Plus, 16mm Argon cavity, 4mm Pilkington Glass with coating on internal face. Swisspacer Ultimate)	1.04 W/m^2K

Figure 1. Drawing of the doorset configuration and overall dimensions (from the internal face)



Internal projected frame area ($A_{f,i}$)	1.580 m^2
External projected frame area ($A_{f,e}$)	1.580 m^2
Glazed area of configuration (A_g)	5.232 m^2
Frame area of configuration (A_f)	1.580 m^2
Perimeter length of the glazing (l_g)	19.237 m

Figure 2. Cross section drawing, including dimensions, of door.

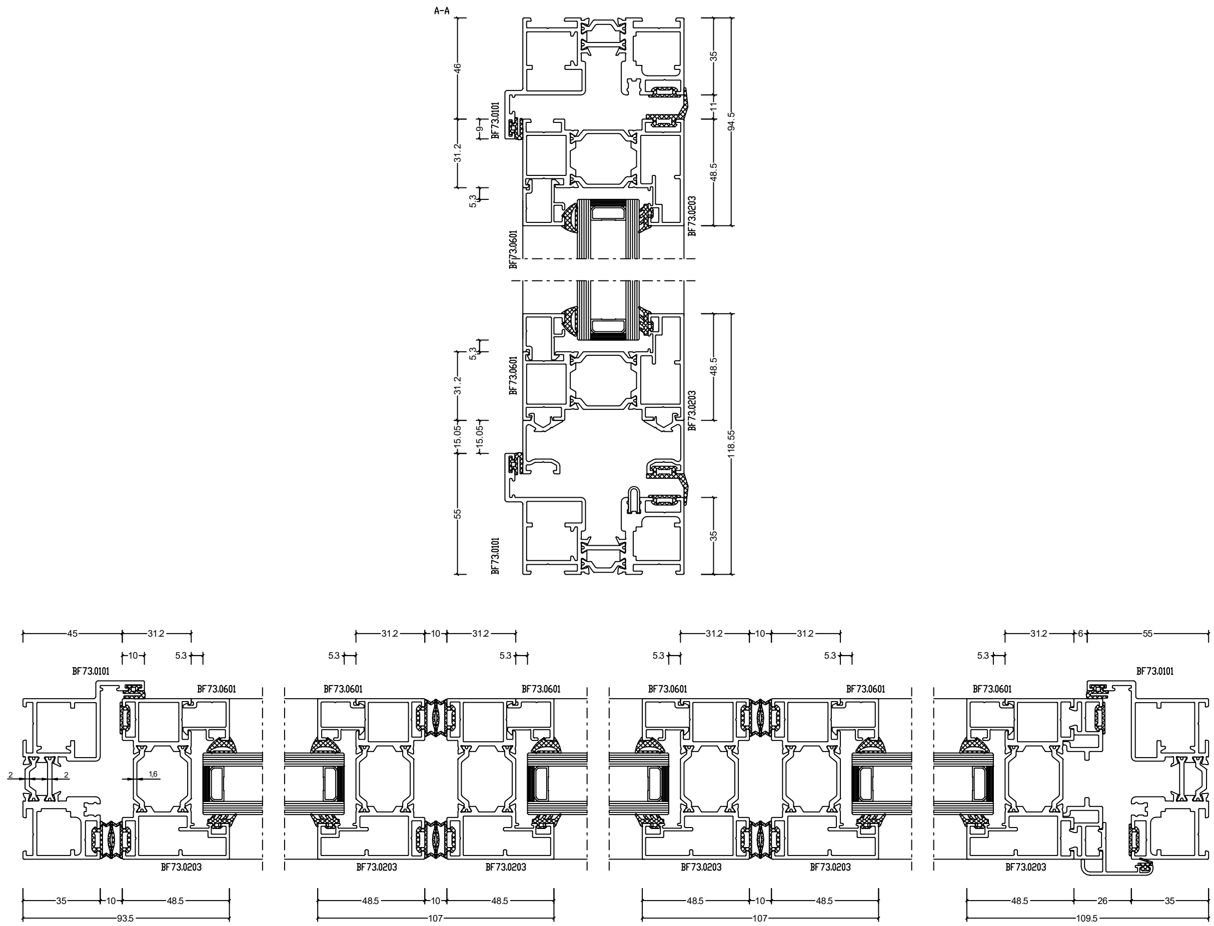
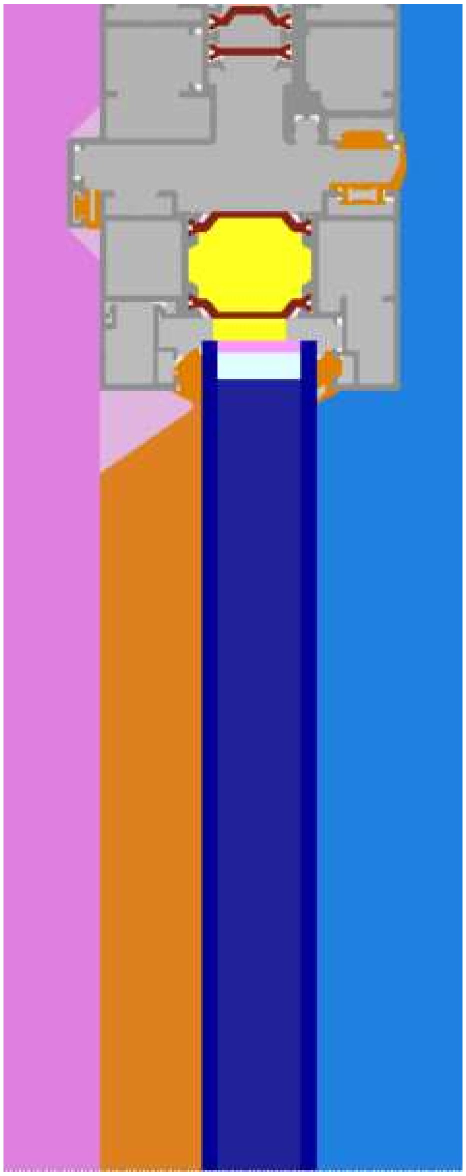


