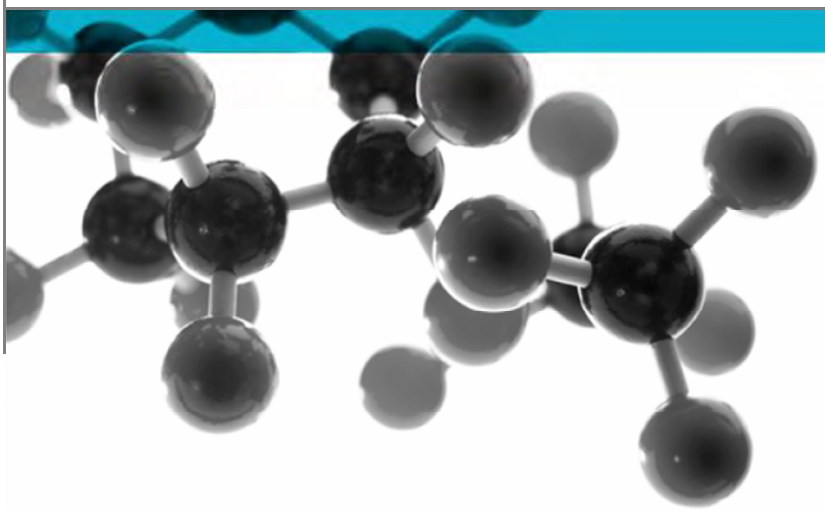
Exova Warringtonfire
Key Industrial Park
Fernside Road
Willenhall
West Midlands
WV13 3YA

T : +44 (0) 1902 722 122
F : +44 (0) 1902 727 242
E : willenhall@exova.com
W: www.exova.com

BS EN ISO 10077-1:2006



Thermal Performance of Windows, Doors & Shutters – Calculation of Thermal Resistance

A Report To: Sapa Building Systems

Document Reference: WIL328908

Date: 03/06/2013

Copy: 1

Issue No.: 1

Testing
Advising
Assuring

CALCULATION CONCLUSIONS

Drawings of:

Manufacturer	Sapa Building Systems
Product	Aluminium windows & doorsets
Model	Dualframe 75mm casement, reversible & sliding windows & doorsets, Dualsecure 75mm doorsets Crown 75mm windows & doorsets & Crown 120mm patio doorset, ST Commercial door, Powerframe windows & doorsets, Dualslide Sliding Windows, 202 Commercial Door

Have been submitted for U-values calculation validification in accordance with BS EN ISO 10077-1:2006. By Mark West, a BFRC certified simulator (No. 055) of Exova Warringtonfire, a UKAS accredited Testing Laboratory (No. 0621) and EC Notified Body number (No. 1104)

At Key Industrial Park, Fernside Rd, Willenhall, West Midlands, WV13 3YA.
Results and comments as detailed below:

Description	U-value W/(m^2.K)
SCE002 Dualframe 75mm Si TBT Window	**1.5 ***
SCE003 Dualsecure 75mm Entrance Door	**2.0 ***
SCE004 Dualframe 75mm Casement Window	**1.9 ***
SCE005 Crown 75mm Casement Window	**1.8 ***
SCE006 Crown 75mm Entrance Door	**1.8 ***
SCE007 Crown 120mm Patio Door	**1.8 ***
SCE008 Crown 75mm Bi-Fold Door	**1.8**
SCE009 Dualframe 75mm Si Casement Window	**1.6**
SCE010 Dualframe 75mm Dualfold Door	**1.9**
SCE011 ST Commercial Door	**2.2**
SCE012 Powerframe 80 Door	**2.4**
SCE013 Powerframe TBT Window	**2.1**
SCE014 Powerframe Casement Window	**2.4**
SCE015 Dualslide Sliding Windows	**2.1**
SCE016 Dualframe 75mm Si Pivot Window	**1.5**
SCE017 202 Commercial Door	**3.6**
SCE018 Dualframe 75mm Reversible Window	**1.7**
SCE019 Dualslide Sliding Windows	**1.9**

* results assessed from test report WIL326044

No inferences can be made regarding performance against other requirements of this standard

AUTHORISATION

Simulation performed by: Mark West, Assistant Operations Manager

Report issued by: Mark West, Assistant Operations Manager

Signed 

Date 03/06/2013

For and on behalf of Exova Warringtonfire

Report authorised by: Ian Keeling, Operations Manager

Signed 

Date 03/06/2013

For and on behalf of Exova Warringtonfire

Report issued: 03 June 2013

UKAS TESTING
0621

NOTE.
Tests marked “Not UKAS Accredited” are not covered by the Laboratory UKAS accreditation schedule.

Tests marked NT were not tested
Tests marked NA are not applicable to the product on test.

Exova Warringtonfire is an EC Notified Body Number 1104

CONTENTS **PAGE NO.**

TEST DETAILS

CLIENT DETAILS

Company name	Sapa Building Systems Ltd
Address	Severn Drive Tewkesbury, Gloucestershire
Postcode	GL20 8TX
Contact	Becky Hewlett

ORDER DETAILS

Order number	1275409 & 1275283
Dated	03/05/2013

PRODUCT DETAILS

Product	Aluminium Window Range
Model	Results asssed from report WIL326044 SCE002 Dualframe 75mm Si TBT Window SCE003 Dualsecure 75mm Entrance Door SCE004 Dualframe 75mm Casement Window SCE005 Crown 75mm Casement Window SCE006 Crown 75mm Entrance Door SCE007 Crown 120mm Patio Door Results calculated in this report SCE008 Crown 75mm Bi-Fold Door SCE009 Dualframe 75mm Si Casement Window SCE010 Dualframe 75mm Dualfold Door SCE011 ST Commercial Door SCE012 Powerframe 80 Door SCE013 Powerframe TBT Window SCE014 Powerframe Casement Window SCE015 Dualslide Sliding Windows SCE016 Dualframe 75mm Si Pivot Window SCE017 202 Commercial Door SCE018 Dualframe 75mm Reversible Window SCE019 Dualslide Sliding Windows
Manufacturer	Sapa Building Systems
Material	Aluminium

TEST DETAILS

Specification	BS EN ISO 10077-1:2006
Calculation methods	BS EN ISO 10077-1:2006 Thermal performance of windows, doors & shutters – Calculation of thermal transmittance – Part 1: General BS EN ISO 10077-2:2012 Thermal performance of windows, doors & shutters – Calculation of thermal transmittance – Part 2: Numerical method for frames BS EN 673:2011 Glass in building – Determination of thermal transmittance (U-value) – Calculation method

Simulation software & spreadsheet versions used	Thermal transmittance models obtained by computer simulation using Therm Finite Element Simulator V5.2.14 provided by LBNL. Software validated in accordance with Annex D of BS EN ISO 10077-2:2012 Exova BS EN 673 glazing U-value spreadsheet TR099 version 1.1. Exova BS EN ISO 10077 window U-value spreadsheet TR096 version 1.1. Exova BS EN ISO 10077 french door U-value spreadsheet TR100 version 1.1. Exova BS EN ISO 10077 patio door U-value spreadsheet TR101 version 1.1.

CALCULATION PROCEDURE

Introduction

This calculation report should be read in conjunction with the Standard BS EN ISO 10077-1:2006 Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 1: General, BS EN ISO 10077-2:2012 Thermal performance of windows, doors and shutters – Calculation of thermal resistance – Part 2: Numerical method for frames & BS EN 673:2011 Glass in building – Determination of thermal transmittance (U value) – Calculation method

THERM files created by Sapa Building Systems were submitted for calculation of thermal transmittance in accordance with BS EN ISO 10077-1:2006.

Instruction To Test

The calculations were conducted on the 24th January – 7th February 2013 and 7th – 14th May 2013 – 2013 on behalf of Sapa Building Systems.

Calculation method

Calculation was carried out in accordance with Clause 5.4 of BS EN ISO 10077-1 using an area weighted average of U_f and U_g as shown in equation 8, plus the edge effect of the glazing perimeter Ψ_g.

As per Clause 5.2 of BS EN ISO 10077-1 the thermal transmittance of the glazing U_g was calculated in accordance with BS EN 673:2011.

As per Clause 6 of BS EN ISO 10077-1 Input Data the thermal transmittance of the frame U_f and the linear thermal transmittance of the frame/glazing junction Ψ_g were carried out by simulation in accordance with Annex C of BS EN ISO 10077-2 using THERM finite element analysis software version 5.2.14 provided by LBNL. Simulations were produced both with the glazing in place, and the glazing replaced with an insulation panel of thermal conductivity 0.035.

Values used for the design thermal conductivity of materials in this calculation were taken from Annex A of BS EN ISO 10077-2 unless otherwise stated, and are listed in Annex A of this report with sources.

As such the result contained in this report is partly derived from tabulated values and should be considered indicative and not definitive.

CONCLUSIONS

Evaluation against objective	The sectional drawings of the windows & doors as provided by the client were subjected to thermal performance calculations in accordance with BS EN ISO 10077-1.
Observations & comments	

LIMITATIONS

Limitations	The results relate only to the behaviour of the specimens of the element of construction under the particular conditions of the calculation. They are not intended to be the sole criteria for assessing the potential performance of the element in use, nor do they reflect the actual behaviour in use.
Uncertainty of Measurement	The uncertainties of measurements calculated for a confidence level of 95% throughout these tests are within the limits of these tolerances. The user and the simulation software have been validated in accordance with Annex D of BS EN ISO 10077-2:2012, giving the following accuracies: ▪ Thermal transmittance ± 5% ▪ Linear thermal transmittance ± 5%

ANNEX A: SOURCE DATA

Materials used

Design thermal conductivity of materials used in the simulation

Material	Conductivity (W/ m.K)	Emissivity	Source
Aluminum alloy (painted) *Frame & casement profiles*	160.00	0.90	ISO10077-2 Table A.1
Aluminum alloy (unpainted) *Various items*	160.00	0.10	ISO10077-2 Table A.1 ISO10077-2 Table A.4
Aluminum alloy (slightly oxidised) *Various items*	160.00	0.30	ISO10077-2 Table A.1 ISO10077-2 Table A.4
Stainless steel (austenitic) *Various items*	17.00	0.30	ISO10077-2 Table A.1 ISO10077-2 Table A.4
Polyamide 6.6 with 25% glass fibre *Thermal breaks*	0.30	0.90	ISO10077-2 Table A.1
Glass *Glazing*	1.00	0.90	ISO10077-2 Table A.1
Cross linked foam *Outer frame packing*	0.05	0.90	EN12424:2000 Table 1
PVC (Flexible,with 40% softener) *Weatherseals*	0.14	0.90	ISO10077-2 Table A.1
PVC (Rigid) *Various trims*	0.17	0.90	ISO10077-2 Table A.1
Pile weatherstrip (polyester mohair) *Weatherseals*	0.14	0.90	ISO10077-2 Table A.1
Elastomeric foam *Weatherseals*	0.05	0.90	ISO10077-2 Table A.1
Silicone *Sealant*	0.35	0.90	ISO10077-2 Table A.1
Polysulphide *Spacer bar secondary sealant*	0.40	0.90	ISO10077-2 Table A.1

Materials used (cont)

Material	Conductivity (W/ m.K)	Emissivity	Source
Swissspacer V Equivalent thermal conductivity *Spacer bar*	0.175	0.90	IFT Rosenheim Test Report no: 10-000414-PB02-K10-06-en-02
4-20-4mm 90%Argon filled DGU Equivalent thermal conductivity *DGU gas filling*	0.0311	0.90	EN673:2011 Calculation
6-16-6mm 90% Argon filled DGU Equivalent thermal conductivity *DGU gas filling*	0.0243	0.90	EN673:2011 Calculation
4-16-4mm 90% Argon filled DGU Equivalent thermal conductivity *DGU gas filling*	0.0243	0.90	EN673:2011 Calculation
9.5-18-6mm 90% Argon filled DGU Equivalent thermal conductivity *DGU gas filling*	0.0277	0.90	EN673:2011 Calculation
7.5-16-6mm 90% Argon filled DGU Equivalent thermal conductivity *DGU gas filling*	0.0243	0.90	EN673:2011 Calculation

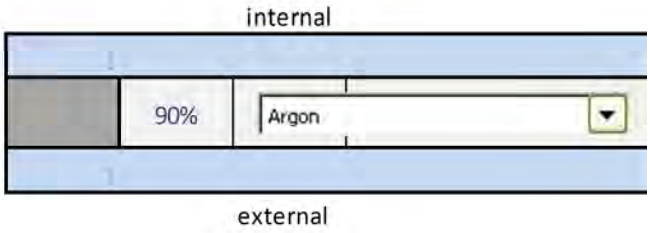
ANNEX B: SIMULATION RESULTS & CALCULATIONS

Results - SCE002 Dualframe 75mm Si Tilt before Turn Window (assessed from WIL326044)

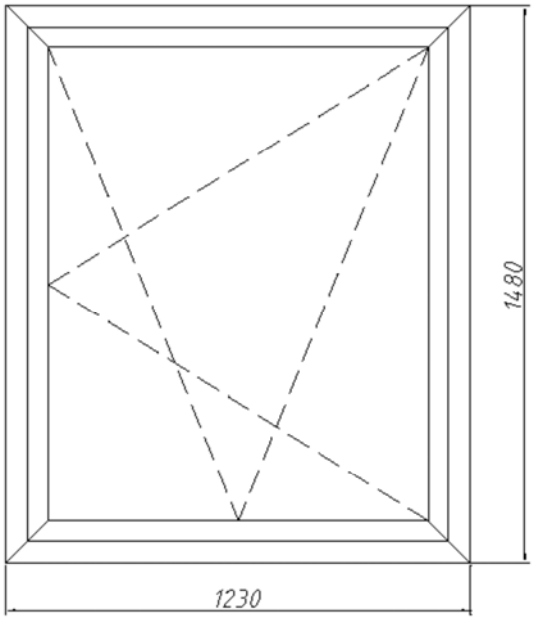
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	4	0.05	
air space 1 (s1) =	20		
external pane (d_j2) =	4	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.008		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.219		**0.64228**		**0.0311**



Results - SCE002 Dualframe 75mm Si Tilt before Turn Window (assessed from WIL326044)

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	Carried out for :	Sapa Building Systems
	U-value calculation for single light window	Product :	SCE002 Dualframe 75mm Si TBT Window
Reference:	TR096	Window configuration :	Tilt Before Turn (1230 x 1480)
Standard issue:	BS EN ISO 10077-2:2012	Glazing :	28mm (4-20-4) Swiss-V Spacer Bar
Author:	Mark West		
Version:	1.1	Calculation date :	5th February 2013
Issue date:	24th January 2013	Carried out by :	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.4153	1.0309	0.1900	0.1180	1.8596
2 Lockside jamb	0.4006	1.0309	0.1900	0.1180	1.7350
3 hingeside jamb	0.4006	1.0309	0.1900	0.1180	1.7350
4 Sill	0.4006	1.0309	0.1900	0.1180	1.7350

Up of insulating panel 1.0309

Glass thickness 0.028 m

Centre pane U-value 1.219

Overall width 1.23 m

Overall height 1.48 m

Overall area 1.8204 m2

Section detail	Lψ2d	Uf	bf	Ud	bd	ψi
1 Head	0.4900	1.8596	0.1180	1.2190	0.1900	0.0390
2 Lockside jamb	0.4761	1.7350	0.1180	1.2190	0.1900	0.0398
3 Hingeside jamb	0.4761	1.7350	0.1180	1.2190	0.1900	0.0398
4 Sill	0.4761	1.7350	0.1180	1.2190	0.1900	0.0398

Frame area	Af	Uf	Af.Uf
1 Head	0.1312	1.8596	0.2440
2 Lockside jamb	0.1607	1.7350	0.2788
3 Hingeside jamb	0.1607	1.7350	0.2788
4 Sill	0.1312	1.7350	0.2277
Σaf=	0.5839	ΣAf.Uf=	1.0293

frame width bf

1 Head 0.118

2 Lockside jamb 0.118

3 Hingeside jamb 0.118

4 Sill 0.118

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	0.9940	0.0390	0.0387
2 Lockside jamb	1.2440	0.0398	0.0495
3 Hingeside jamb	1.2440	0.0398	0.0495
4 sill	0.9940	0.0398	0.0395
Σlg=	4.4760	Σlg.ψg =	0.1772

	Ag	Ug	Ag.Ug
Glass	1.2365	1.2190	1.5073

$$U_w = \frac{\Sigma A_f \times U_f + \Sigma A_g \times U_g + \Sigma l_g \times \psi_g}{A_g + A_p + A_f}$$

$$U_w = \frac{1.0293 + 1.5073 + 0.1772}{1.8204}$$

$$U_w = 1.491 \ W / m^2 \cdot K$$

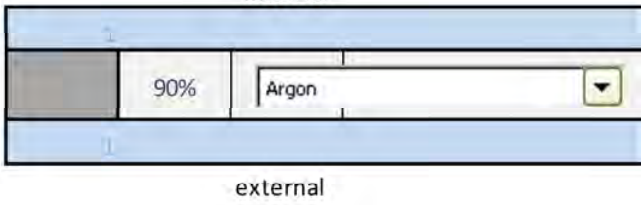
Reported Value **1.5** $W / m^2 \cdot K$ (to 1 decimal place)

Results – SCE003 Dualsecure 75mm Entrance Door (assessed from WIL326044)

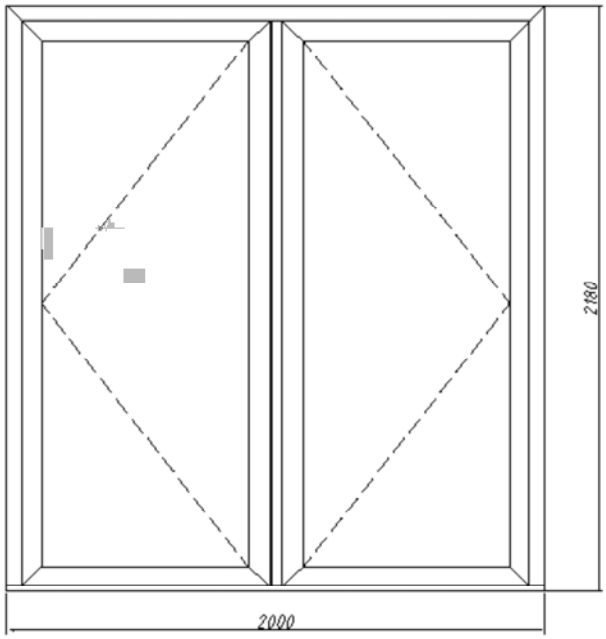
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	6	0.05	
air space 1 (s1) =	16		
external pane (d_j2) =	6	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.012		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.190		**0.65864**		**0.0243**



Results – SCE003 Dualsecure 75mm Entrance Door (assessed from WIL326044)

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	Carried out for :	Sapa Building Systems
	U-value calculation for French doorset	Product :	SCE003 Dualsecure 75mm Entrance Door
Reference:	TR100	Doorset configuration :	Low Threshold Double Door Open Out / Glaze
Standard issue:	BS EN ISO 10077-2:2012	Glazing :	28mm (6-16-6) Swiss-V Spacer Bar
Author:	Mark West		
Version:	1.1	Calculation date :	5th February 2013
Issue date:	5th February 2013	Carried out by :	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.6019	1.0309	0.1900	0.1310	3.0994
2 Left jamb	0.6019	1.0309	0.1900	0.1310	3.0994
3 Right jamb	0.6019	1.0309	0.1900	0.1310	3.0994
4 Meeting stile	1.0694	1.0309	0.3800	0.2090	3.2423
5 Sill	0.7509	1.0309	0.1900	0.1220	4.5494

Up of insulating panel: 1.030928

Glass thickness: 0.028 m
Centre pane U-value: 1.19

Section detail	Lψ2d	Uf	bf	Ug	bd	ψi
1 Head	0.6712	3.0994	0.1310	1.1900	0.1900	0.0391
2 Left jamb	0.6712	3.0994	0.1310	1.1900	0.1900	0.0391
3 Right jamb	0.6712	3.0994	0.1310	1.1900	0.1900	0.0391
4 Meeting stile	1.2056	3.2423	0.2090	1.1900	0.3800	0.0758
5 Sill	0.8243	4.5494	0.1220	1.1900	0.1900	0.0432