Figure 3. Simulation of head profile

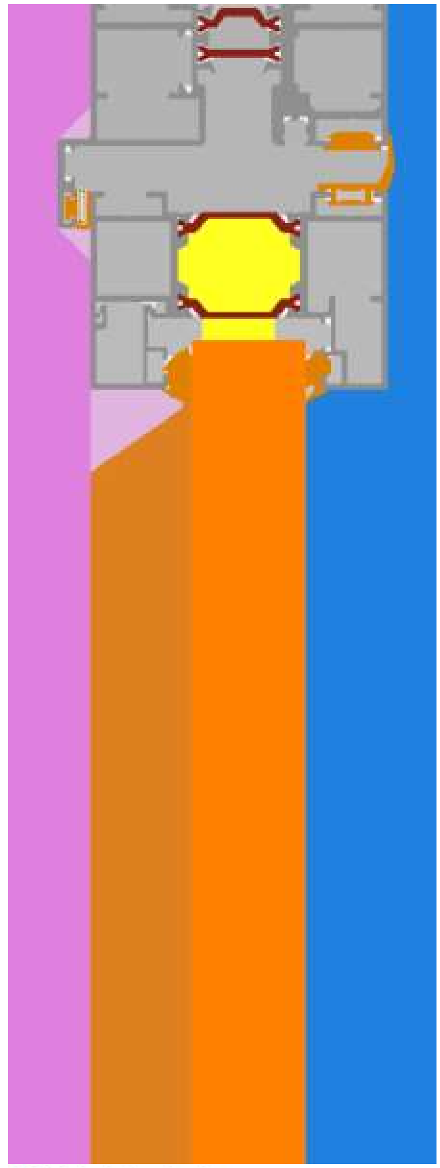


```
BISCO Calculation Results

BISCO data file: head.bsc

Number of nodes = 61094
Heat flow divergence for total object = 0.000253562
Heat flow divergence for worst node = 0.569667

Thermal transmittance of frame (EN 10077-2)
Uf = (Q/(ti-te) - Up1*wp1 - Up2*wp2) / wf = 3.289 W/(m².K)
Thermal coupling coefficient
L2D = Q/(ti-te) = 0.4943 W/(m.K)
  Q = 9.885 W/m
  ti = 20.00°C
  te = 0.00°C
  Up1 = 0.966 W/(m².K)   (bottom edge of bitmap)
  wp1 = 0.1900 m         (distance no. 2)
  Up2 = 0.000 W/(m².K)
  wp2 = 0.0000 m
  wf = 0.0945 m          (distance no. 1)
```