Overall width: 2.00 m
Overall height: 2.18 m
Overall area: 4.36 m2

Frame area	Af	Uf	Af.Uf
1 Head	0.2448	3.0994	0.7589
2 Left jamb	0.2690	3.0994	0.8338
3 Right jamb	0.2690	3.0994	0.8338
4 Meeting stile	0.4027	3.2423	1.3058
5 Sill	0.2280	4.5494	1.0373
Σaf=	1.4136	ΣAf.Uf=	4.7696

	frame width bf	
1 Head	0.131	m
2 Left jamb	0.131	m
3 Right jamb	0.131	m
4 Meeting stile	0.209	m
5 Sill	0.122	m

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	1.5290	0.0391	0.0597
2 Left jamb	1.9270	0.0391	0.0753
3 Right jamb	1.9270	0.0391	0.0753
4 Meeting stile	1.9270	0.0758	0.1460
5 Sill	1.5290	0.0432	0.0660
Σlg=	8.8390	Σlg.ψg =	0.4223

	Ag	Ug	Ag.Ug
Glass	2.9464	1.1900	3.5062

$$U_d = \frac{\Sigma Af \times Uf + \Sigma Ag \times Ug + \Sigma lg \times \psi g}{Ag + Ap + Af}$$

$$U_d = \frac{4.7696 + 3.5062 + 0.4223}{4.36}$$

$$U_d = 1.995 \ W / m^2 \cdot K$$

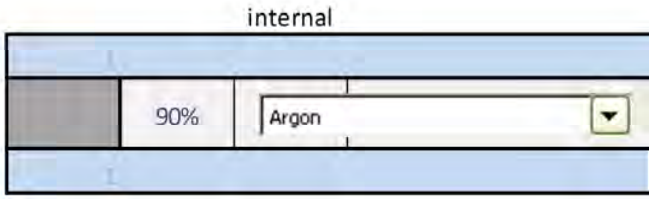
Reported Value **2.0** $W / m^2 \cdot K$ (to 1 decimal place)

Results – SCE004 Dualframe 75mm Casement Window (assessed from WIL326044)

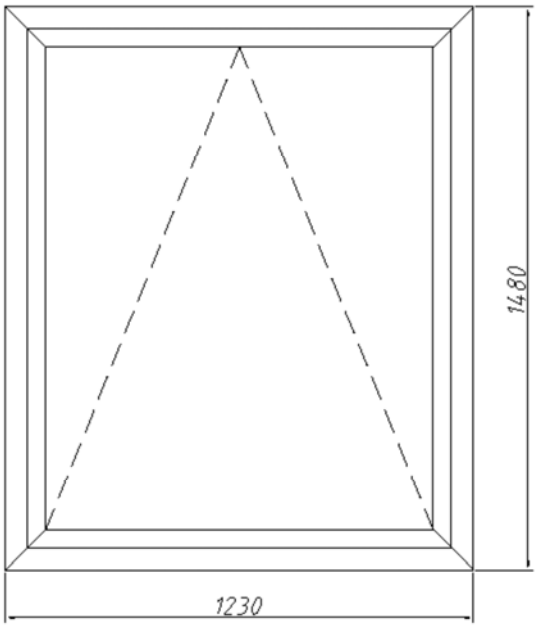
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	4	0.05	
air space 1 (s1) =	20		
external pane (d_j2) =	4	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.008		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.219		**0.64228**		**0.0311**



Results – SCE004 Dualframe 75mm Casement Window (assessed from WIL326044)

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	Carried out for :	Sapa Building Systems
	U-value calculation for single light window	Product :	SCE004 Dualframe 75mm Window
Reference:	TR096	Window configuration :	Casement Top Hung (1230 x 1480)
Standard issue:	BS EN ISO 10077-2:2012	Glazing :	28mm (4-20-4) Swiss-V Spacer Bar
Author:	Mark West		
Version:	1.1	Calculation date :	5th February 2013
Issue date:	24th January 2013	Carried out by :	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 head	0.5452	1.0309	0.1900	0.1060	3.2956
2 jamb lock	0.5452	1.0309	0.1900	0.1060	3.2956
3 jamb hinge	0.5452	1.0309	0.1900	0.1060	3.2956
4 sill	0.5444	1.0309	0.1900	0.1060	3.2880

Up of insulating panel	1.0309	
Glass thickness	0.028	m
Centre pane U-value	1.219	

Section detail	Lψ2d	Uf	bf	Ud	bd	ψi
1 head	0.6113	3.2956	0.1060	1.2190	0.1900	0.0304
2 jamb lock	0.6113	3.2956	0.1060	1.2190	0.1900	0.0304
3 jamb hinge	0.6113	3.2956	0.1060	1.2190	0.1900	0.0304
4 sill	0.6106	3.2880	0.1060	1.2190	0.1900	0.0305

Overall width	1.23	m
Overall height	1.48	m
Overall area	1.8204	m2

Frame area	Af	Uf	Af.Uf
1 head	0.1191	3.2956	0.3926
2 jamb lock	0.1456	3.2956	0.4800
3 jamb hinge	0.1456	3.2956	0.4800
4 sill	0.1191	3.2880	0.3917
Σaf=	0.5296	ΣAf.Uf=	1.7443

frame width bf

1 head	0.106	m
2 jamb lock	0.106	m
3 jamb hinge	0.106	m
4 sill	0.106	m

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 head	1.0180	0.0304	0.0309
2 jamb lock	1.2680	0.0304	0.0385
3 jamb hinge	1.2680	0.0304	0.0385
4 sill	1.0180	0.0305	0.0310
Σlg=	4.5720	Σlg.ψg =	0.1389

	Ag	Ug	Ag.Ug
Glass	1.2908	1.2190	1.5735

$$U_w = \frac{\Sigma Af \times Uf + \Sigma Ag \times Ug + \Sigma lg \times \psi g}{Ag + Ap + Af}$$

$$U_w = \frac{1.7443 + 1.5735 + 0.1389}{1.8204}$$

$$U_w = 1.899 \ W / m^2 \cdot K$$

Reported Value **1.9** W / m^2·K (to 1 decimal place)

Results – SCE005 Crown 75mm Casement Window (assessed from WIL326044)

U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

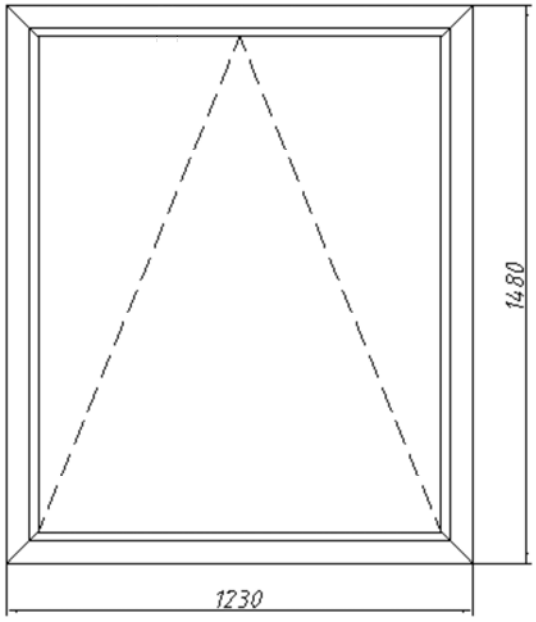
	thickness (mm)	ε normal	
internal pane (d_j1) =	4	0.05	
air space 1 (s1) =	16		
external pane (d_j2) =	4	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.008		

internal

90% Argon

external

Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.195		**0.65864**		**0.0243**



Results – SCE005 Crown 75mm Casement Window (assessed from WIL326044)

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	Carried out for :	Sapa Building Systems
	U-value calculation for single light window	Product :	SCE005 Crown 75mm Casement Window
Reference:	TR096	Window configuration :	Casement Top Hung (1230 x 1480)
Standard issue:	BS EN ISO 10077-2:2012	Glazing :	24mm (4-16-4) Swiss-V Spacer Bar
Author:	Mark West		
Version:	1.1	Calculation date :	4th February 2013
Issue date:	24th January 2013	Carried out by :	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 head	0.4846	1.1686	0.1900	0.0820	3.2020
2 jamb lock	0.4846	1.1686	0.1900	0.0820	3.2020
3 jamb hinge	0.4846	1.1686	0.1900	0.0820	3.2020
4 sill	0.4836	1.1686	0.1900	0.0820	3.1898

Up of insulating panel 1.168614

Glass thickness 0.024 m
Centre pane U-value 1.195

Section detail	L_ψ2d	Uf	bf	Ud	bd	ψi
1 head	0.5292	3.2020	0.0820	1.1950	0.1900	0.0396
2 jamb lock	0.5292	3.2020	0.0820	1.1950	0.1900	0.0396
3 jamb hinge	0.5292	3.2020	0.0820	1.1950	0.1900	0.0396
4 sill	0.5285	3.1898	0.0820	1.1950	0.1900	0.0399

Overall width 1.23 m
Overall height 1.48 m
Overall area 1.8204 m2

Frame area	Af	Uf	Af.Uf
1 head	0.0941	3.2020	0.3014
2 jamb lock	0.1146	3.2020	0.3671
3 jamb hinge	0.1146	3.2020	0.3671
4 sill	0.0941	3.1898	0.3003
∑af=	0.4175	∑Af.Uf=	1.3358

frame width bf
1 head 0.082 m
2 jamb lock 0.082 m
3 jamb hinge 0.082 m
4 sill 0.082 m
largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 head	1.0660	0.0396	0.0422
2 jamb lock	1.3160	0.0396	0.0521
3 jamb hinge	1.3160	0.0396	0.0521
4 sill	1.0660	0.0399	0.0425
∑lg=	4.7640	∑lg.ψg =	0.1889

	Ag	Ug	Ag.Ug
Glass	1.4029	1.1950	1.6764

$$U_w = \frac{\sum A_f \times U_f + \sum A_g \times U_g + \sum l_g \times \psi_g}{A_g + A_p + A_f}$$

$$U_w = \frac{1.3358 + 1.6764 + 0.1889}{1.8204}$$

$$U_w = 1.758 \ W / m^2 \cdot K$$

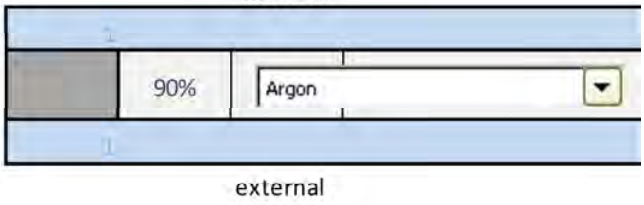
Reported Value **1.8** $W / m^2 \cdot K$ (to 1 decimal place)

Results – SCE006 Crown 75mm Entrance Door (assessed from WIL326044)

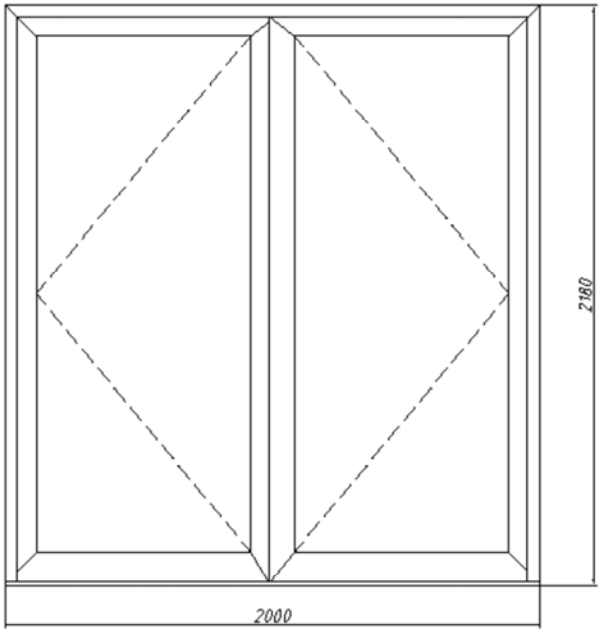
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	6	0.05	
air space 1 (s1) =	16		
external pane (d_j2) =	6	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.012		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.190		**0.65864**		**0.0243**



Results – SCE006 Crown 75mm Entrance Door (assessed from WIL326044)

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	Carried out for :	Sapa Building Systems
	U-value calculation for French doorset	Product :	SCE006 Crown 75mm Entrance Door
Reference:	TR100	Doorset configuration :	Low Threshold Double Door Open Out / Glaze
Standard issue:	BS EN ISO 10077-2:2012	Glazing :	28mm (6-16-6 / 1.2 'U' Value) Swiss-V Spacer
Author:	Mark West		
Version:	1.1	Calculation date :	7th February 2013
Issue date:	5th February 2013	Carried out by :	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.5704	1.0309	0.1900	0.1280	2.9260
2 Left jamb	0.5235	1.0309	0.1900	0.1150	2.8489
3 Right jamb	0.5235	1.0309	0.1900	0.1150	2.8489
4 Meeting stile	0.8340	1.0309	0.3800	0.1620	2.7299
5 Sill	0.7249	1.0309	0.1900	0.1290	4.1010

Up of insulating panel 1.030928

Glass thickness 0.028 m
Centre pane U-value 1.19

Overall width 2.00 m
Overall height 2.18 m
Overall area 4.36 m2

Section detail	Lψ2d	Uf	bf	Ug	bd	ψi
1 Head	0.6409	2.9260	0.1280	1.1900	0.1900	0.0403
2 Left jamb	0.5942	2.8489	0.1150	1.1900	0.1900	0.0405
3 Right jamb	0.5942	2.8489	0.1150	1.1900	0.1900	0.0405
4 Meeting stile	0.9766	2.7299	0.1620	1.1900	0.3800	0.0822
5 Sill	0.7944	4.1010	0.1290	1.1900	0.1900	0.0393

Frame area	Af	Uf	Af.Uf
1 Head	0.2413	2.9260	0.7060
2 Left jamb	0.2359	2.8489	0.6721
3 Right jamb	0.2359	2.8489	0.6721
4 Meeting stile	0.3115	2.7299	0.8504
5 Sill	0.2432	4.1010	0.9972
total Σ Af	1.2678	ΣAf.Uf=	3.8979

	frame width bf	
1 Head	0.128	m
2 Left jamb	0.115	m
3 Right jamb	0.115	m
4 Meeting stile	0.162	m
5 Sill	0.129	m

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	1.6080	0.0403	0.0648
2 Left jamb	1.9230	0.0405	0.0778
3 Right jamb	1.9230	0.0405	0.0778
4 Meeting stile	1.9230	0.0822	0.1580
5 Sill	1.6080	0.0393	0.0632
Σlg=	8.9850	Σlg.ψg =	0.4416

	Ag	Ug	Ag.Ug
Glass	3.0922	1.1900	3.6797

$$U_d = \frac{\Sigma A_f \times U_f + \Sigma A_g \times U_g + \Sigma l_g \times \psi_g}{A_g + A_p + A_f}$$

$$U_d = \frac{3.8979 + 3.6797 + 0.4416}{4.36}$$

$$U_d = 1.839 \ W / m^2 \cdot K$$

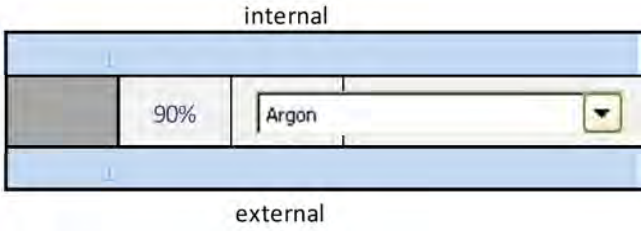
Reported Value **1.8** W / m^2·K (to 1 decimal place)

Results – SCE007 Crown 120mm Patio Door (assessed from WIL326044)

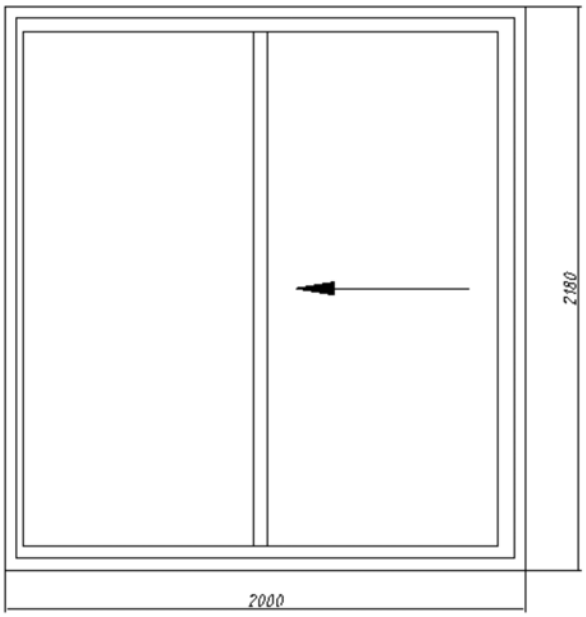
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	6	0.05	
air space 1 (s1) =	16		
external pane (d_j2) =	6	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.012		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.190		**0.65864**		**0.0243**



Results – SCE007 Crown 120mm Patio Door (assessed from WIL326044)

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	Carried out for :	Sapa Building Systems
	U-value calculation for Sliding doorset	Product :	SCE007 Crown 120mm Patio Door
Reference:	TR101	Doorset configuration :	Patio Door With Heavy Duty Interlocks Glaze
Standard issue:	BS EN ISO 10077-2:2012	Glazing :	28mm (6-16-6 / 1.2 'U' Value) Swiss-V Spacer
Author:	Mark West		
Version:	1.1	Calculation date :	7th February 2013
Issue date:	7th February 2013	Carried out by :	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Fixed Head	0.5065	1.0309	0.1900	0.0960	3.2357
2 Sliding Head	0.5035	1.0309	0.1900	0.0960	3.2044
3 Fixed jamb	0.4124	1.0309	0.1900	0.0690	3.1380
4 Locking jamb	0.5056	1.0309	0.1900	0.1070	2.8946
5 Interlocks	0.7549	1.0309	0.3800	0.0510	7.1205
6 Fixed Sill	0.5288	1.0309	0.1900	0.0990	3.3629
7 Sliding Sill	0.5369	1.0309	0.1900	0.0990	3.4447

Up of insulating panel 1.030928

Glass thickness 0.028 m
Centre pane U-value 1.19

Overall width 2.00 m
Overall height 2.18 m
Overall area 4.36 m2

Section detail	Lψ2d	Uf	bf	Ug	bd	ψi
1 Fixed Head	0.5756	3.2357	0.0960	1.1900	0.1900	0.0389
2 Sliding Head	0.5724	3.2044	0.0960	1.1900	0.1900	0.0387
3 Fixed jamb	0.4824	3.1380	0.0690	1.1900	0.1900	0.0398
4 Locking jamb	0.5767	2.8946	0.1070	1.1900	0.1900	0.0409
5 Interlocks	0.8931	7.1205	0.0510	1.1900	0.3800	0.0778
6 Fixed Sill	0.5977	3.3629	0.0990	1.1900	0.1900	0.0387
7 Sliding Sill	0.6070	3.4447	0.0990	1.1900	0.1900	0.0399

Frame area	Af	Uf	Af.Uf
1 Fixed Head	0.0942	3.2357	0.3047
2 Sliding Head	0.0978	3.2044	0.3135
3 Fixed jamb	0.1370	3.1380	0.4298
4 Locking jamb	0.2124	2.8946	0.6148
5 Interlocks	0.1012	7.1205	0.7208
6 Fixed Sill	0.0971	3.3629	0.3266
7 Sliding Sill	0.1009	3.4447	0.3475
total Σ Af	0.8406	ΣAf.Uf=	3.0577

	frame width bf	
1 Fixed Head	0.096	m
2 Sliding Head	0.096	m
3 Fixed jamb	0.069	m
4 Locking jamb	0.107	m
5 Interlocks	0.051	m
6 Fixed Sill	0.099	m
7 Sliding Sill	0.099	m

largest of the visible areas of both sides, to nearest mm

interlock offset to give equal glass size

Panel length	lg	ψg	lg.ψg
1 Fixed Head	0.8865	0.0389	0.0345
2 Sliding Head	0.8865	0.0387	0.0343
3 Fixed jamb	1.9850	0.0398	0.0790
4 Locking jamb	1.9850	0.0409	0.0811
5 Interlocks	1.9850	0.0778	0.1543
6 Fixed Sill	0.8865	0.0387	0.0343
7 Sliding Sill	0.8865	0.0399	0.0354
Σlg=	9.5010	Σlg.ψg =	0.4528