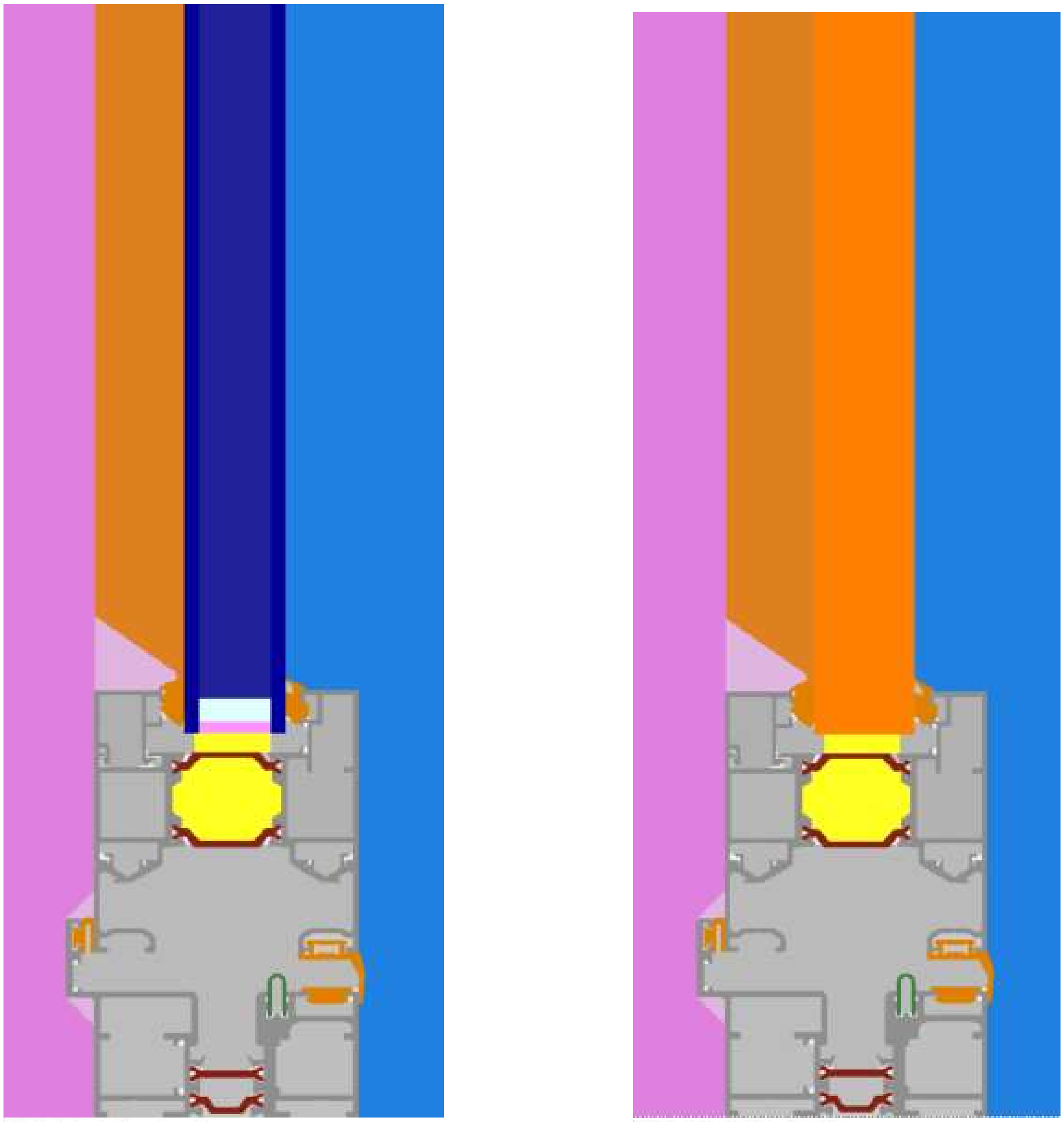
```
BISCO Calculation Results

BISCO data file: head panel.bsc

Number of nodes = 61295
Heat flow divergence for total object = 3.66468e-05
Heat flow divergence for worst node = 0.36884

Thermal transmittance of frame (EN 10077-2)
Uf = (Q/(ti-te) - Up1*wp1 - Up2*wp2) / wf = 3.022 W/(m².K)
Thermal coupling coefficient
L2D = Q/(ti-te) = 0.4631 W/(m.K)
  Q = 9.263 W/m
  ti = 20.00°C
  te = 0.00°C
  Up1 = 0.935 W/(m².K)   (bottom edge of bitmap)
  wp1 = 0.1900 m         (distance no. 2)
  Up2 = 0.000 W/(m².K)
  wp2 = 0.0000 m
  wf = 0.0945 m          (distance no. 1)
```