	Ag	Ug	Ag.Ug
Glass	3.5194	1.1900	4.1881

$$U_d = \frac{\Sigma Af \times Uf + \Sigma Ag \times Ug + \Sigma lg \times \psi g}{Ag + Ap + Af}$$

$$U_d = \frac{3.0577 + 4.1881 + 0.4528}{4.36}$$

$$U_d = 1.766 \ W / m^2 \cdot K$$

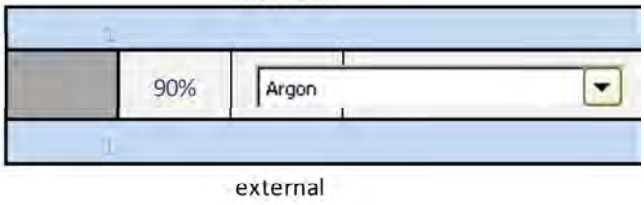
Reported Value **1.8** $W / m^2 \cdot K$ (to 1 decimal place)

Results – SCE008 Crown 75mm Bi-Fold Door

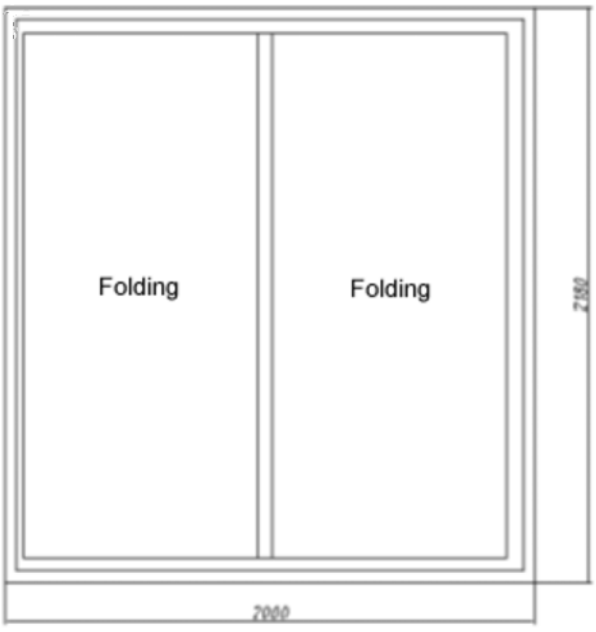
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	6	0.05	
air space 1 (s1) =	16		
external pane (d_j2) =	6	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.012		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.190		**0.65864**		**0.0243**



Results – SCE008 Crown 75mm Bi-Fold Door

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall U-value calculation for french doorset	**Carried out for :**	Sapa Building Systems
		Product :	SCE008 Crown 75mm Bifold Door
Reference:	TR100	**Model :**	Bi-Fold door Low Threshold Open In - Glaze O
Standard issue:	BS EN ISO 10077-2:2012	**Glazing details :**	28mm (6-16-6 / 1.2 'U' Value) Swiss-V Spacer
Author:	Mark West		
Version:	1.1	**Calculation date :**	7th May 2013
Issue date:	5th February 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.5004	1.0309	0.1900	0.1220	2.4961
2 Hinge jamb	0.5016	1.0309	0.1900	0.1220	2.5059
3 Locking jamb	0.5178	1.0309	0.1900	0.1260	2.5550
4 Meeting stile	0.8299	1.0309	0.3800	0.1650	2.6554
5 Cill	0.6176	1.0309	0.1900	0.0950	4.4392

U of insulating panel = 1.0309

Glass thickness = 0.028 m

Centre pane U-value Ug = 1.19

Section detail	L_ψ2d	Uf	bf	Ug	bd	ψi
1 Head	0.5705	2.4961	0.1220	1.1900	0.1900	0.0399
2 Hinge jamb	0.5718	2.5059	0.1220	1.1900	0.1900	0.0400
3 Locking jamb	0.5873	2.5550	0.1260	1.1900	0.1900	0.0393
4 Meeting stile	0.9717	2.6554	0.1650	1.1900	0.3800	0.0814
5 Cill	0.6866	4.4392	0.0950	1.1900	0.1900	0.0388

Overall width = 2.00 m

Overall height = 2.18 m

Overall area A_D = 4.36 m2

Frame area	Af	Uf	Af.Uf
1 Head	0.2289	2.4961	0.5713
2 Hinge jamb	0.2527	2.5059	0.6333
3 Locking jamb	0.2610	2.5550	0.6669
4 Meeting stile	0.3239	2.6554	0.8601
5 Cill	0.1782	4.4392	0.7912
Σaf=	1.2447	ΣAf.Uf=	3.5227

Frame width bf

1 Head	0.122
2 Hinge jamb	0.122
3 Locking jamb	0.126
4 Meeting stile	0.165
5 Cill	0.095

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	1.5870	0.0399	0.0633
2 Hinge jamb	1.9630	0.0400	0.0785
3 Locking jamb	1.9630	0.0393	0.0771
4 Meeting stile	1.9630	0.0814	0.1597
5 Cill	1.5870	0.0388	0.0615
Σlg=	9.0630	Σlg.ψg =	0.4401

	Ag	Ug	Ag.Ug
Glass	3.1153	1.1900	3.7072

$$U_D = \frac{\Sigma Af \times Uf + \Sigma Ag \times Ug + \Sigma lg \times \psi g}{Ag + Ap + Af}$$

$$U_D = \frac{3.5227 + 3.7072 + 0.4401}{4.36}$$

$$U_D = 1.759 \text{ W / m}^2\text{·K}$$

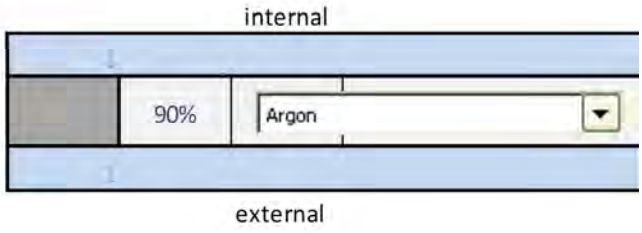
Reported Value **1.8** W / m^2·K (to 1 decimal place)

Results - SCE009 Dualframe 75mm Si Casement Window

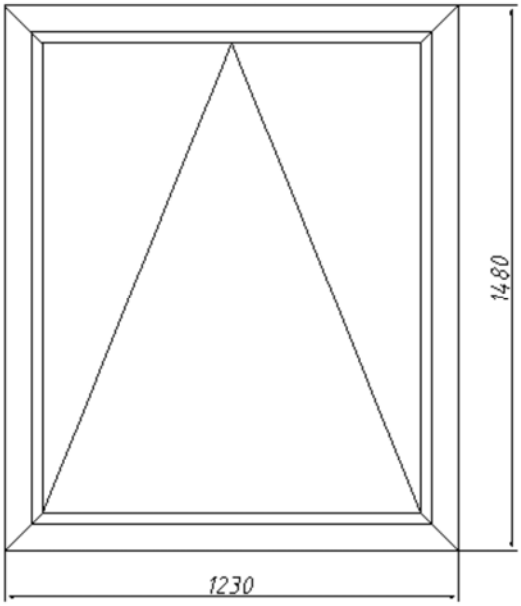
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	4	0.05	
air space 1 (s1) =	20		
external pane (d_j2) =	4	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.008		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.219		**0.64228**		**0.0311**



Results - SCE009 Dualframe 75mm Si Casement Window

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	**Carried out for :**	Sapa Building Systems
	U-value calculation for single light window	**Product :**	SCE009 Dualframe 75mm Si Casement
Reference:	TR096	**Model :**	Casement Top Hung
Standard issue:	BS EN ISO 10077-2:2012	**Glazing details :**	28mm (4-20-4 / 1.2 'U' Value) Swiss-V Spacer
Author:	Mark West		
Version:	1.1	**Calculation date :**	14th May 2013
Issue date:	24th January 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.4530	1.0309	0.1900	0.1230	2.0904
2 Left jamb	0.4530	1.0309	0.1900	0.1230	2.0904
3 Right jamb	0.4530	1.0309	0.1900	0.1230	2.0904
4 Cill	0.4998	1.0309	0.1900	0.1230	2.4709

U of insulating panel = 1.0309

Glass thickness = 0.028 m

Centre pane U-value Ug = 1.219

Section detail	L_ψ2d	Uf	bf	Ug	bd	ψi
1 Head	0.5253	2.0904	0.1230	1.2190	0.1900	0.0366
2 Left jamb	0.5253	2.0904	0.1230	1.2190	0.1900	0.0366
3 Right jamb	0.5253	2.0904	0.1230	1.2190	0.1900	0.0366
4 Cill	0.5696	2.4709	0.1230	1.2190	0.1900	0.0341

Overall width = 1.23 m

Overall height = 1.48 m

Overall area A_W = 1.8204 m2

Frame area	Af	Uf	Af.Uf
1 Head	0.1362	2.0904	0.2846
2 Left jamb	0.1669	2.0904	0.3489
3 Right jamb	0.1669	2.0904	0.3489
4 Cill	0.1362	2.4709	0.3364
Σaf=	0.6061	ΣAf.Uf=	1.3189

Frame width bf

1 Head	0.123	m
2 Left jamb	0.123	m
3 Right jamb	0.123	m
4 Cill	0.123	m

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	0.9840	0.0366	0.0360
2 Left jamb	1.2340	0.0366	0.0451
3 Right jamb	1.2340	0.0366	0.0451
4 Cill	0.9840	0.0341	0.0335
Σlg=	4.4360	Σlg.ψg =	0.1597

	Ag	Ug	Ag.Ug
Glass	1.2143	1.2190	1.4802

$$U_W = \frac{\Sigma\, Af \times Uf + \Sigma\, Ag \times Ug + \Sigma\, lg \times \psi g}{Ag + Ap + Af}$$

$$U_W = \frac{1.3189 + 1.4802 + 0.1597}{1.8204}$$

$$U_W = 1.625 \text{ W / m}^2\text{·K}$$

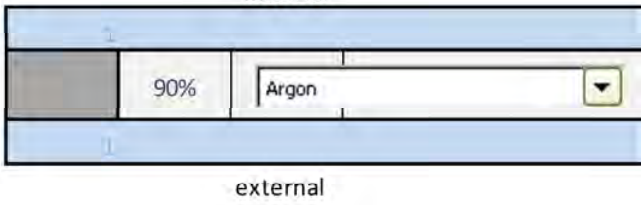
Reported Value **1.6** W / m^2·K (to 1 decimal place)

Results – SCE010 Dualframe 75mm Dualfold Door

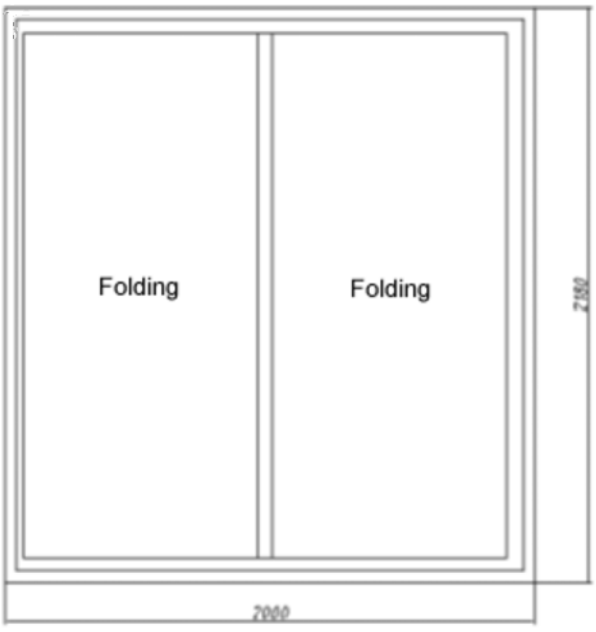
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	6	0.05	
air space 1 (s1) =	16		
external pane (d_j2) =	6	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.012		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.190		**0.65864**		**0.0243**



Results – SCE010 Dualframe 75mm Dualfold Door

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall U-value calculation for french doorset	**Carried out for :**	Sapa Building Systems
		Product :	SCE010 Dualframe 75mm Dualfold Door
Reference:	TR100	**Model :**	Dualfold Door Low Threshold Open Out/Glaze
Standard issue:	BS EN ISO 10077-2:2012	**Glazing details :**	28mm (6-16-6 / 1.2 'U' Value) Swiss-V Spacer
Author:	Mark West		
Version:	1.1	**Calculation date :**	7th May 2013
Issue date:	5th February 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.6656	1.0309	0.1900	0.1400	3.3552
2 Hinge jamb	0.5727	1.0309	0.1900	0.1220	3.0887
3 Locking jamb	0.6652	1.0309	0.1900	0.1590	2.9517
4 Meeting stile	0.8164	1.0309	0.3800	0.1580	2.6876
5 Cill	0.6489	1.0309	0.1900	0.0920	4.9242

U of insulating panel = 1.0309

Glass thickness = 0.028 m

Centre pane U-value Ug = 1.19

Section detail	L_ψ2d	Uf	bf	Ug	bd	ψi
1 Head	0.7323	3.3552	0.1400	1.1900	0.1900	0.0365
2 Hinge jamb	0.6412	3.0887	0.1220	1.1900	0.1900	0.0383
3 Locking jamb	0.7359	2.9517	0.1590	1.1900	0.1900	0.0405
4 Meeting stile	0.9569	2.6876	0.1580	1.1900	0.3800	0.0801
5 Cill	0.7145	4.9242	0.0920	1.1900	0.1900	0.0354

Overall width = 2.00 m

Overall height = 2.18 m

Overall area A_D = 4.36 m2

Frame area	Af	Uf	Af.Uf
1 Head	0.2603	3.3552	0.8735
2 Hinge jamb	0.2518	3.0887	0.7778
3 Locking jamb	0.3282	2.9517	0.9687
4 Meeting stile	0.3078	2.6876	0.8272
5 Cill	0.1711	4.9242	0.8424
Σaf=	1.3192	ΣAf.Uf=	4.2895

Frame width bf	
1 Head	0.14
2 Hinge jamb	0.122
3 Locking jamb	0.159
4 Meeting stile	0.158
5 Cill	0.092

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	1.5610	0.0365	0.0569
2 Hinge jamb	1.9480	0.0383	0.0746
3 Locking jamb	1.9480	0.0405	0.0788
4 Meeting stile	1.9480	0.0801	0.1559
5 Cill	1.5610	0.0354	0.0552
Σlg=	8.9660	Σlg.ψg =	0.4215

	Ag	Ug	Ag.Ug
Glass	3.0408	1.1900	3.6186

$$U_D = \frac{\Sigma Af \times Uf + \Sigma Ag \times Ug + \Sigma lg \times \psi g}{Ag + Ap + Af}$$

$$U_D = \frac{4.2895 + 3.6186 + 0.4215}{4.36}$$

$$U_D = 1.910 \ W / m^2 \cdot K$$

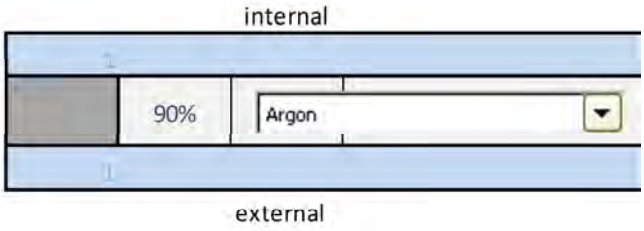
Reported Value **1.9** W / m^2·K (to 1 decimal place)

Results – SCE011 ST Commercial Door

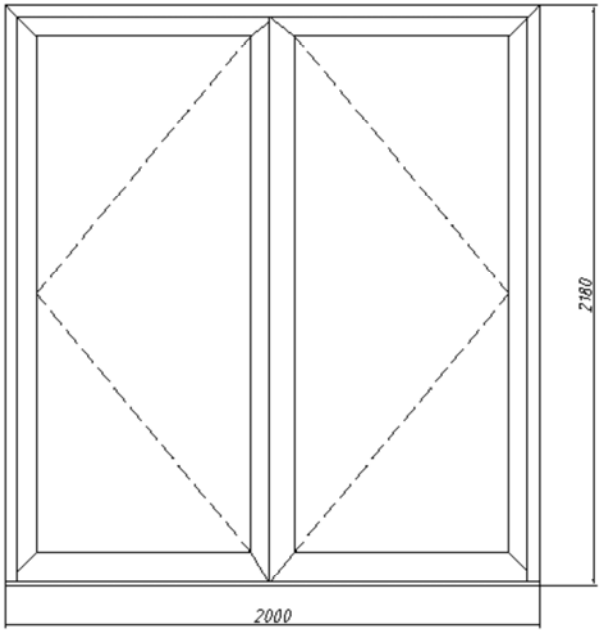
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	6	0.05	
air space 1 (s1) =	16		
external pane (d_j2) =	6	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.012		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.190		**0.65864**		**0.0243**



Results – SCE011 ST Commercial Door

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall U-value calculation for french doorset	**Carried out for :**	Sapa Building Systems
		Product :	SCE011 ST Commercial Door
Reference:	TR100	**Model :**	Double Door Low Threshold Open Out / Glaze
Standard issue:	BS EN ISO 10077-2:2012	**Glazing details :**	28mm (6-16-6 / 1.2 'U' Value) Swiss-V Spacer
Author:	Mark West		
Version:	1.1	**Calculation date :**	7th May 2013
Issue date:	5th February 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.7599	1.0309	0.1900	0.1430	3.9442
2 Left jamb	0.7873	1.0309	0.1900	0.1880	3.1459
3 Right jamb	0.7873	1.0309	0.1900	0.1880	3.1459
4 Meeting stile	1.1634	1.0309	0.3800	0.2730	2.8265
5 Cill	0.8531	1.0309	0.1900	0.1440	4.5641

U of insulating panel = 1.0309

Glass thickness = 0.028 m

Centre pane U-value Ug = 1.19

Section detail	L_ψ2d	Uf	bf	Ug	bd	ψi
1 Head	0.8258	3.9442	0.1430	1.1900	0.1900	0.0357
2 Left jamb	0.8555	3.1459	0.1880	1.1900	0.1900	0.0380
3 Right jamb	0.8555	3.1459	0.1880	1.1900	0.1900	0.0380
4 Meeting stile	1.3015	2.8265	0.2730	1.1900	0.3800	0.0777
5 Cill	0.9216	4.5641	0.1440	1.1900	0.1900	0.0383

Overall width = 2.00 m

Overall height = 2.18 m

Overall area A_D = 4.36 m2

Frame area	Af	Uf	Af.Uf
1 Head	0.2591	3.9442	1.0220
2 Left jamb	0.3829	3.1459	1.2044
3 Right jamb	0.3829	3.1459	1.2044
4 Meeting stile	0.5168	2.8265	1.4607
5 Cill	0.2609	4.5641	1.1909
Σaf=	1.8026	ΣAf.Uf=	6.0825

Frame width bf	
1 Head	0.143
2 Left jamb	0.188
3 Right jamb	0.188
4 Meeting stile	0.273
5 Cill	0.144

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	1.3510	0.0357	0.0482
2 Left jamb	1.8930	0.0380	0.0719
3 Right jamb	1.8930	0.0380	0.0719
4 Meeting stile	1.8930	0.0777	0.1470
5 Cill	1.3510	0.0383	0.0517
Σlg=	8.3810	Σlg.ψg =	0.3907

	Ag	Ug	Ag.Ug
Glass	2.5574	1.1900	3.0434

$$U_D = \frac{\Sigma Af \times Uf + \Sigma Ag \times Ug + \Sigma lg \times \psi g}{Ag + Ap + Af}$$

$$U_D = \frac{6.0825 + 3.0434 + 0.3907}{4.36}$$

$$U_D = 2.183 \text{ W / m}^2\text{·K}$$

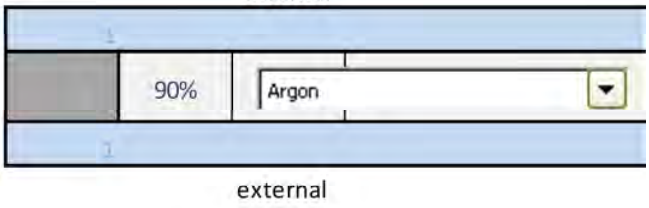
Reported Value **2.2** W / m^2·K (to 1 decimal place)

Results – SCE012 Powerframe 80 Door

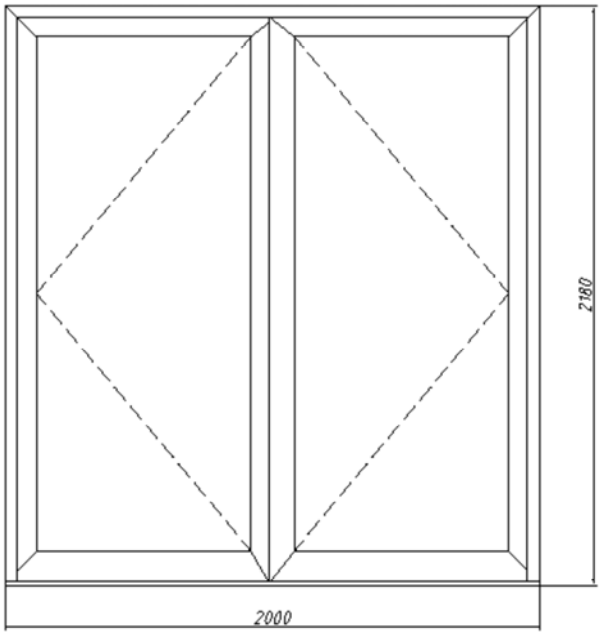
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	9.5	0.05	
air space 1 (s1) =	18		
external pane (d_j2) =	6	0.89	uncoated
Σ $d_j.r_j$ =	0.0155		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.197		**0.64997**		**0.0277**



Results – SCE012 Powerframe 80 Door

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	**Carried out for :**	Sapa Building Systems
	U-value calculation for french doorset	**Product :**	SCE012 Powerframe 80 Door
Reference:	TR100	**Model :**	Double Door Low Threshold Open Out / Glaze
Standard issue:	BS EN ISO 10077-2:2012	**Glazing details :**	33.5mm (6-18-9.5 / 1.2 'U' Value) Swiss-V Spa
Author:	Mark West		
Version:	1.1	**Calculation date :**	7th May 2013
Issue date:	5th February 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.8263	0.8872	0.1900	0.1960	3.3558
2 Left jamb	0.8263	0.8872	0.1900	0.1960	3.3558
3 Right jamb	0.8263	0.8872	0.1900	0.1960	3.3558
4 Meeting stile	1.2097	0.8872	0.3800	0.2830	3.0833
5 Cill	0.8836	0.8872	0.1900	0.1450	4.9313

U of insulating panel = 0.8872

Glass thickness = 0.0335 m

Centre pane U-value Ug = 1.197

Section detail	L_ψ2d	Uf	bf	Ug	bd	ψi
1 Head	0.9519	3.3558	0.1960	1.1970	0.1900	0.0667
2 Left jamb	0.9519	3.3558	0.1960	1.1970	0.1900	0.0667
3 Right jamb	0.9519	3.3558	0.1960	1.1970	0.1900	0.0667
4 Meeting stile	1.4671	3.0833	0.2830	1.1970	0.3800	0.1397
5 Cill	1.0229	4.9313	0.1450	1.1970	0.1900	0.0804

Overall width = 2.00 m

Overall height = 2.18 m

Overall area A_D = 4.36 m2

Frame area	Af	Uf	Af.Uf
1 Head	0.3536	3.3558	1.1865
2 Left jamb	0.3939	3.3558	1.3217
3 Right jamb	0.3939	3.3558	1.3217
4 Meeting stile	0.5204	3.0833	1.6046
5 Cill	0.2616	4.9313	1.2899
Σaf=	1.9233	ΣAf.Uf=	6.7245

	Frame width bf
1 Head	0.196
2 Left jamb	0.196
3 Right jamb	0.196
4 Meeting stile	0.283
5 Cill	0.145

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	1.3250	0.0667	0.0884
2 Left jamb	1.8390	0.0667	0.1227
3 Right jamb	1.8390	0.0667	0.1227
4 Meeting stile	1.8390	0.1397	0.2569
5 Cill	1.3250	0.0804	0.1066
Σlg=	8.1670	Σlg.ψg =	0.6973

	Ag	Ug	Ag.Ug
Glass	2.4367	1.1970	2.9167

$$U_D = \frac{\Sigma\, Af \times Uf + \Sigma\, Ag \times Ug + \Sigma\, lg \times \psi g}{Ag + Ap + Af}$$

$$U_D = \frac{6.7245 + 2.9167 + 0.6973}{4.36}$$

$$U_D = 2.371 \text{ W / m}^2\text{·K}$$

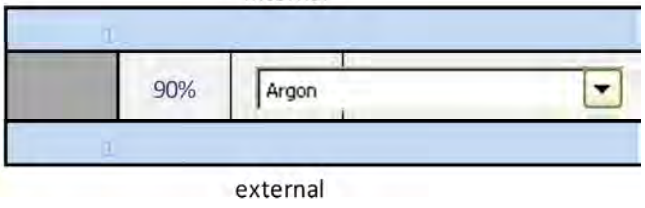
Reported Value **2.4** W / m^2·K (to 1 decimal place)

Results - SCE013 Powerframe TBT Window

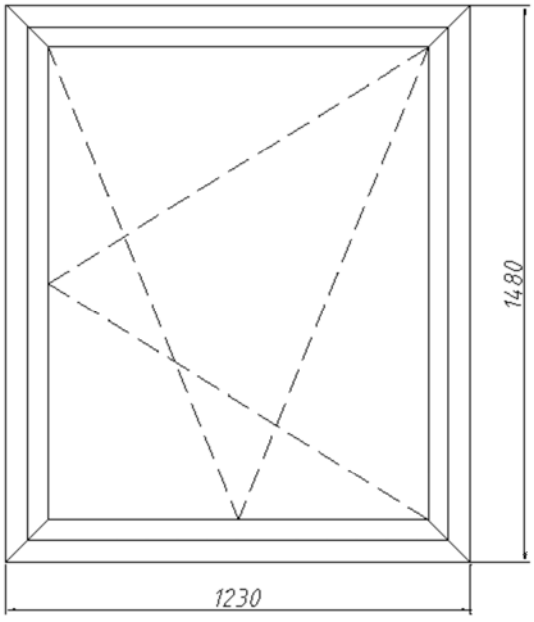
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	7.5	0.05	
air space 1 (s1) =	16		
external pane (d_j2) =	6	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.0135		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.188		**0.65864**		**0.0243**



Results - SCE013 Powerframe TBT Window

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	**Carried out for :**	Sapa Building Systems
	U-value calculation for single light window	**Product :**	SCE013 Powerframe TBT Window
Reference:	TR096	**Model :**	Tilt Before Turn
Standard issue:	BS EN ISO 10077-2:2012	**Glazing details :**	29.5mm (6-16-7.5 / 1.2 'U' Value) Swiss-V Spa
Author:	Mark West		
Version:	1.1	**Calculation date :**	7th May 2013
Issue date:	24th January 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.6550	0.9873	0.1900	0.1080	4.3279
2 Left jamb	0.5824	0.9873	0.1900	0.1080	3.6557
3 Right jamb	0.5824	0.9873	0.1900	0.1080	3.6557
4 Cill	0.5824	0.9873	0.1900	0.1080	3.6557

U of insulating panel = 0.9873

Glass thickness = 0.0295 m

Centre pane U-value Ug = 1.188

Section detail	Lψ2d	Uf	bf	Ug	bd	ψi
1 Head	0.7497	4.3279	0.1080	1.1880	0.1900	0.0566
2 Left jamb	0.6867	3.6557	0.1080	1.1880	0.1900	0.0662
3 Right jamb	0.6867	3.6557	0.1080	1.1880	0.1900	0.0662
4 Cill	0.6867	3.6557	0.1080	1.1880	0.1900	0.0662

Overall width = 1.23 m

Overall height = 1.48 m

Overall area A_W = 1.8204 m2

Frame area	Af	Uf	Af.Uf
1 Head	0.1212	4.3279	0.5244
2 Left jamb	0.1482	3.6557	0.5417
3 Right jamb	0.1482	3.6557	0.5417
4 Cill	0.1212	3.6557	0.4430
Σaf=	0.5387	ΣAf.Uf=	2.0508

Frame width bf

1 Head	0.108	m
2 Left jamb	0.108	m
3 Right jamb	0.108	m
4 Cill	0.108	m

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	1.0140	0.0566	0.0574
2 Left jamb	1.2640	0.0662	0.0836
3 Right jamb	1.2640	0.0662	0.0836
4 Cill	1.0140	0.0662	0.0671
Σlg=	4.5560	Σlg.ψg =	0.2917

	Ag	Ug	Ag.Ug
Glass	1.2817	1.1880	1.5227

$$U_W = \frac{\Sigma\, Af \times Uf + \Sigma\, Ag \times Ug + \Sigma\, lg \times \psi g}{Ag + Ap + Af}$$

$$U_W = \frac{2.0508 + 1.5227 + 0.2917}{1.8204}$$

$$U_W = 2.123 \text{ W / m}^2\text{·K}$$

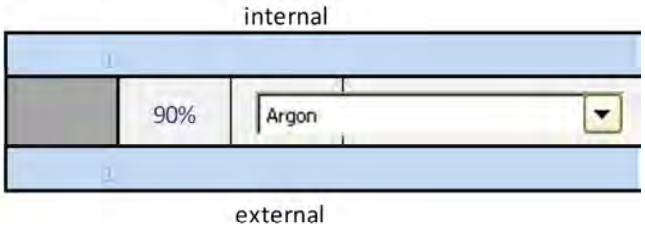
Reported Value **2.1** W / m^2·K (to 1 decimal place)

Results - SCE014 Powerframe Casement Window

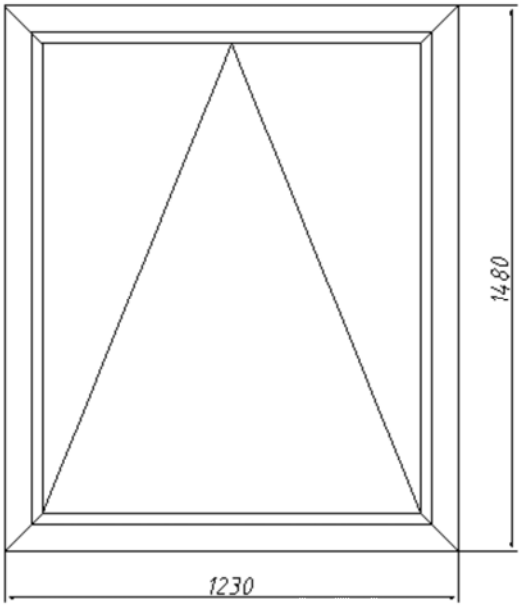
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	7.5	0.05	
air space 1 (s1) =	16		
external pane (d_j2) =	6	0.89	uncoated
$\Sigma\ d_j.r_i$ =	0.0135	0.89	



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.188		**0.65864**		**0.0243**



Results - SCE014 Powerframe Casement Window

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	**Carried out for :**	Sapa Building Systems
	U-value calculation for single light window	**Product :**	SCE014 Powerframe Casement Window
Reference:	TR096	**Model :**	Casement Top Hung
Standard issue:	BS EN ISO 10077-2:2012	**Glazing details :**	29.5mm (6-16-7.5 / 1.2 'U' Value) Swiss-V Spa
Author:	Mark West		
Version:	1.1	**Calculation date :**	7th May 2013
Issue date:	24th January 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.7466	0.9873	0.1900	0.1380	4.0508
2 Left jamb	0.7466	0.9873	0.1900	0.1380	4.0508
3 Right jamb	0.7466	0.9873	0.1900	0.1380	4.0508
4 Cill	0.7474	0.9873	0.1900	0.1380	4.0566

U of insulating panel = 0.9873

Glass thickness = 0.0295 m

Centre pane U-value Ug = 1.188

Section detail	L_ψ2d	Uf	bf	Ug	bd	ψi
1 Head	0.8488	4.0508	0.1380	1.1880	0.1900	0.0641
2 Left jamb	0.8488	4.0508	0.1380	1.1880	0.1900	0.0641
3 Right jamb	0.8488	4.0508	0.1380	1.1880	0.1900	0.0641
4 Cill	0.8509	4.0566	0.1380	1.1880	0.1900	0.0654

Overall width = 1.23 m

Overall height = 1.48 m

Overall area A_W = 1.8204 m2

Frame area	Af	Uf	Af.Uf
1 Head	0.1507	4.0508	0.6104
2 Left jamb	0.1852	4.0508	0.7502
3 Right jamb	0.1852	4.0508	0.7502
4 Cill	0.1507	4.0566	0.6113
	Σaf= 0.6718	ΣAf.Uf=	2.7221

Frame width bf

1 Head	0.138	m
2 Left jamb	0.138	m
3 Right jamb	0.138	m
4 Cill	0.138	m

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	0.9540	0.0641	0.0611
2 Left jamb	1.2040	0.0641	0.0771
3 Right jamb	1.2040	0.0641	0.0771
4 Cill	0.9540	0.0654	0.0624
	Σlg= 4.3160	Σlg.ψg =	0.2778

	Ag	Ug	Ag.Ug
Glass	1.1486	1.1880	1.3646

$$U_W = \frac{\Sigma\, Af \times Uf + \Sigma\, Ag \times Ug + \Sigma\, lg \times \psi g}{Ag + Ap + Af}$$

$$U_W = \frac{2.7221 + 1.3646 + 0.2778}{1.8204}$$

$$U_W = 2.398 \ W / m^2 \cdot K$$

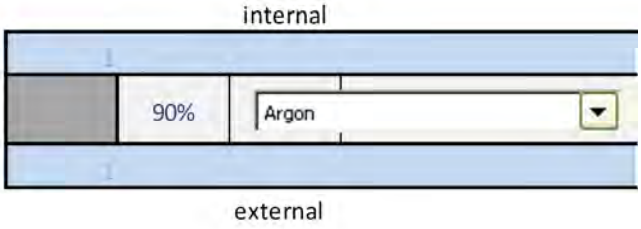
Reported Value **2.4** W / m^2·K (to 1 decimal place)

Results – SCE015 Dualslide Sliding Windows

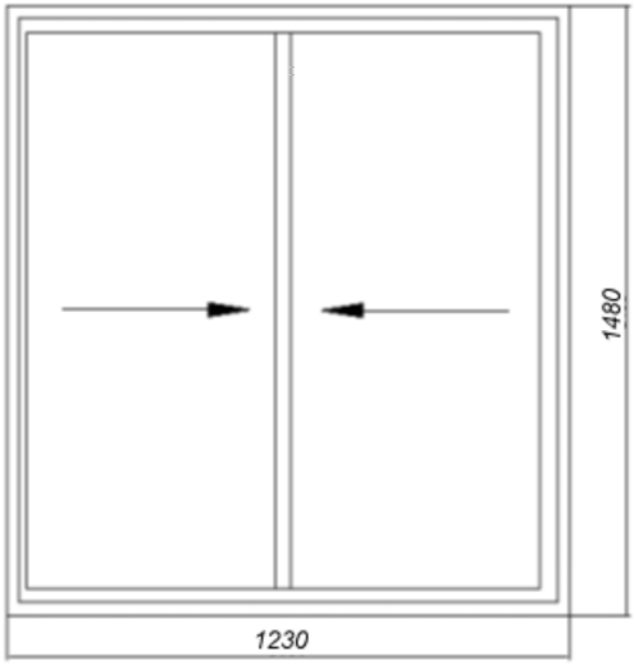
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	4	0.05	
air space 1 (s1) =	20		
external pane (d_j2) =	4	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.008		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.219		**0.64228**		**0.0311**



Results – SCE015 Dualslide Sliding Windows

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall U-value calculation for Sliding doorset	**Carried out for :**	Sapa Building Systems
		Product :	SCE015 Dualslide Sliding Window
Reference:	TR101	**Model :**	Horizontal Sliding Window
Standard issue:	BS EN ISO 10077-2:2012	**Glazing details :**	28mm (4-20-4 / 1.2 'U' Value) Swiss-V Spacer
Author:	Mark West		
Version:	1.1	**Calculation date :**	8th May 2013
Issue date:	7th February 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head Outer	0.4971	1.0309	0.1900	0.0870	3.4623
2 Head Inner	0.5026	1.0309	0.1900	0.0870	3.5256
3 Jamb Outer	0.5409	1.0309	0.1900	0.0970	3.5569
4 Jamb Inner	0.5203	1.0309	0.1900	0.0970	3.3446
5 Interlocks	0.6599	1.0309	0.3800	0.0500	5.3629
6 Sill Outer	0.4918	1.0309	0.1900	0.0860	3.4410
7 Sill Inner	0.4983	1.0309	0.1900	0.0860	3.5166

U of insulating panel = 1.030928

Glass thickness = 0.028 m

Centre pane U-value Ug = 1.219 W/m2K

Overall width = 1.23 m

Overall height = 1.48 m

Overall area A_D = 1.8204 m2

Section detail	L_ψ2d	Uf	bf	Ug	bd	ψi
1 Head Outer	0.5662	3.4623	0.0870	1.2190	0.1900	0.0334
2 Head Inner	0.5710	3.5256	0.0870	1.2190	0.1900	0.0327
3 Jamb Outer	0.6094	3.5569	0.0970	1.2190	0.1900	0.0328
4 Jamb Inner	0.5897	3.3446	0.0970	1.2190	0.1900	0.0337
5 Interlocks	0.8103	5.3629	0.0500	1.2190	0.3800	0.0789
6 Sill Outer	0.5609	3.4410	0.0860	1.2190	0.1900	0.0334
7 Sill Inner	0.5668	3.5166	0.0860	1.2190	0.1900	0.0328

Frame area	Af	Uf	Af.Uf
1 Head Outer	0.0535	3.4623	0.1853
2 Head Inner	0.0535	3.5256	0.1886
3 Jamb Outer	0.1268	3.5569	0.4509
4 Jamb Inner	0.1268	3.3446	0.4240
5 Interlocks	0.0654	5.3629	0.3505
6 Sill Outer	0.0529	3.4410	0.1820
7 Sill Inner	0.0529	3.5166	0.1860
total Σ Af	0.5317	ΣAf.Uf=	1.9673

	Frame width bf	
1 Head Outer	0.087	m
2 Head Inner	0.087	m
3 Jamb Outer	0.097	m
4 Jamb Inner	0.097	m
5 Interlocks	0.05	m
6 Sill Outer	0.086	m
7 Sill Inner	0.086	m

largest of the visible areas of both sides, to nearest mm

interlock offset to give equal glass size

Panel length	lg	ψg	lg.ψg
1 Head Outer	0.4930	0.0334	0.0164
2 Head Inner	0.4930	0.0327	0.0161
3 Jamb Outer	1.3070	0.0328	0.0428
4 Jamb Inner	1.3070	0.0337	0.0440
5 Interlocks	1.3070	0.0789	0.1032
6 Sill Outer	0.4930	0.0334	0.0164
7 Sill Inner	0.4930	0.0328	0.0162
Σlg=	5.8930	Σlg.ψg =	0.2551

	Ag	Ug	Ag.Ug
Glass	1.2887	1.2190	1.5709

$$U_D = \frac{\Sigma Af \times Uf + \Sigma Ag \times Ug + \Sigma lg \times \psi g}{Ag + Ap + Af}$$

$$U_D = \frac{1.9673 + 1.5709 + 0.2551}{1.8204}$$

$$U_D = 2.084 \ W / m^2 \cdot K$$

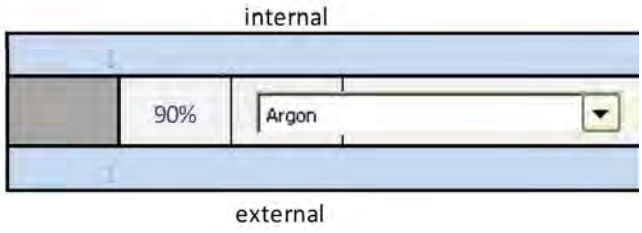
Reported Value **2.1** W / m^2·K (to 1 decimal place)

Results - SCE016 Dualframe 75mm Si Pivot Window

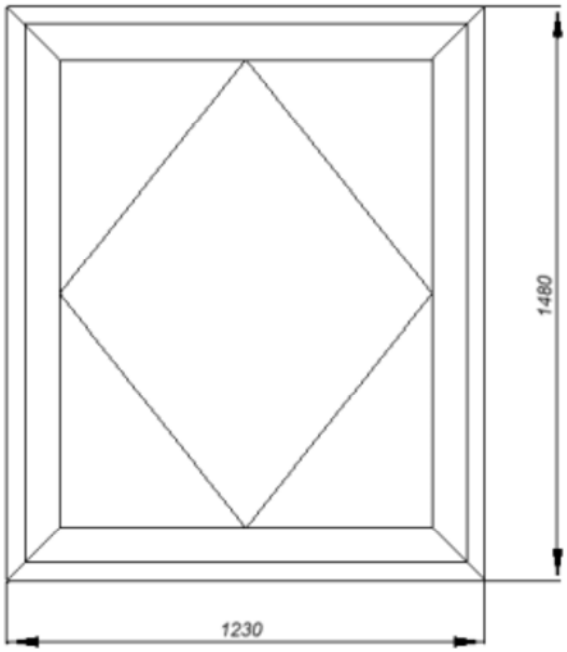
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	4	0.05	
air space 1 (s1) =	20		
external pane (d_j2) =	4	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.008		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.219		**0.64228**		**0.0311**