Figure 4. Simulation of Threshold profile.



BISCO Calculation Results

```
BISCO data file: threshold.bsc

Number of nodes = 69865
Heat flow divergence for total object = 0.000968328
Heat flow divergence for worst node = 0.960079

Thermal transmittance of frame (EN 10077-2)
Uf = (Q/(ti-te) - Up1*wp1 - Up2*wp2) / wf = 3.294 W/(m².K)
Thermal coupling coefficient
L2D = Q/(ti-te) = 0.5738 W/(m.K)
  Q = 11.476 W/m
  ti = 20.00°C
  te = 0.00°C
  Up1 = 0.966 W/(m².K)   (top edge of bitmap)
  wp1 = 0.1900 m         (distance no. 2)
  Up2 = 0.000 W/(m².K)
  wp2 = 0.0000 m
  wf = 0.1185 m          (distance no. 1)
```

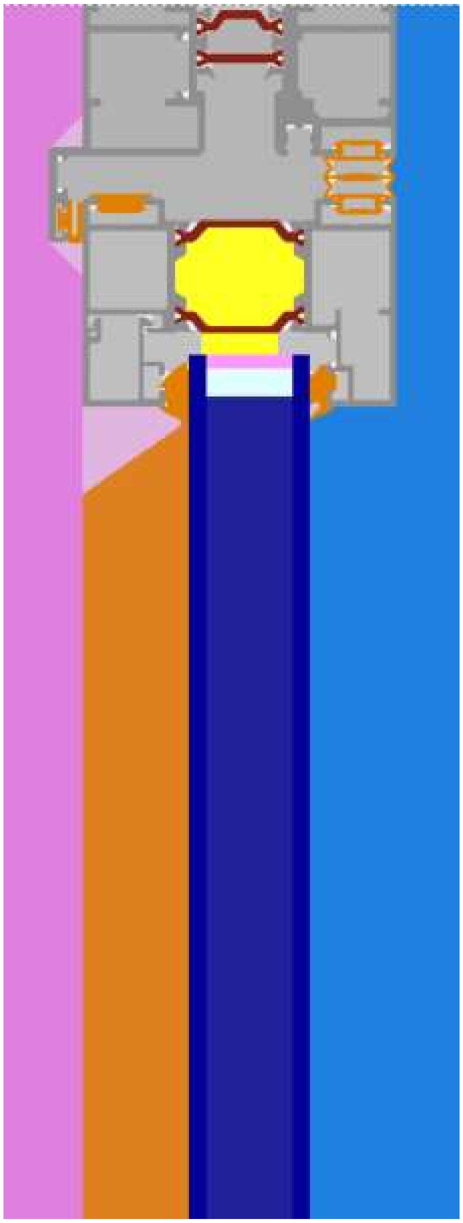
BISCO Calculation Results

```
BISCO data file: threshold panel.bsc

Number of nodes = 70067
Heat flow divergence for total object = 0.000810512
Heat flow divergence for worst node = 0.76002

Thermal transmittance of frame (EN 10077-2)
Uf = (Q/(ti-te) - Up1*wp1 - Up2*wp2) / wf = 3.089 W/(m².K)
Thermal coupling coefficient
L2D = Q/(ti-te) = 0.5436 W/(m.K)
  Q = 10.872 W/m
  ti = 20.00°C
  te = 0.00°C
  Up1 = 0.935 W/(m².K)   (top edge of bitmap)
  wp1 = 0.1900 m         (distance no. 2)
  Up2 = 0.000 W/(m².K)
  wp2 = 0.0000 m
  wf = 0.1185 m          (distance no. 1)
```

Figure 5. Simulation of Left Jamb profile.