Results - SCE016 Dualframe 75mm Si Pivot Window

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	**Carried out for :**	Sapa Building Systems
	U-value calculation for single light window	**Product :**	SCE016 Dualframe 75mm Si Pivot Window
Reference:	TR096	**Model :**	Pivot Window
Standard issue:	BS EN ISO 10077-2:2012	**Glazing details :**	28mm (4-20-4 / 1.2 'U' Value) Swiss-V Spacer
Author:	Mark West		
Version:	1.1	**Calculation date :**	8th May 2013
Issue date:	24th January 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.4134	1.0309	0.1900	0.1350	1.6113
2 Left jamb	0.4134	1.0309	0.1900	0.1350	1.6113
3 Right jamb	0.4153	1.0309	0.1900	0.1350	1.6254
4 Cill	0.4153	1.0309	0.1900	0.1350	1.6254

U of insulating panel = 1.0309

Glass thickness = 0.028 m

Centre pane U-value Ug = 1.219

Section detail	L_ψ2d	Uf	bf	Ug	bd	ψi
1 Head	0.4893	1.6113	0.1350	1.2190	0.1900	0.0402
2 Left jamb	0.4893	1.6113	0.1350	1.2190	0.1900	0.0402
3 Right jamb	0.4904	1.6254	0.1350	1.2190	0.1900	0.0394
4 Cill	0.4904	1.6254	0.1350	1.2190	0.1900	0.0394

Overall width = 1.23 m

Overall height = 1.48 m

Overall area A_W = 1.8204 m2

Frame area	Af	Uf	Af.Uf
1 Head	0.1478	1.6113	0.2382
2 Left jamb	0.1816	1.6113	0.2926
3 Right jamb	0.1816	1.6254	0.2951
4 Cill	0.1478	1.6254	0.2403
Σaf=	0.6588	ΣAf.Uf=	1.0662

Frame width bf

1 Head	0.135	m
2 Left jamb	0.135	m
3 Right jamb	0.135	m
4 Cill	0.135	m

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	0.9600	0.0402	0.0386
2 Left jamb	1.2100	0.0402	0.0486
3 Right jamb	1.2100	0.0394	0.0476
4 Cill	0.9600	0.0394	0.0378
Σlg=	4.3400	Σlg.ψg =	0.1726

	Ag	Ug	Ag.Ug
Glass	1.1616	1.2190	1.4160

$$U_W = \frac{\Sigma\, Af \times Uf + \Sigma\, Ag \times Ug + \Sigma\, lg \times \psi g}{Ag + Ap + Af}$$

$$U_W = \frac{1.0662 + 1.4160 + 0.1726}{1.8204}$$

$$U_W = 1.458 \text{ W / m}^2\text{·K}$$

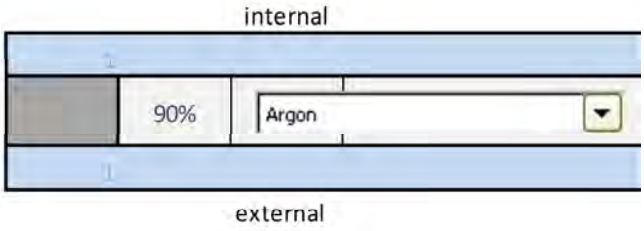
Reported Value **1.5** W / m^2·K (to 1 decimal place)

Results – SCE017 202 Commercial Door

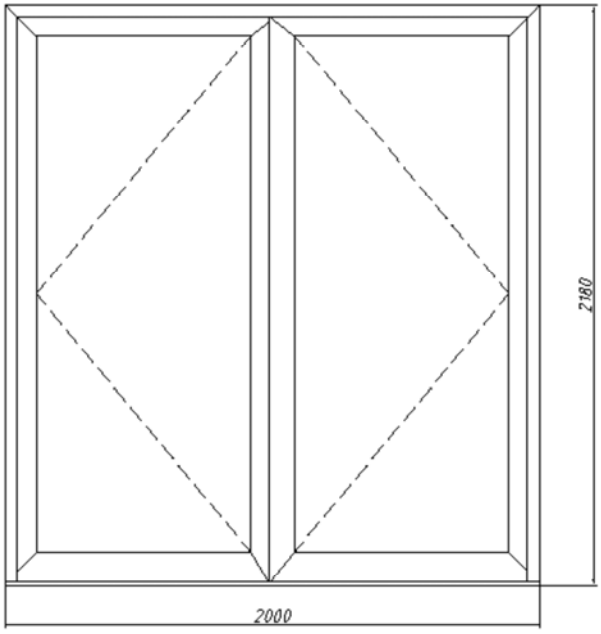
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	6	0.05	
air space 1 (s1) =	12		
external pane (d_j2) =	6	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.012		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.339		**0.56470**		**0.0213**



Results – SCE017 202 Commercial Door

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall U-value calculation for french doorset	**Carried out for :**	Sapa Building Systems
		Product :	SCE017 202 Commercial Door
Reference:	TR100	**Model :**	Double Door Low Threshold Open Out / Glaze
Standard issue:	BS EN ISO 10077-2:2012	**Glazing details :**	24mm (6-12-6 / 1.3 'U' Value) Swiss-V Spacer
Author:	Mark West		
Version:	1.1	**Calculation date :**	7th May 2013
Issue date:	5th February 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	1.5787	1.1686	0.1900	0.2220	6.1111
2 Left jamb	1.3524	1.1686	0.1900	0.1820	6.2108
3 Right jamb	1.3524	1.1686	0.1900	0.1820	6.2108
4 Meeting stile	2.0430	1.1686	0.3800	0.2690	5.9440
5 Cill	1.3187	1.1686	0.1900	0.1730	6.3391

U of insulating panel = 1.1686

Glass thickness = 0.024 m

Centre pane U-value Ug = 1.339

Section detail	L_ψ2d	Uf	bf	Ug	bd	ψi
1 Head	1.6579	6.1111	0.2220	1.3390	0.1900	0.0468
2 Left jamb	1.4316	6.2108	0.1820	1.3390	0.1900	0.0468
3 Right jamb	1.4316	6.2108	0.1820	1.3390	0.1900	0.0468
4 Meeting stile	2.2003	5.9440	0.2690	1.3390	0.3800	0.0926
5 Cill	1.3974	6.3391	0.1730	1.3390	0.1900	0.0463

Overall width = 2.00 m

Overall height = 2.18 m

Overall area A_D = 4.36 m2

Frame area	Af	Uf	Af.Uf
1 Head	0.4036	6.1111	2.4664
2 Left jamb	0.3608	6.2108	2.2409
3 Right jamb	0.3608	6.2108	2.2409
4 Meeting stile	0.4802	5.9440	2.8541
5 Cill	0.3145	6.3391	1.9937
Σaf=	1.9199	ΣAf.Uf=	11.7961

Frame width bf

1 Head	0.222
2 Left jamb	0.182
3 Right jamb	0.182
4 Meeting stile	0.269
5 Cill	0.173

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	1.3670	0.0468	0.0640
2 Left jamb	1.7850	0.0468	0.0836
3 Right jamb	1.7850	0.0468	0.0836
4 Meeting stile	1.7850	0.0926	0.1652
5 Cill	1.3670	0.0463	0.0633
Σlg=	8.0890	Σlg.ψg =	0.4597

	Ag	Ug	Ag.Ug
Glass	2.4401	1.3390	3.2673

$$U_D = \frac{\Sigma Af \times Uf + \Sigma Ag \times Ug + \Sigma lg \times \psi g}{Ag + Ap + Af}$$

$$U_D = \frac{11.7961 + 3.2673 + 0.4597}{4.36}$$

$$U_D = 3.560 \ W / m^2 \cdot K$$

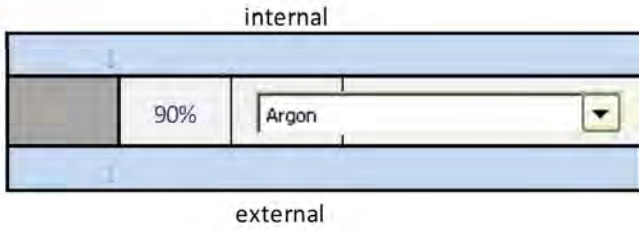
Reported Value **3.6** W / m^2·K (to 1 decimal place)

Results - SCE018 Dualframe 75mm Reversible Window

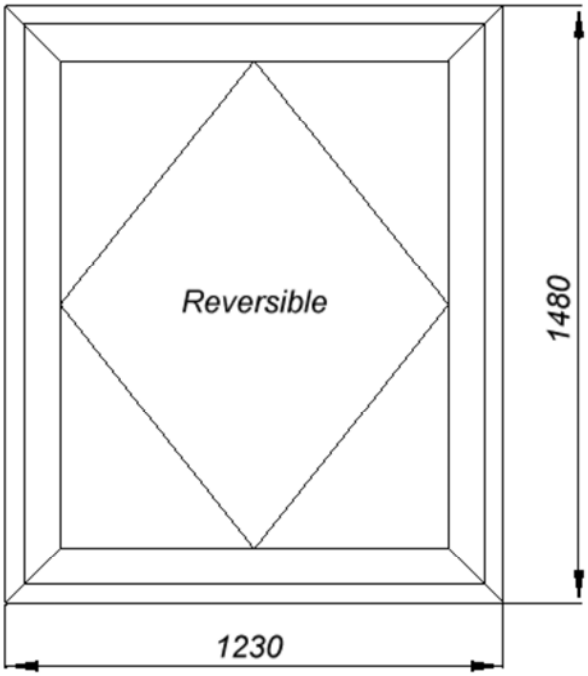
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	4	0.05	
air space 1 (s1) =	20		
external pane (d_j2) =	4	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.008		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.219		**0.64228**		**0.0311**



Results - SCE018 Dualframe 75mm Reversible Window

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	**Carried out for :**	Sapa Building Systems
	U-value calculation for single light window	**Product :**	SCE018 Dualframe 75mm Reversible Window
Reference:	TR096	**Model :**	Reversible Window
Standard issue:	BS EN ISO 10077-2:2012	**Glazing details :**	28mm (4-20-4 / 1.2 'U' Value) Swiss-V Spacer
Author:	Mark West		
Version:	1.1	**Calculation date :**	8th May 2013
Issue date:	24th January 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.4613	1.0309	0.1900	0.0870	3.0508
2 Left jamb	0.4489	1.0309	0.1900	0.0870	2.9083
3 Right jamb	0.4489	1.0309	0.1900	0.0870	2.9083
4 Cill	0.4535	1.0309	0.1900	0.0870	2.9612

U of insulating panel = 1.0309

Glass thickness = 0.028 m

Centre pane U-value Ug = 1.219

Section detail	L_ψ2d	Uf	bf	Ug	bd	ψi
1 Head	0.5305	3.0508	0.0870	1.2190	0.1900	0.0335
2 Left jamb	0.5185	2.9083	0.0870	1.2190	0.1900	0.0339
3 Right jamb	0.5185	2.9083	0.0870	1.2190	0.1900	0.0339
4 Cill	0.5234	2.9612	0.0870	1.2190	0.1900	0.0342

Overall width = 1.23 m

Overall height = 1.48 m

Overall area A_W = 1.8204 m2

Frame area	Af	Uf	Af.Uf
1 Head	0.0994	3.0508	0.3034
2 Left jamb	0.1212	2.9083	0.3525
3 Right jamb	0.1212	2.9083	0.3525
4 Cill	0.0994	2.9612	0.2945
∑af=	0.4413	∑Af.Uf=	1.3028

Frame width bf

1 Head	0.087	m
2 Left jamb	0.087	m
3 Right jamb	0.087	m
4 Cill	0.087	m

largest of the visible areas of both sides, to nearest mm

Panel length	lg	ψg	lg.ψg
1 Head	1.0560	0.0335	0.0353
2 Left jamb	1.3060	0.0339	0.0442
3 Right jamb	1.3060	0.0339	0.0442
4 Cill	1.0560	0.0342	0.0361
∑lg=	4.7240	∑lg.ψg =	0.1599

	Ag	Ug	Ag.Ug
Glass	1.3791	1.2190	1.6812

$$U_W = \frac{\sum Af \times Uf + \sum Ag \times Ug + \sum lg \times \psi g}{Ag + Ap + Af}$$

$$U_W = \frac{1.3028 + 1.6812 + 0.1599}{1.8204}$$

$$U_W = 1.727 \ W / m^2 \cdot K$$

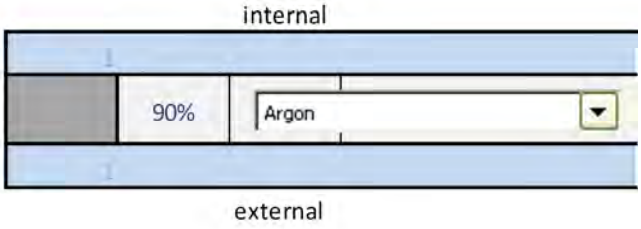
Reported Value **1.7** W / m^2·K (to 1 decimal place)

Results – SCE019 Dualslide Sliding Windows

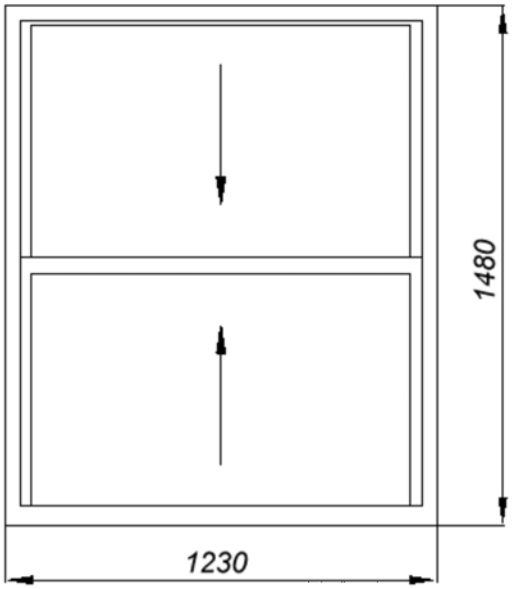
U_g-values created by calculation in accordance with BS EN 673:2011

Title:	**Exova Warringtonfire Willenhall**
	BS EN 673 Thermal transmittance of glazing spreadsheet
Reference :	**TR099**
Standard issue:	**BS EN 673:2011**
Author:	**Mark West**
Version:	**1.1**
Issue date:	**24th January 2013**

	thickness (mm)	ε normal	
internal pane (d_j1) =	4	0.05	
air space 1 (s1) =	20		
external pane (d_j2) =	4	0.89	uncoated
$\Sigma\ d_j.r_j$ =	0.008		



Ug W/(m².K)		Σ1/hs (m².K)/W		λ eff W/(m.K)
1.219		**0.64228**		**0.0311**



Results – SCE019 Dualslide Sliding Windows

L_f^{2d} and L_ψ^{2d} values created by simulation in accordance with BS EN ISO 10077-2

Title:	Exova Warringtonfire Willenhall	**Carried out for :**	Sapa Building Systems
	U-value calculation for Sliding doorset	**Product :**	SCE019 Dualslide Sliding Windows
Reference:	TR101	**Model :**	Vertical Sliding Window
Standard issue:	BS EN ISO 10077-2:2012	**Glazing details :**	28mm (4-20-4 / 1.2 'U' Value) Swiss-V Spacer
Author:	Mark West		
Version:	1.1	**Calculation date :**	8th May 2013
Issue date:	7th February 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Jamb Outer RH	0.4485	1.0309	0.1900	0.0750	3.3683
2 Jamb Inner RH	0.4526	1.0309	0.1900	0.0750	3.4230
3 Head	0.4095	1.0309	0.1900	0.0570	3.7478
4 Sill	0.3863	1.0309	0.1900	0.0540	3.5264
5 Interlocks	0.6594	1.0309	0.3800	0.0500	5.3529
6 Jamb Outer LH	0.4485	1.0309	0.1900	0.0750	3.3683
7 Jamb Inner LH	0.4526	1.0309	0.1900	0.0750	3.4230

U of insulating panel = 1.030928

Glass thickness = 0.028 m

Centre pane U-value Ug = 1.219 W/m2K

Overall height = 1.48 m

Overall width = 1.23 m

Overall area A_D = 1.8204 m2

Section detail	L_ψ2d	Uf	bf	Ug	bd	ψi
1 Jamb Outer RH	0.5177	3.3683	0.0750	1.2190	0.1900	0.0335
2 Jamb Inner RH	0.5212	3.4230	0.0750	1.2190	0.1900	0.0329
3 Head	0.4814	3.7478	0.0570	1.2190	0.1900	0.0362
4 Sill	0.4561	3.5264	0.0540	1.2190	0.1900	0.0341
5 Interlocks	0.8097	5.3529	0.0500	1.2190	0.3800	0.0788
6 Jamb Outer LH	0.5177	3.3683	0.0750	1.2190	0.1900	0.0335
7 Jamb Inner LH	0.5212	3.4230	0.0750	1.2190	0.1900	0.0329

Frame area	Af	Uf	Af.Uf
1 Jamb Outer RH	0.0556	3.3683	0.1873
2 Jamb Inner RH	0.0554	3.4230	0.1896
3 Head	0.0616	3.7478	0.2307
4 Sill	0.0583	3.5264	0.2057
5 Interlocks	0.0540	5.3529	0.2891
6 Jamb Outer LH	0.0556	3.3683	0.1873
7 Jamb Inner LH	0.0554	3.4230	0.1896
total Σ Af	0.3959	ΣAf.Uf=	1.4793

	Frame width bf	
1 Jamb Outer RH	0.075	m
2 Jamb Inner RH	0.075	m
3 Head	0.057	m
4 Sill	0.054	m
5 Interlocks	0.05	m
6 Jamb Outer LH	0.075	m
7 Jamb Inner LH	0.075	m

largest of the visible areas of both sides, to nearest mm

interlock offset to give equal glass size

Panel length	lg	ψg	lg.ψg
1 Jamb Outer RH	0.6595	0.0335	0.0221
2 Jamb Inner RH	0.6595	0.0329	0.0217
3 Head	1.0800	0.0362	0.0391
4 Sill	1.0800	0.0341	0.0368
5 Interlocks	1.0800	0.0788	0.0851
6 Jamb Outer LH	0.6595	0.0335	0.0221
7 Jamb Inner LH	0.6595	0.0329	0.0217
Σlg=	5.8780	Σlg.ψg =	0.2485

	Ag	Ug	Ag.Ug
Glass	1.4245	1.2190	1.7365

$$U_D = \frac{\Sigma Af \times Uf + \Sigma Ag \times Ug + \Sigma lg \times \psi g}{Ag + Ap + Af}$$

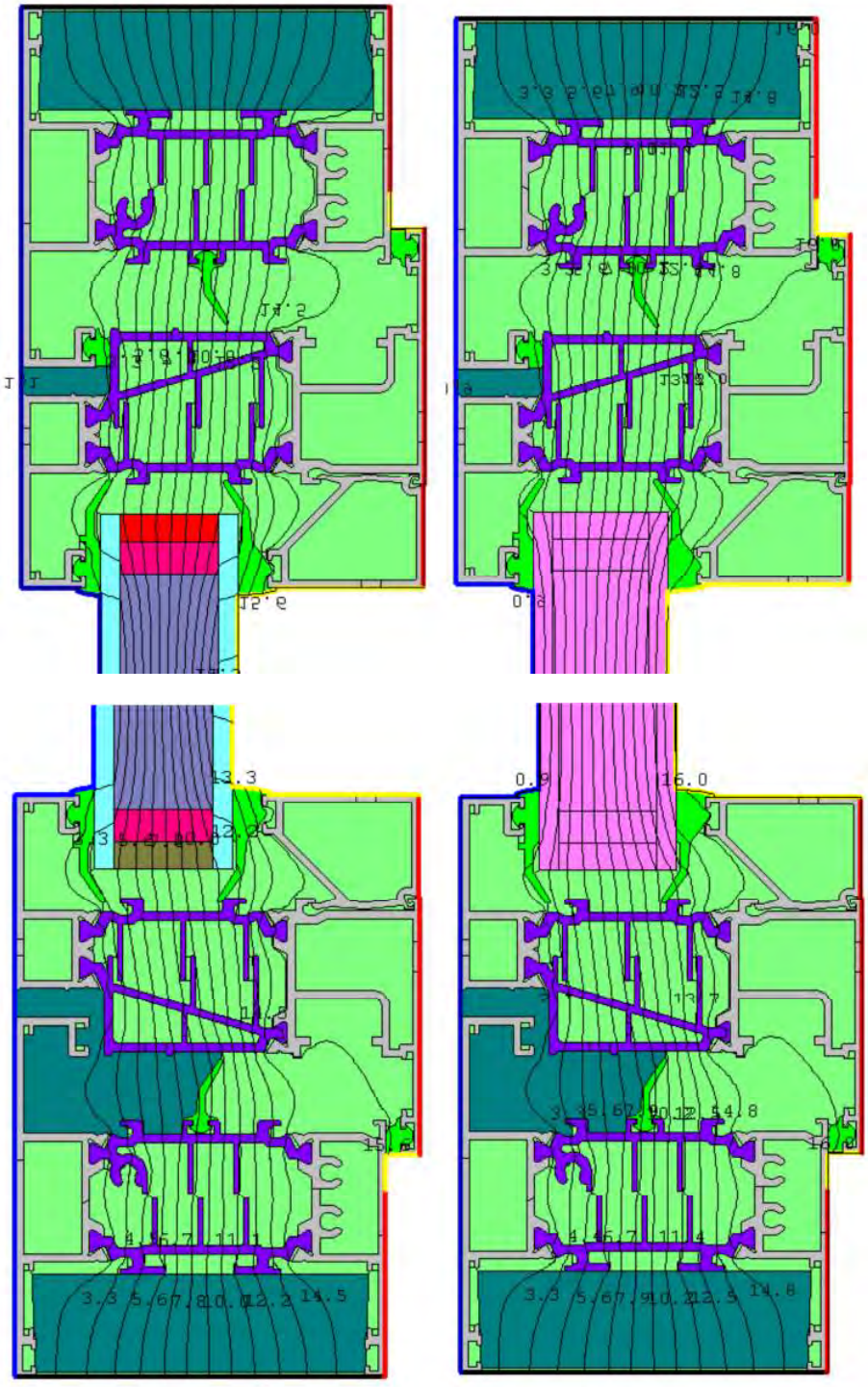
$$U_D = \frac{1.4793 + 1.7365 + 0.2485}{1.8204}$$

$$U_D = 1.903 \ W / m^2 \cdot K$$

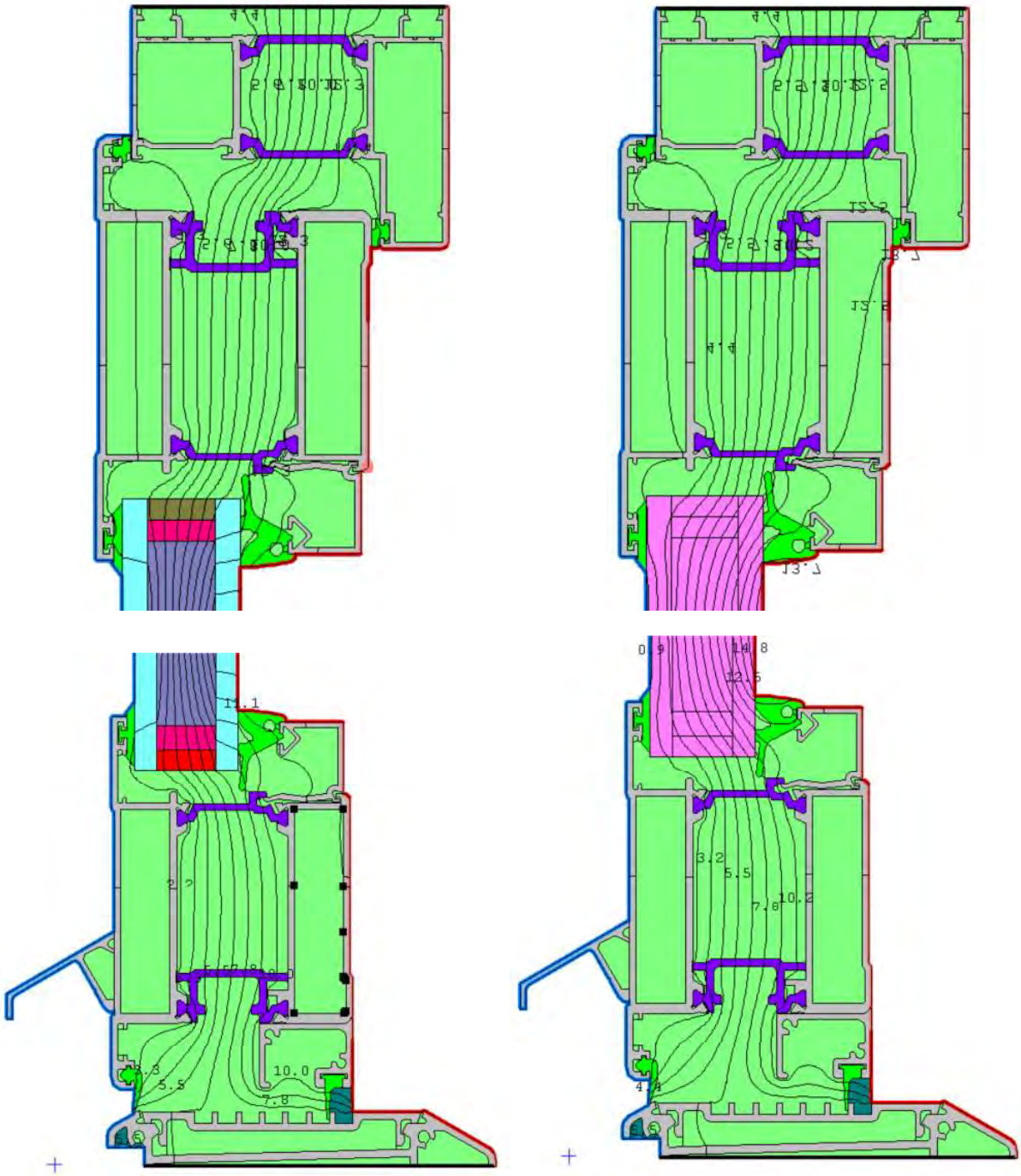
Reported Value **1.9** W / m^2·K (to 1 decimal place)

ANNEX C: THERM MODELS

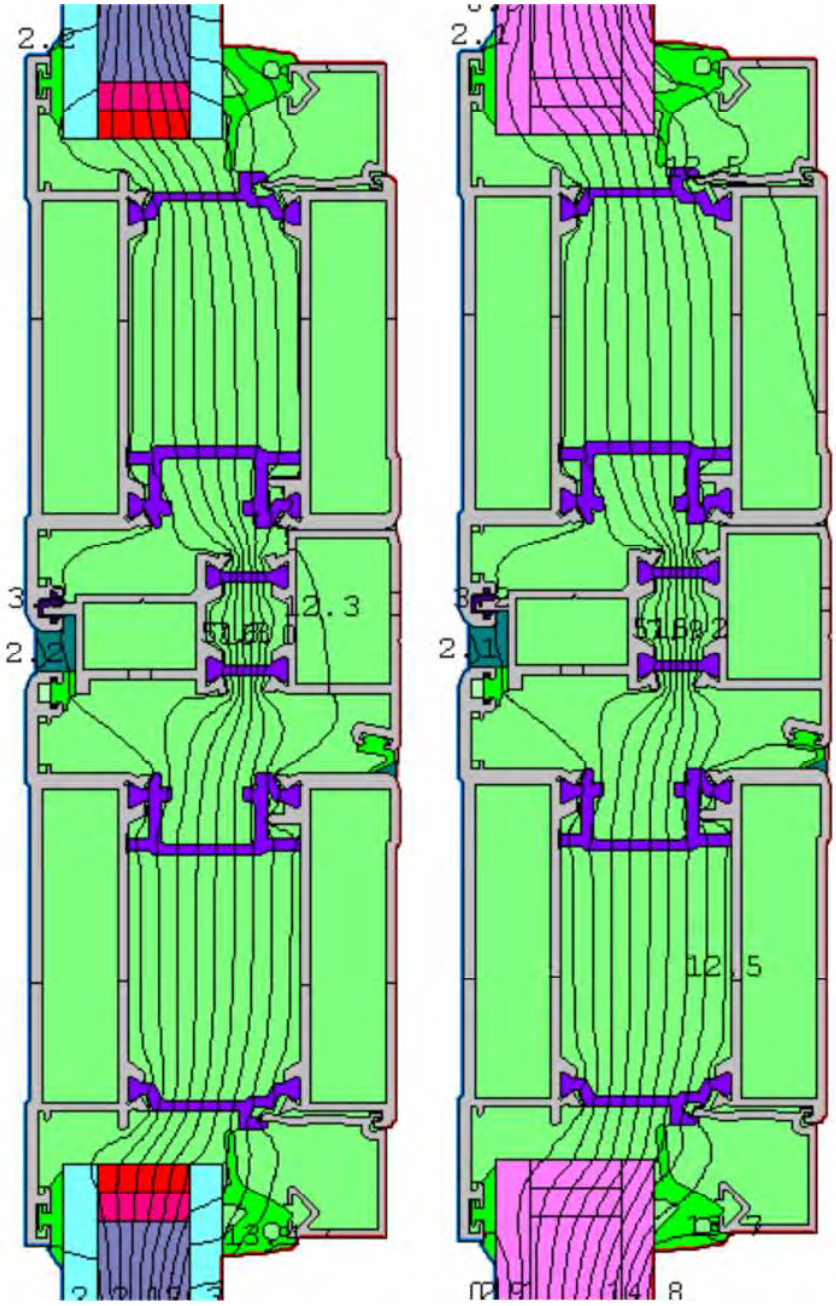
Jamb/cill & head models - SCE002 Dualframe 75mm Si TBT Window



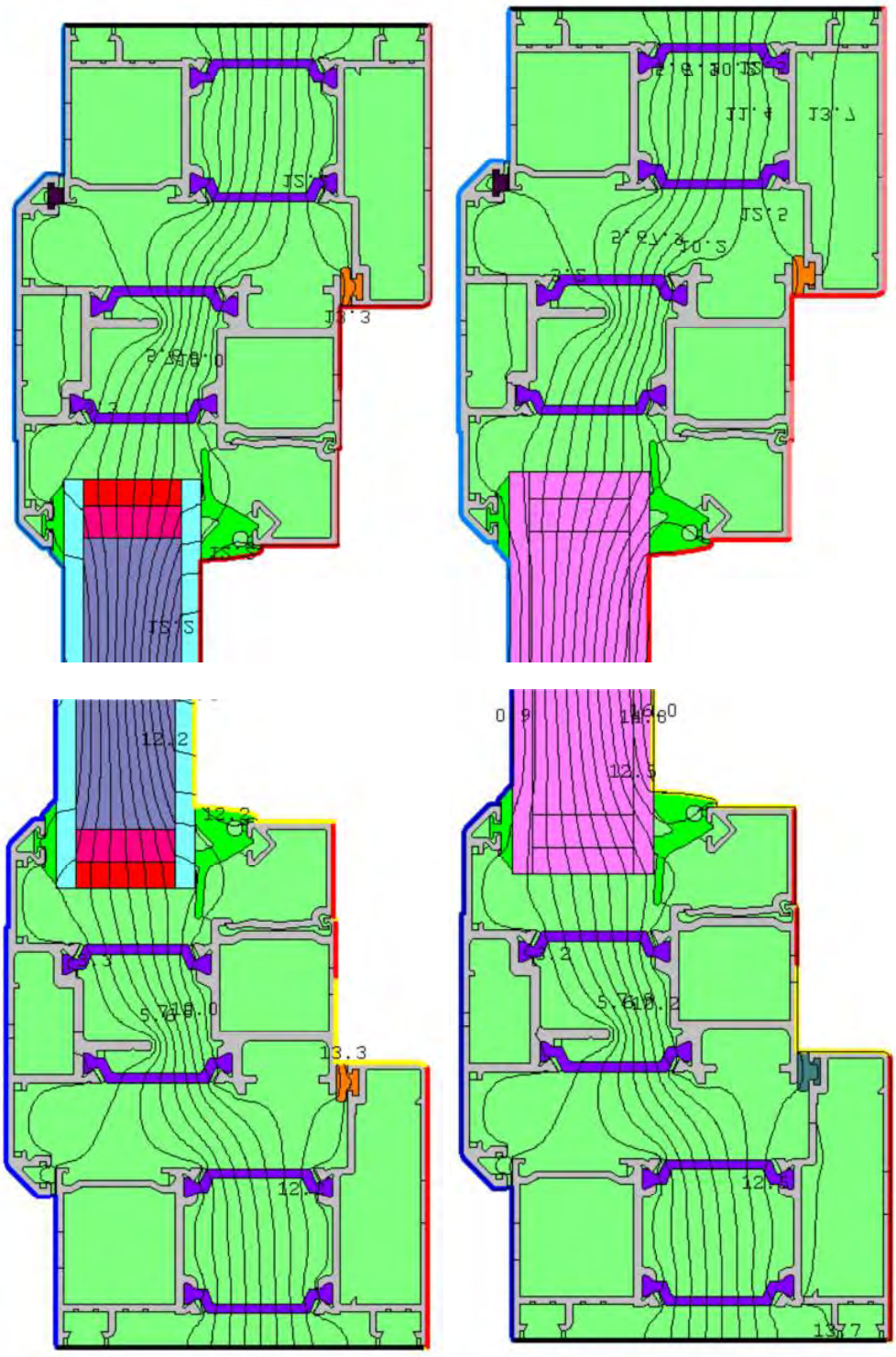
Jamb/head & cill models - SCE003 Dualsecure 75mm Entrance Door



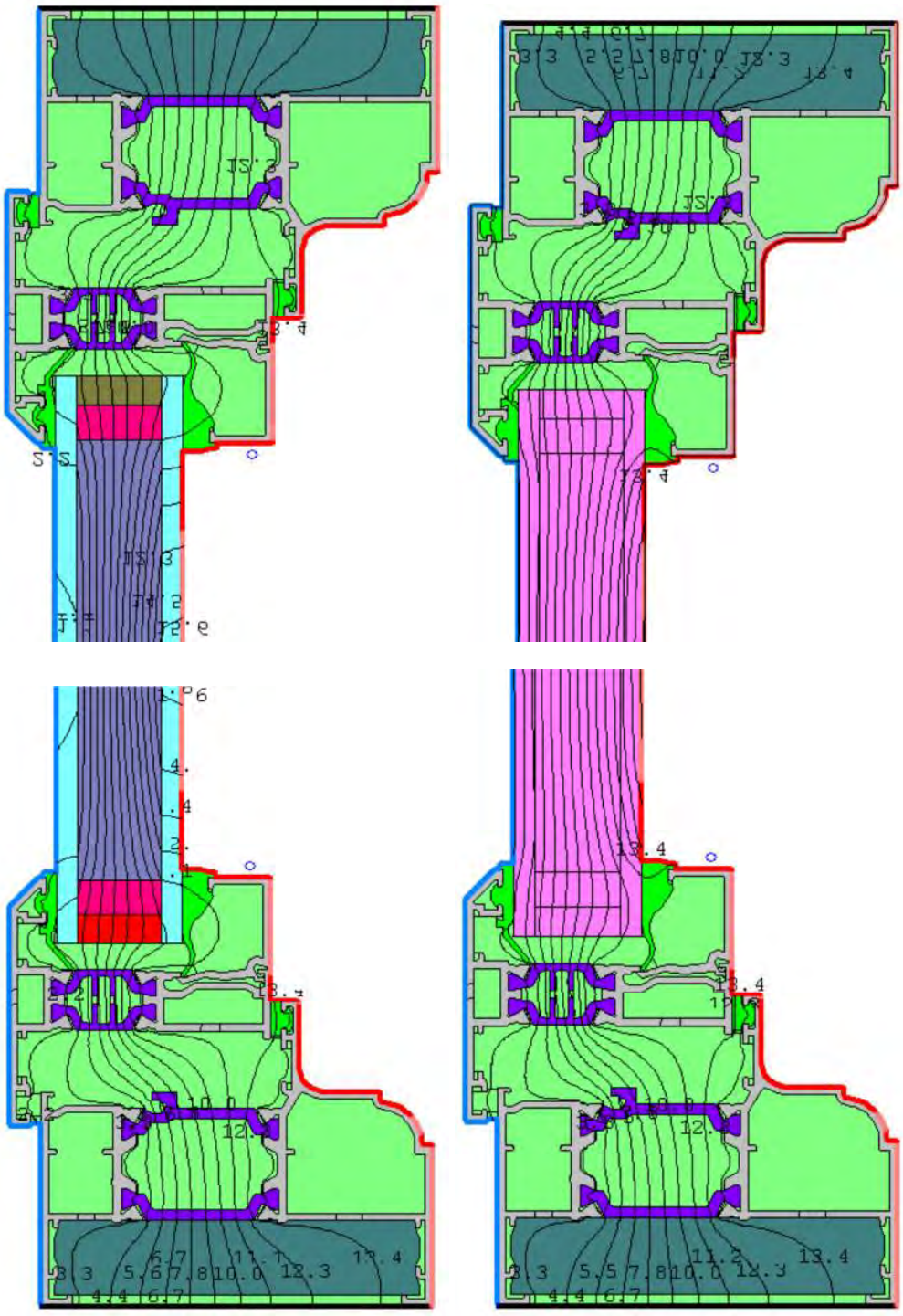
Meeting stile models - SCE003 Dualsecure 75mm Entrance Door


2.1
3
2.1
12.3
2.1
3
2.1
12.5

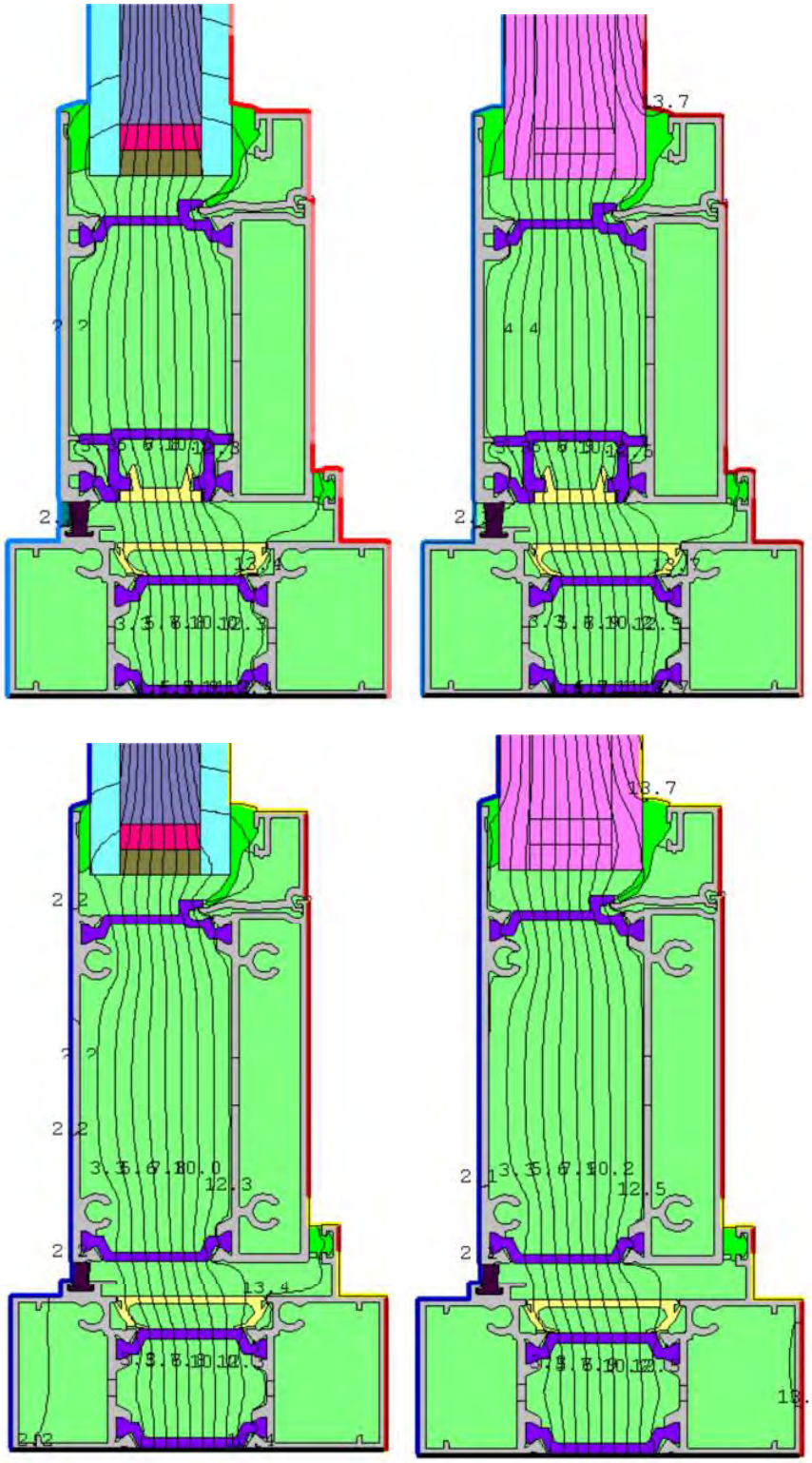
Jamb/head & cill models - SCE004 Dualframe 75mm Casement Window