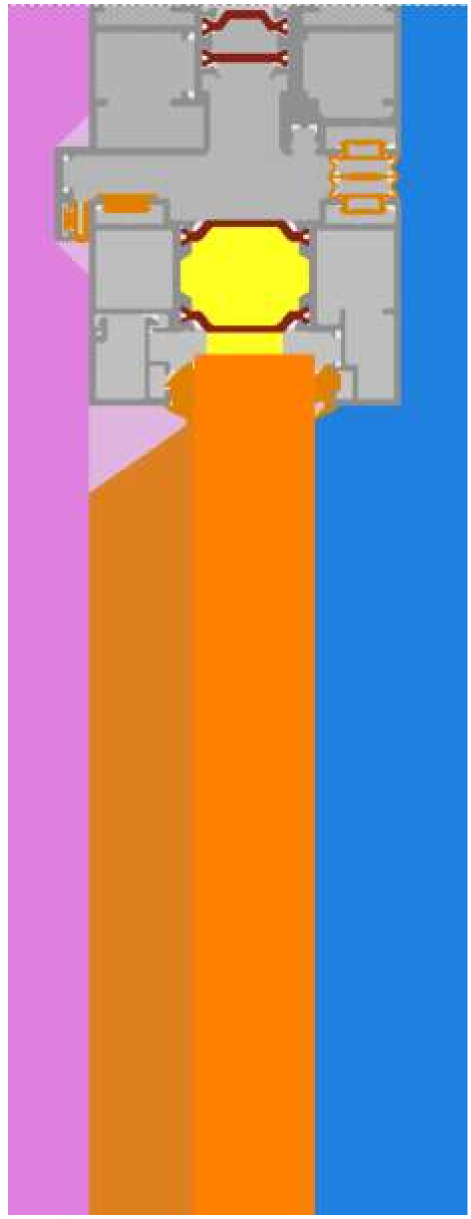


```
BISCO Calculation Results

BISCO data file: left jamb.bsc

Number of nodes = 60282
Heat flow divergence for total object = 4.88554e-05
Heat flow divergence for worst node = 0.919999

Thermal transmittance of frame (EN 10077-2)
Uf = (Q/(ti-te) - Up1*wp1 - Up2*wp2) / wf = 3.207 W/(m².K)
Thermal coupling coefficient
L2D = Q/(ti-te) = 0.4833 W/(m.K)
  Q = 9.666 W/m
  ti = 20.00°C
  te = 0.00°C
  Up1 = 0.966 W/(m².K)  (bottom edge of bitmap)
  wp1 = 0.1900 m        (distance no. 2)
  Up2 = 0.000 W/(m².K)
  wp2 = 0.0000 m
  wf = 0.0935 m         (distance no. 1)
```