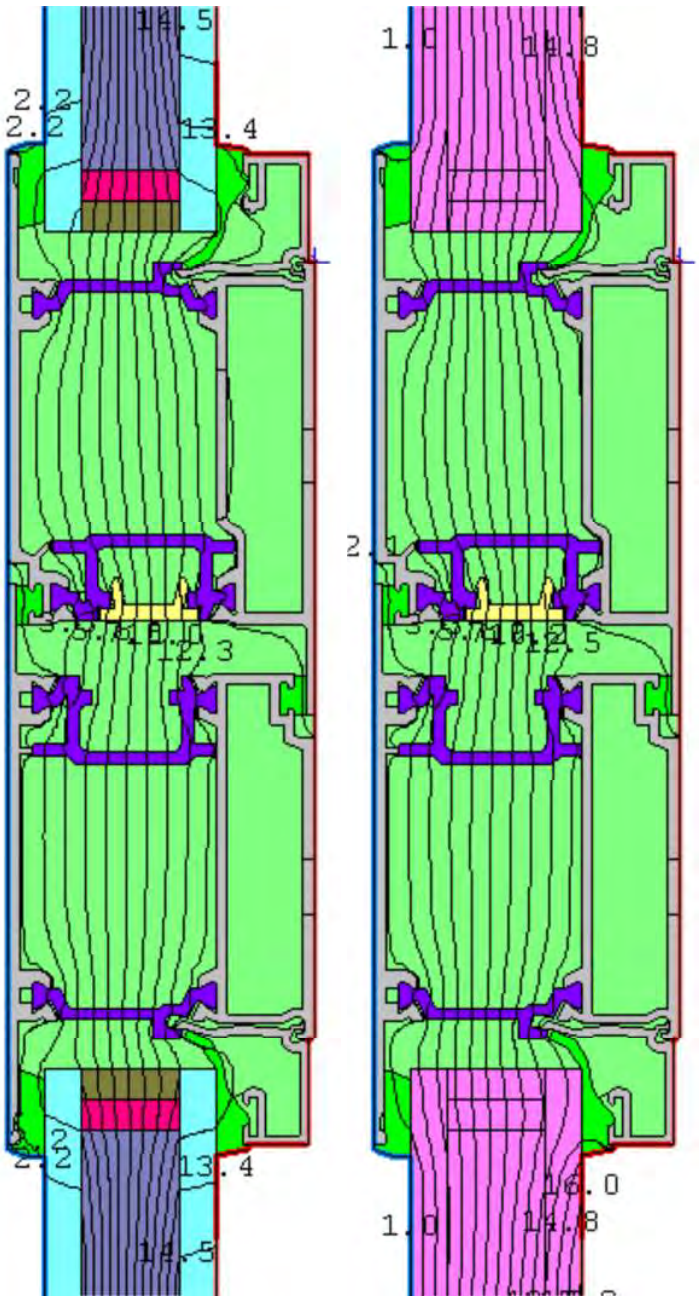
Jamb/head & cill models - SCE005 Crown 75mm Casement Window



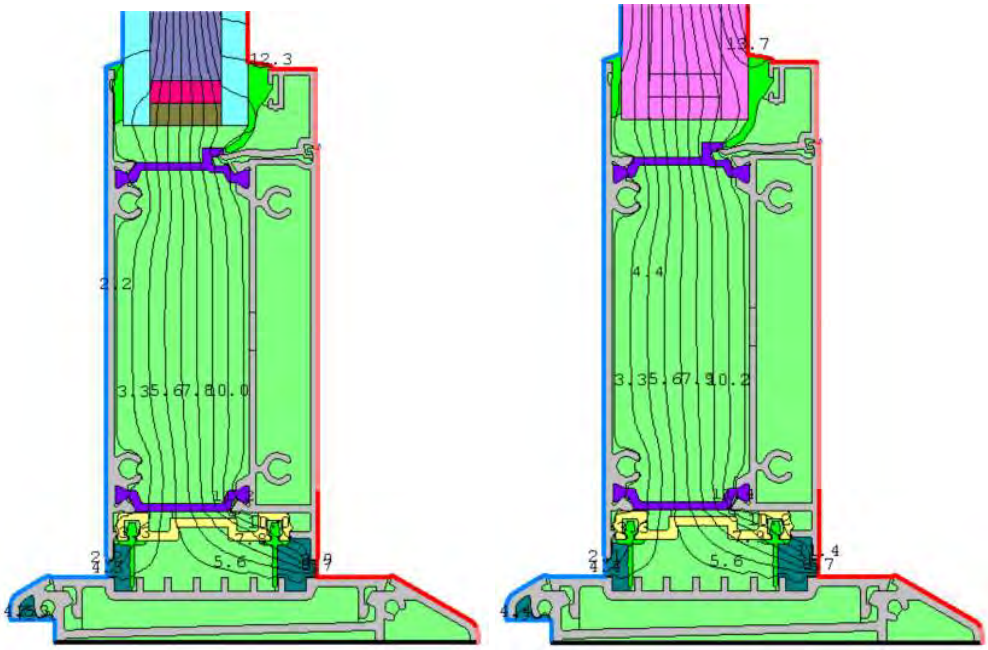
Jamb & head models - SCE006 Crown 75mm Entrance Door



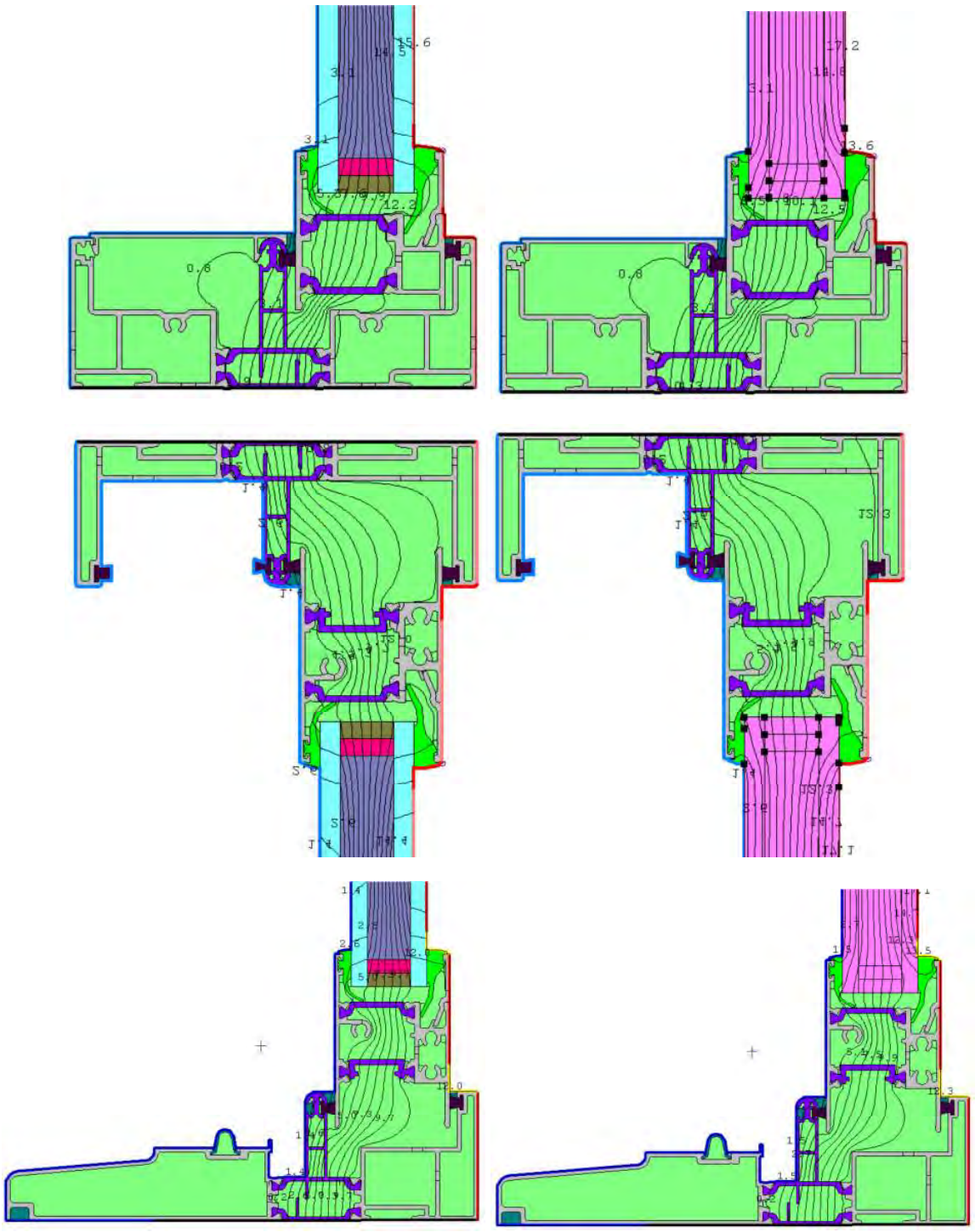
Meeting stile models - SCE006 Crown 75mm Entrance Door



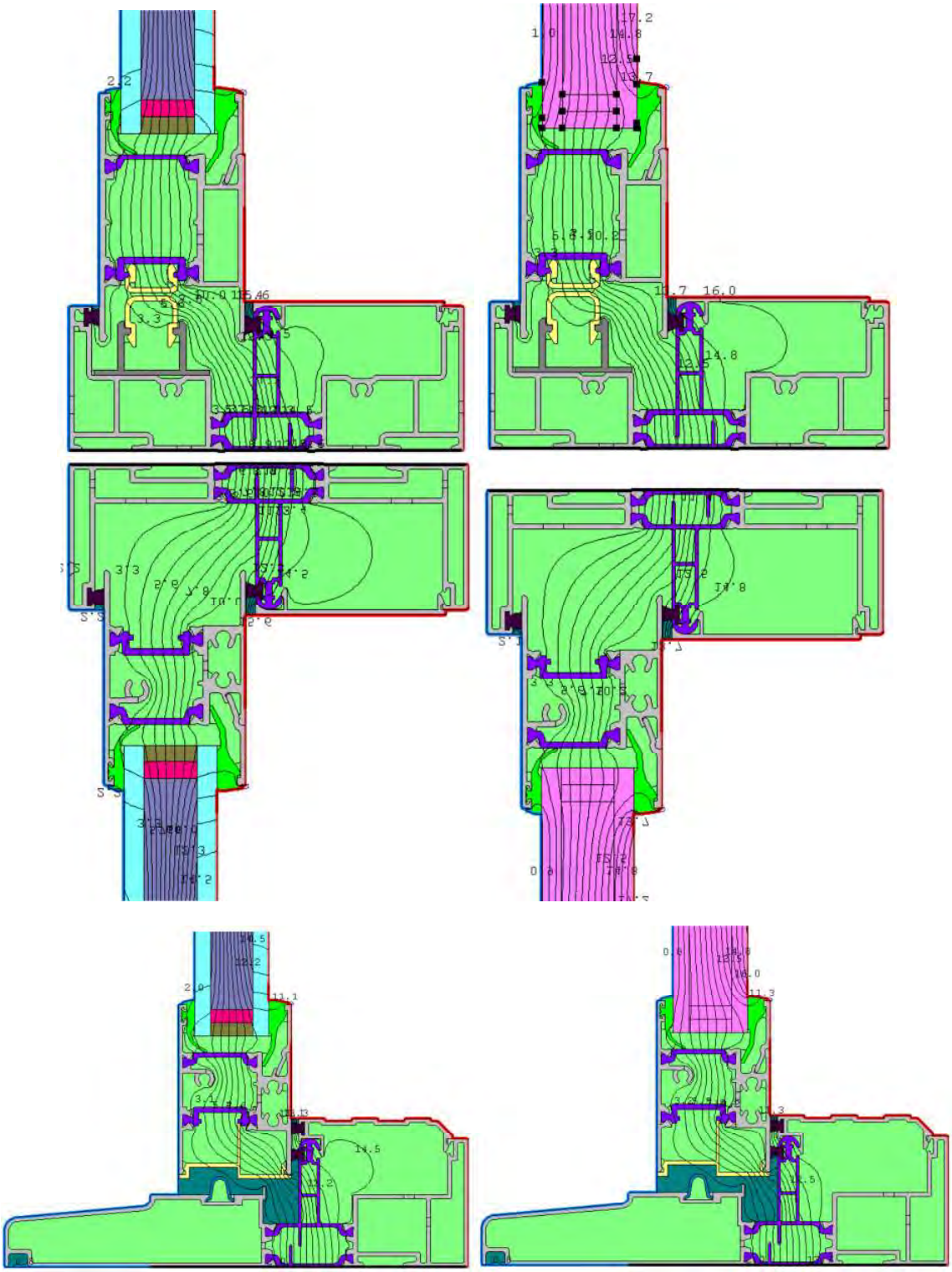
Cill models - SCE006 Crown 75mm Entrance Door



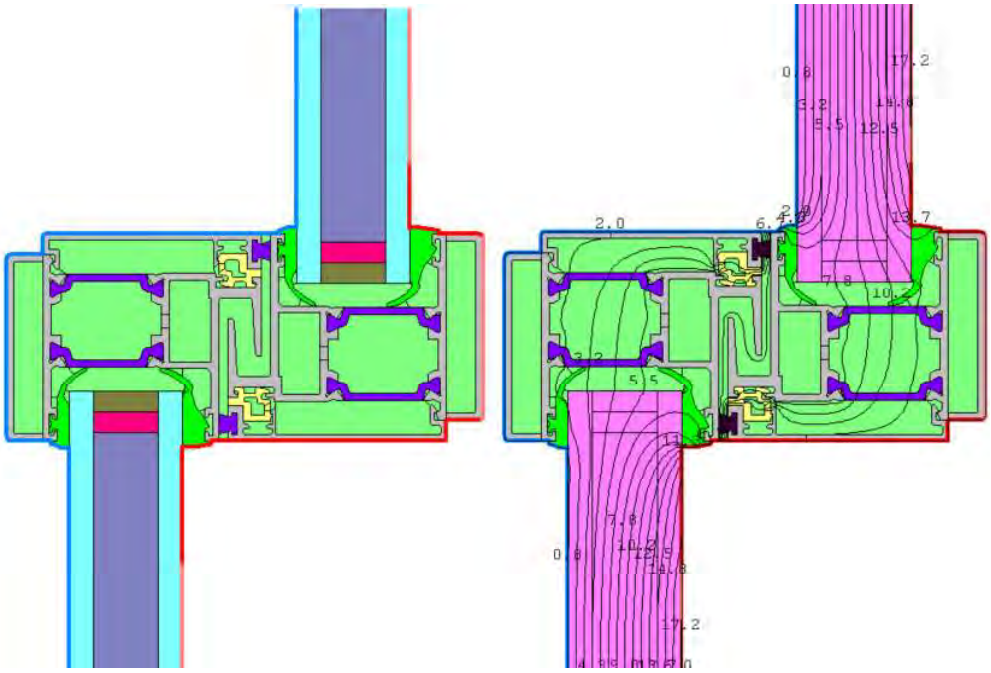
Fixed jamb, fixed head & fixed cill models - SCE007 Crown 120mm Patio Door



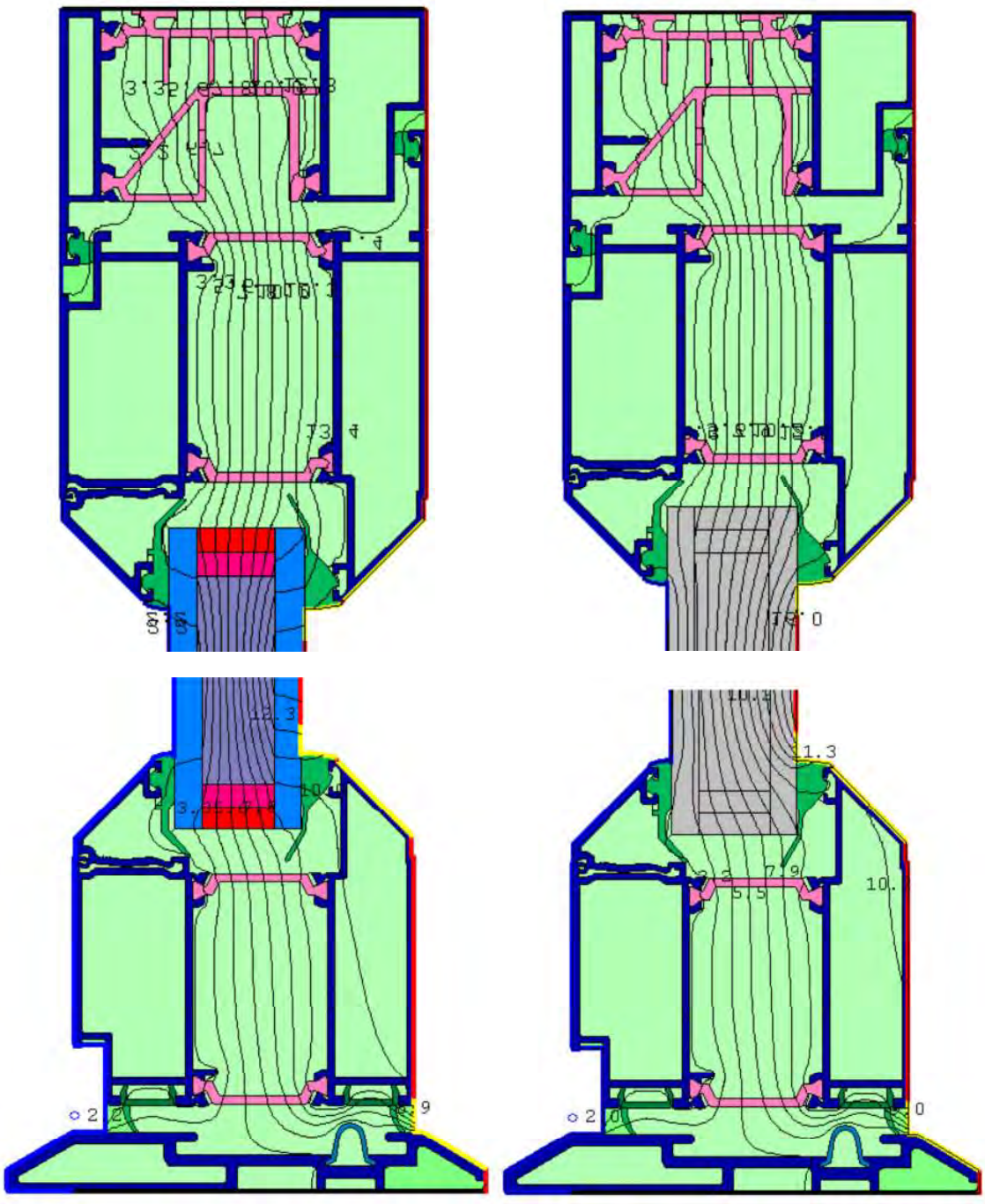
Locking jamb, sliding head & sliding cill models - SCE007 Crown 120mm Patio Door