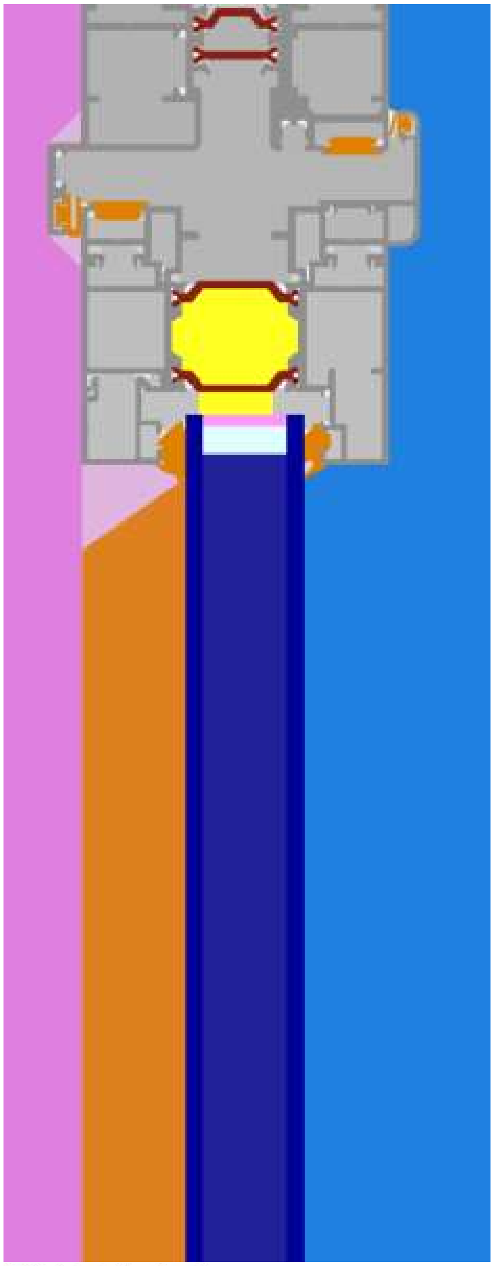
```
BISCO Calculation Results

BISCO data file: left jamb panel.bsc

Number of nodes = 60872
Heat flow divergence for total object = 0.000102284
Heat flow divergence for worst node = 0.766375

Thermal transmittance of frame (EN 10077-2)
Uf = (Q/(ti-te) - Up1*wp1 - Up2*wp2) / wf = 2.931 W/(m².K)
Thermal coupling coefficient
L2D = Q/(ti-te) = 0.4516 W/(m.K)
  Q = 9.032 W/m
  ti = 20.00°C
  te = 0.00°C
  Up1 = 0.935 W/(m².K)  (bottom edge of bitmap)
  wp1 = 0.1900 m        (distance no. 2)
  Up2 = 0.000 W/(m².K)
  wp2 = 0.0000 m
  wf = 0.0935 m         (distance no. 1)
```

Figure 6. Simulation of Right Jamb profile.

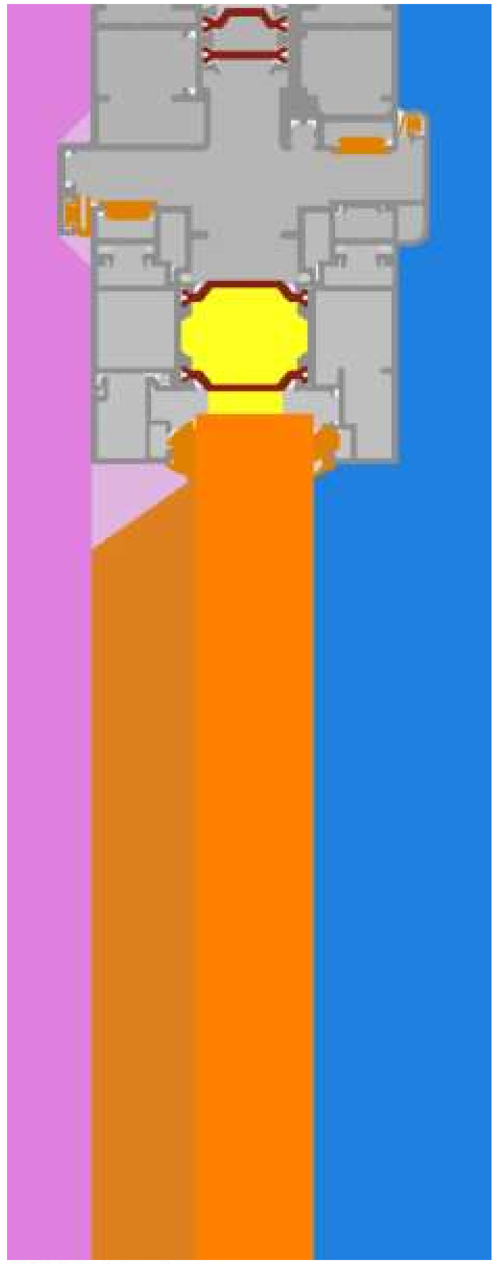


BISCO Calculation Results

```
BISCO data file: right jamb.bsc

Number of nodes = 68208
Heat flow divergence for total object = 0.000661905
Heat flow divergence for worst node = 0.901238

Thermal transmittance of frame (EN 10077-2)
Uf = (Q/(ti-te) - Up1*wp1 - Up2*wp2) / wf = 3.352 W/(m².K)
Thermal coupling coefficient
L2D = Q/(ti-te) = 0.5505 W/(m.K)
  Q = 11.010 W/m
  ti = 20.00°C
  te = 0.00°C
  Up1 = 0.966 W/(m².K)  (bottom edge of bitmap)
  wp1 = 0.1900 m        (distance no. 2)
  Up2 = 0.000 W/(m².K)
  wp2 = 0.0000 m
  wf = 0.1095 m         (distance no. 1)
```



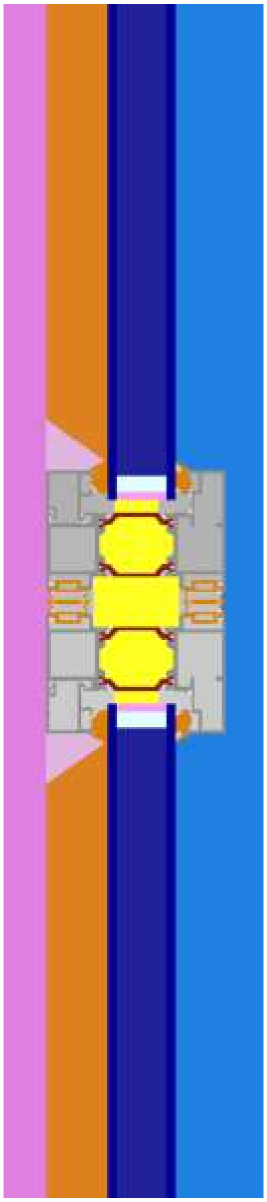
BISCO Calculation Results

```
BISCO data file: right jamb panel.bsc

Number of nodes = 68334
Heat flow divergence for total object = 0.000791587
Heat flow divergence for worst node = 0.864614

Thermal transmittance of frame (EN 10077-2)
Uf = (Q/(ti-te) - Up1*wp1 - Up2*wp2) / wf = 3.131 W/(m².K)
Thermal coupling coefficient
L2D = Q/(ti-te) = 0.5204 W/(m.K)
  Q = 10.408 W/m
  ti = 20.00°C
  te = 0.00°C
  Up1 = 0.935 W/(m².K)  (bottom edge of bitmap)
  wp1 = 0.1900 m        (distance no. 2)
  Up2 = 0.000 W/(m².K)
  wp2 = 0.0000 m
  wf = 0.1095 m         (distance no. 1)
```

Figure 7. Simulation of Meeting Stile profile.

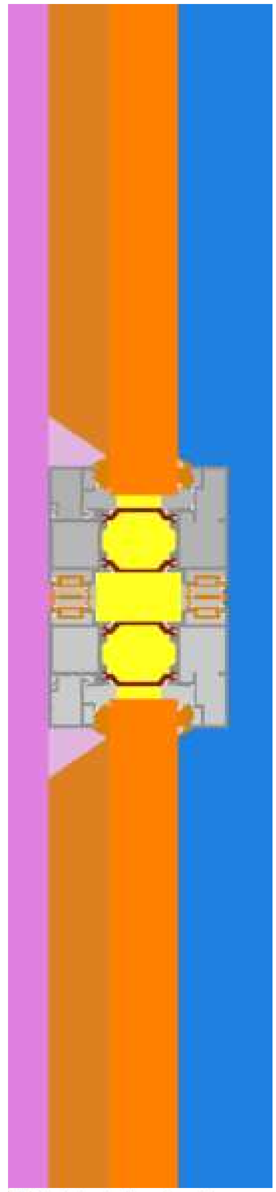


BISCO Calculation Results

```
BISCO data file: meeting stile.bsc

Number of nodes = 90151
Heat flow divergence for total object = 0.000420861
Heat flow divergence for worst node = 0.261116

Thermal transmittance of frame (EN 10077-2)
Uf = (Q/(ti-te) - Up1*wp1 - Up2*wp2) / wf = 2.378 W/(m².K)
Thermal coupling coefficient
L2D = Q/(ti-te) = 0.6214 W/(m.K)
  Q = 12.427 W/m
  ti = 20.00°C
  te = 0.00°C
  Up1 = 0.966 W/(m².K)   (top edge of bitmap)
  wp1 = 0.1900 m         (distance no. 2)
  Up2 = 0.966 W/(m².K)   (bottom edge of bitmap)
  wp2 = 0.1900 m         (distance no. 3)
  wf = 0.1070 m          (distance no. 1)
```



BISCO Calculation Results

```
BISCO data file: meeting stile panel.bsc

Number of nodes = 90478
Heat flow divergence for total object = 0.000372582
Heat flow divergence for worst node = 0.324873

Thermal transmittance of frame (EN 10077-2)
Uf = (Q/(ti-te) - Up1*wp1 - Up2*wp2) / wf = 1.768 W/(m².K)
Thermal coupling coefficient
L2D = Q/(ti-te) = 0.5443 W/(m.K)
  Q = 10.886 W/m
  ti = 20.00°C
  te = 0.00°C
  Up1 = 0.935 W/(m².K)   (top edge of bitmap)
  wp1 = 0.1900 m         (distance no. 2)
  Up2 = 0.935 W/(m².K)   (bottom edge of bitmap)
  wp2 = 0.1900 m         (distance no. 3)
  wf = 0.1070 m          (distance no. 1)
```

Key To Figures

Type	Subtype	Physical flow dir.	Geometrical flow dir.	Name	ε1 / ε2 [- / -]	λ [W/mK]	ε [-]	θ [°C]	h [W/m²K]
MATERIAL				aluminium		160.000	0.90		
MATERIAL				soda lime		1.000	0.90		
MATERIAL				Stainless steel		30.000	0.90		
MATERIAL				Swisspacer U		0.140	0.90		
MATERIAL				polyamide 6.6 with 25 % glass fibre		0.300	0.90		
MATERIAL				EPDM		0.250	0.90		
MATERIAL				polysulfide		0.400	0.90		
MATERIAL				polyurethane (PU) foam		0.050	0.90		
MATERIAL				Alunet 0.968 IGU cavity - 0.0264		0.026	0.90		
BC_SIMPL	HE	HOR		exterior				0.0	25.00
BC_SIMPL	HI_NORML	HOR		interior (normal) horizontal heat flow				20.0	7.70
BC_SIMPL	HI_REDUC	HOR		indoors (reduced)				20.0	5.00
BC_SIMPL	NIHIL			0.14 normal emissivity low e on internal				20.0	4.35
MATERIAL				insulation panel		0.035	0.90		

All material conductivities taken from either BS EN 10077-2 or BS EN 10456, except for Swisspacer Ultimate spacer (see below for evidence).

Glazing unit 4-20-4 Low E 0.01 and 0.14 uncorrected 90% argon 10% air filled

BTF 01 Issue 0, September 2023. Calculations according to BS EN 673:2011

Number of spaces
1

Glazing orientation	
	Vertical
Resistivity panes	1	m·K/W

Spaces 1

Outside

	Pane 1	90%	Pane 2
		Gas	
		Argon	
Thickness (mm)	4.0	20	4.0
Normal emissivity		0.01 / 0.89	0.14
$\sum d_j \cdot r_j =$ 0.008		Uncoated	

Calculate

For uncoated surfaces input 0.89 for normal emissivity, which corresponds to a corrected emissivity of 0.837

External, R_{se}	0.04	$(m^2 \cdot K)/W$
Internal, R_{si}	0.23	$(m^2 \cdot K)/W$

Iteration number	U value $W/(m^2 \cdot K)$	$\sum 1/h_s$ $(m^2 \cdot K)/W$	λeff W/(mK)	ΔT
1	0.968	0.75659	0.0264	15
2	0.968	0.75659	0.0264	15

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