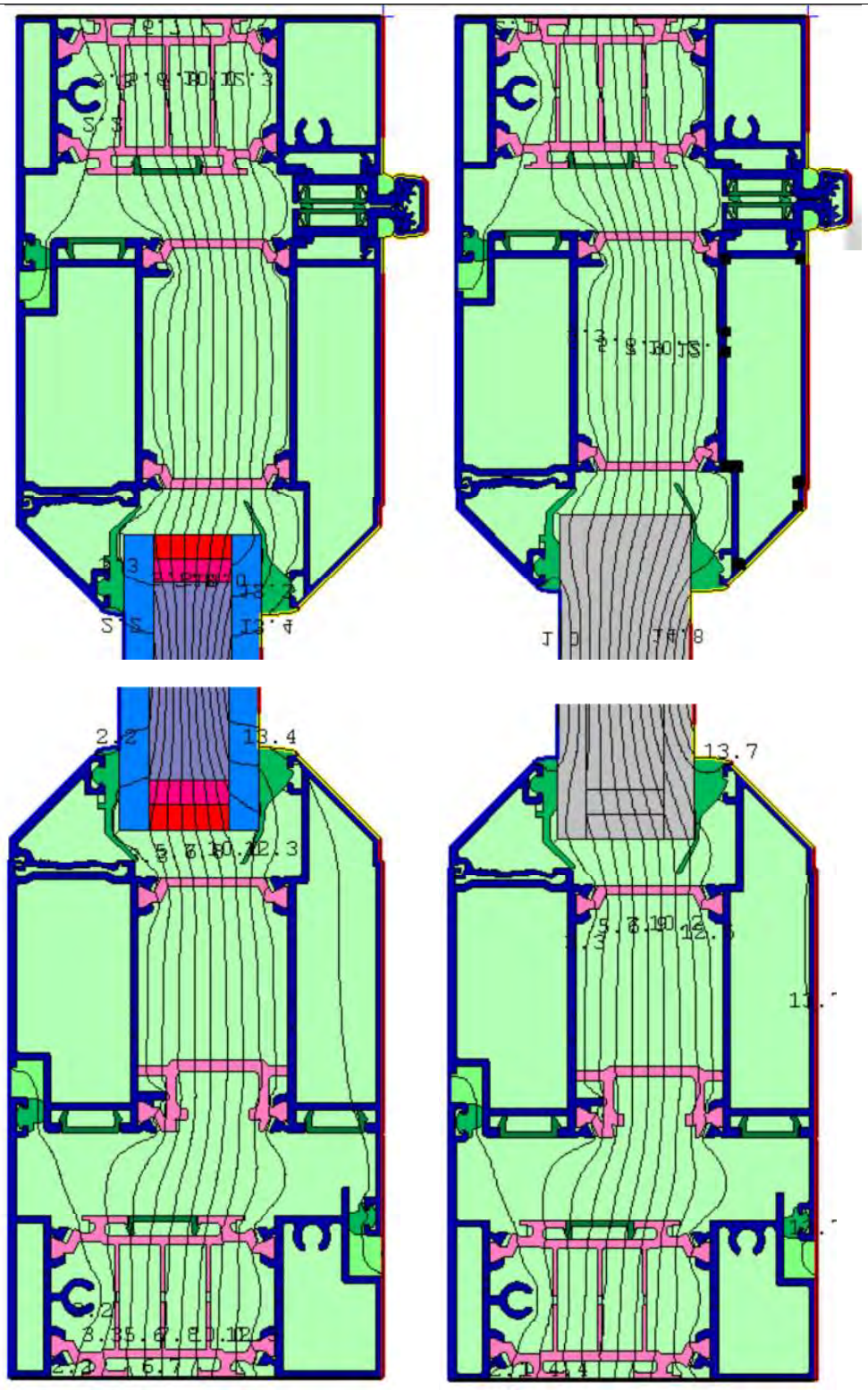
Interlock models - SCE007 Crown 120mm Patio Door



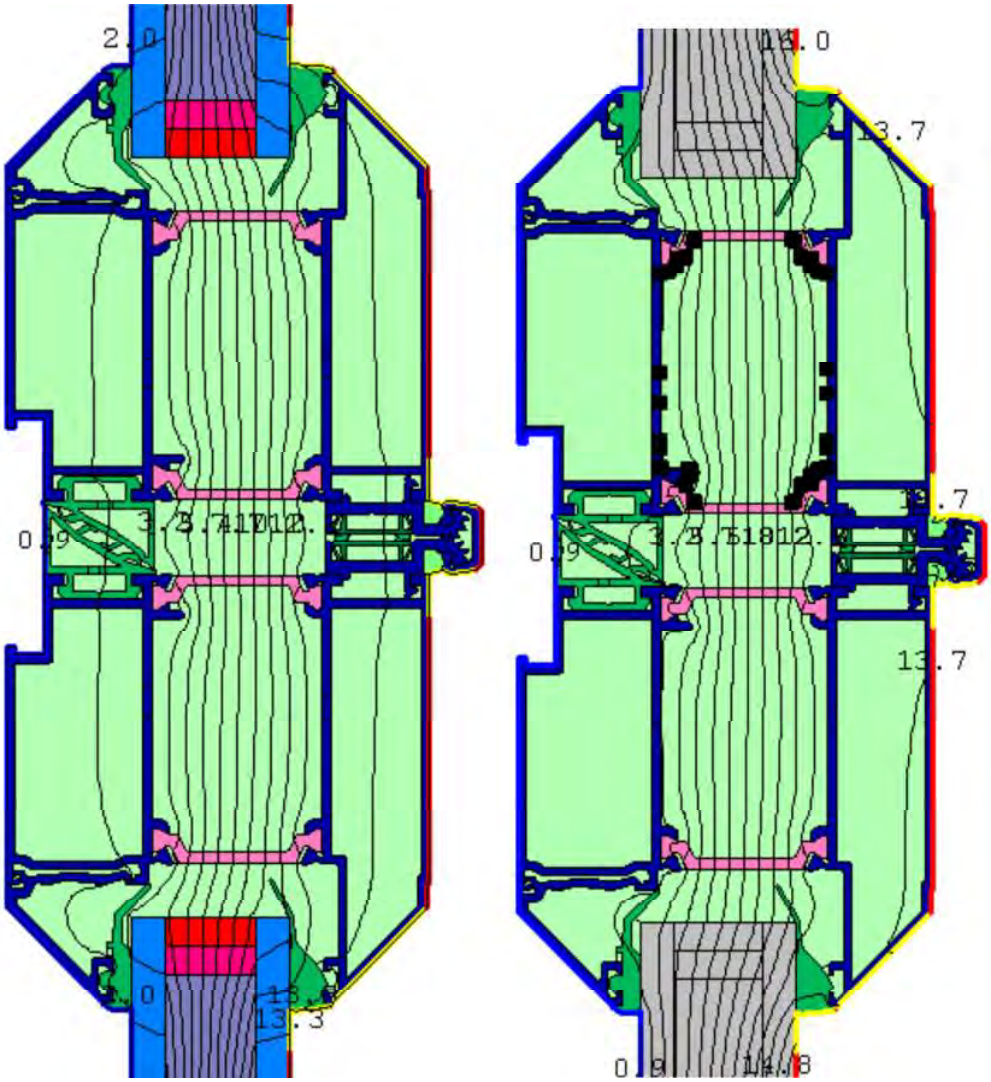
Head & sill models - SCE008 Crown 75mm Bifold Door



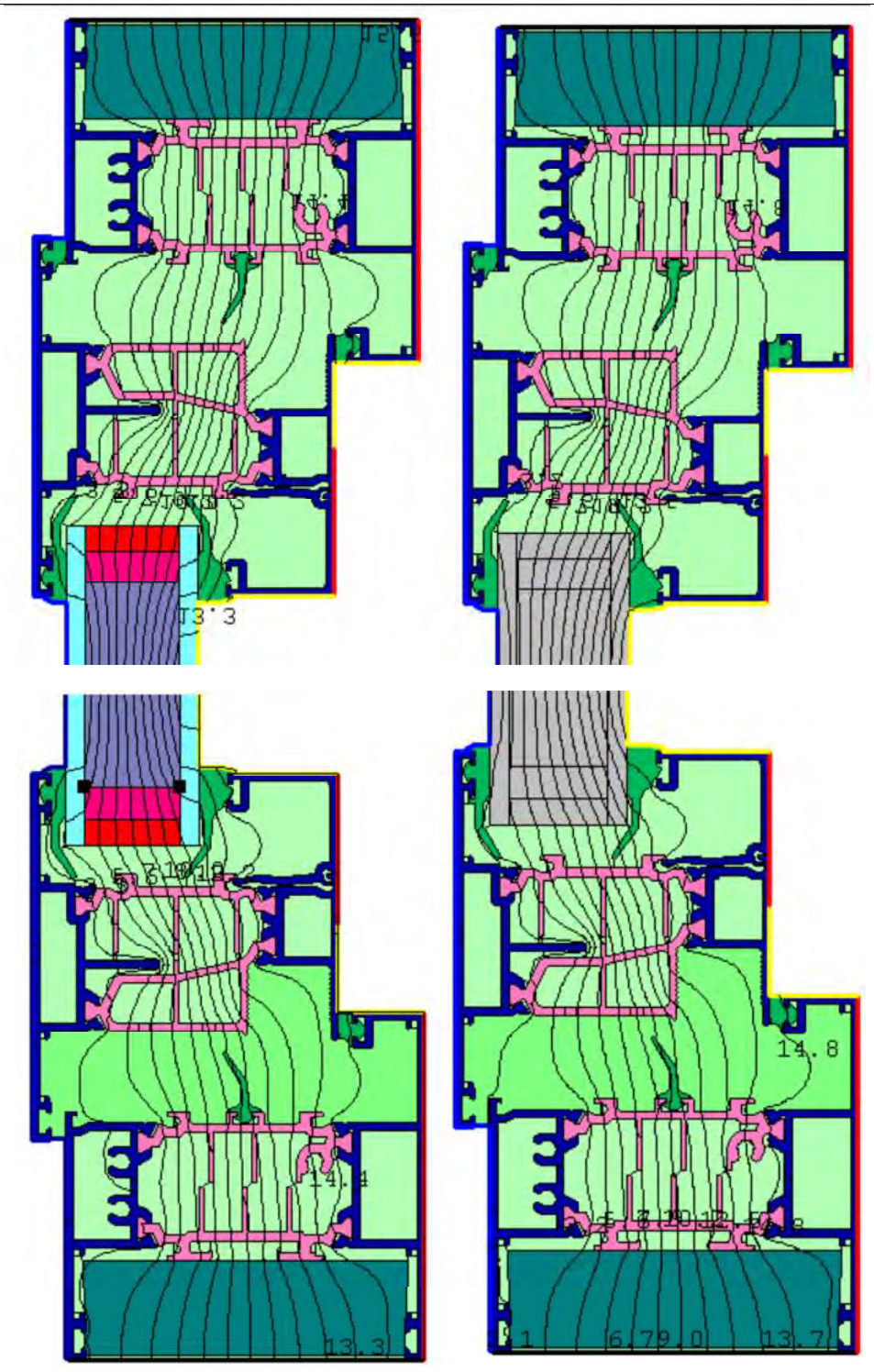
Hinged & locking jamb models - SCE008 Crown 75mm Bifold Door



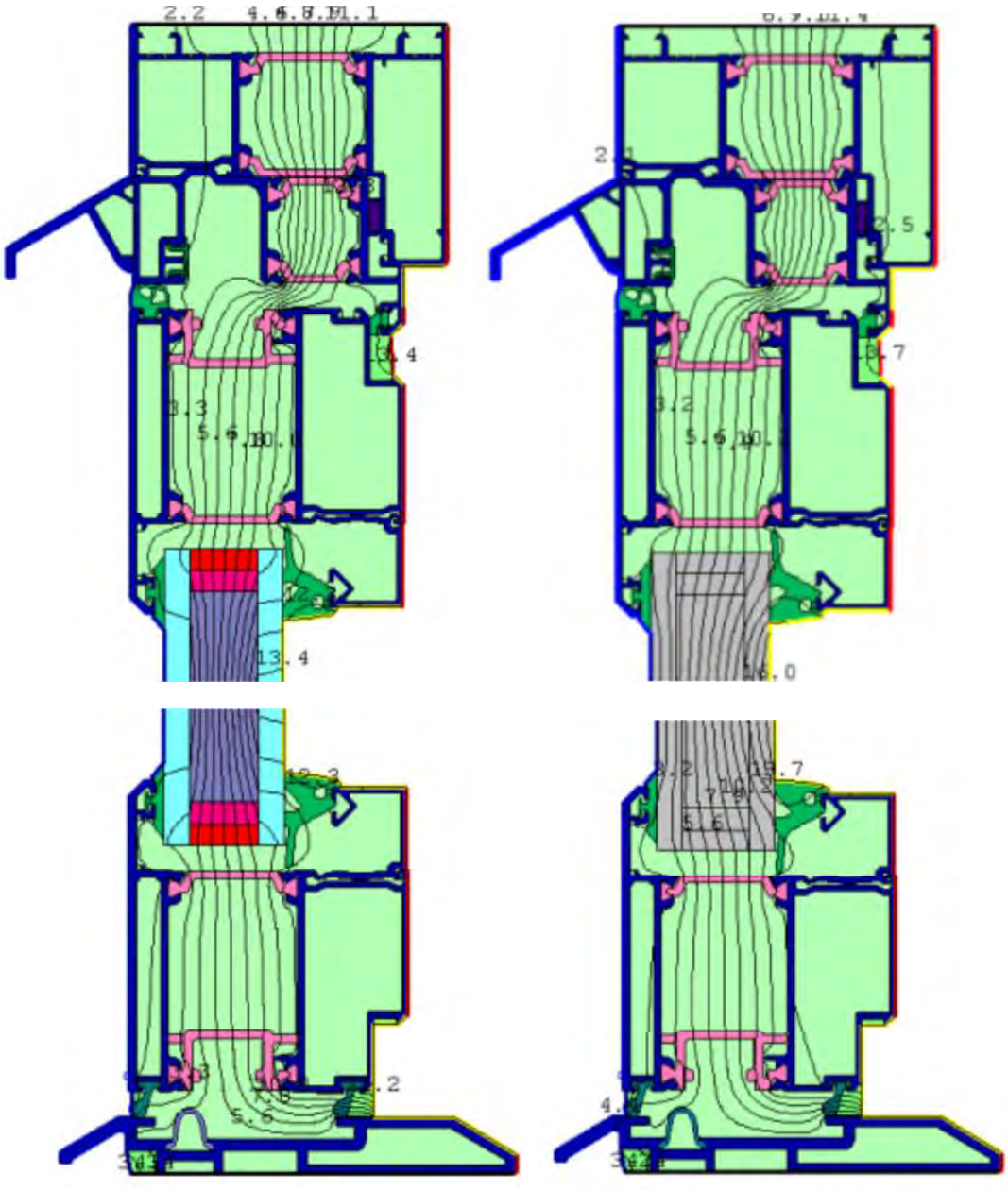
Meeting stile models - SCE008 Crown 75mm Bifold Door



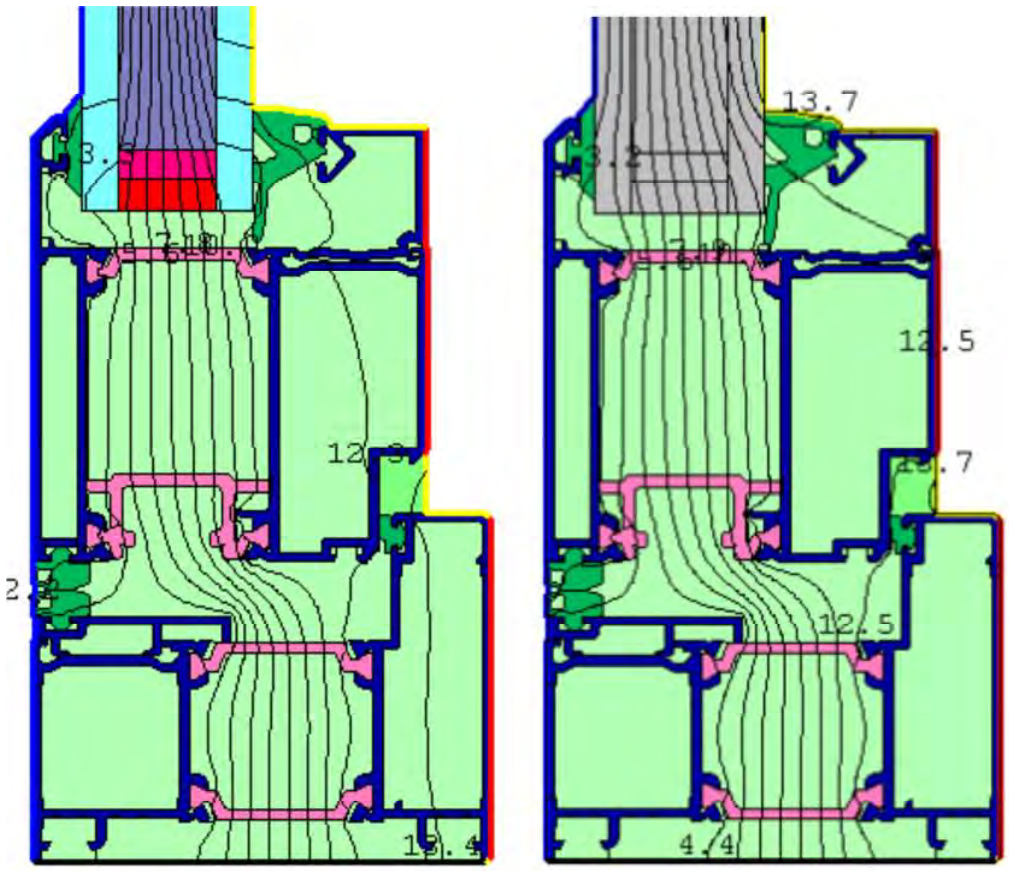
Jamb/head & sill models – SCE009 Dualframe 75mm Si Casement



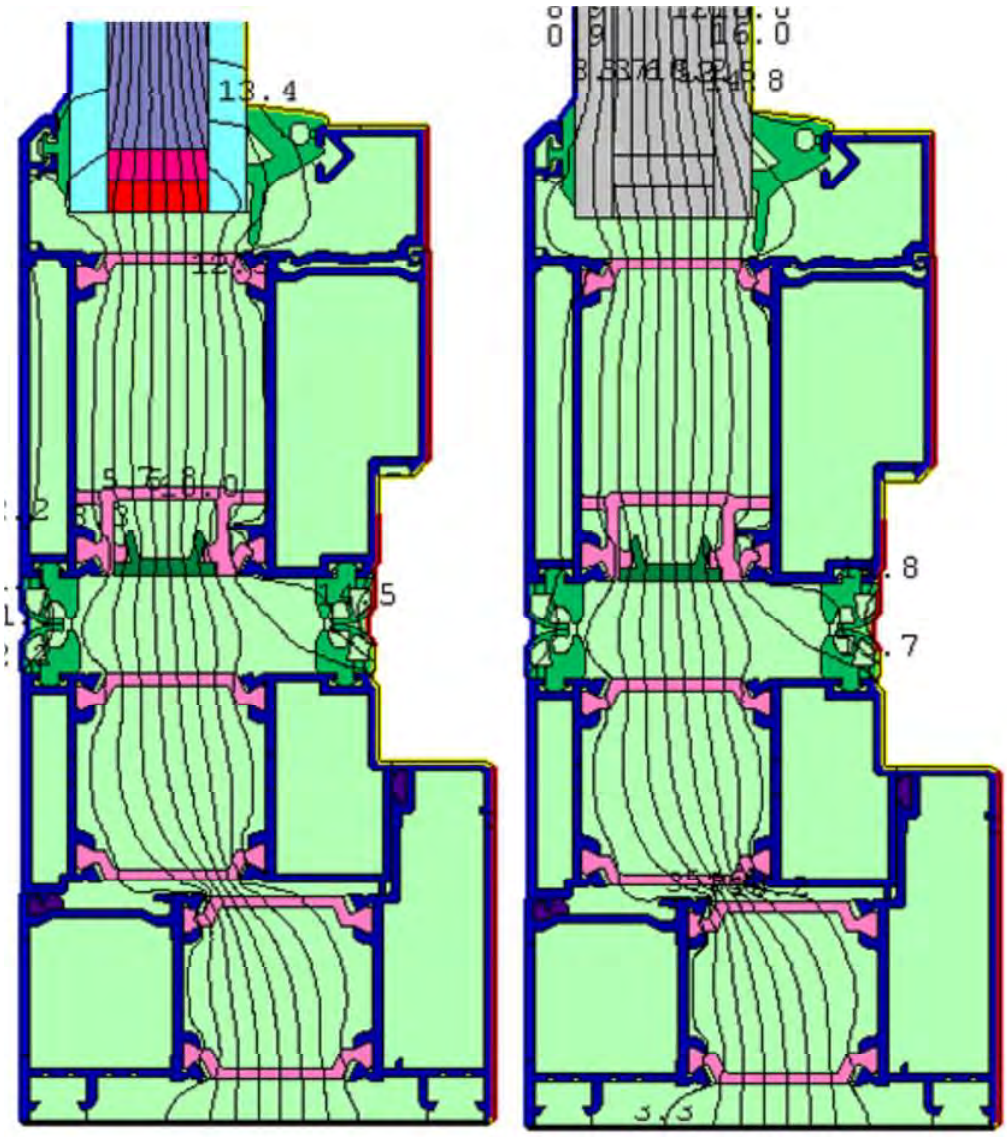
Head & sill models – SCE010 Dualframe 75mm Dualfold Door



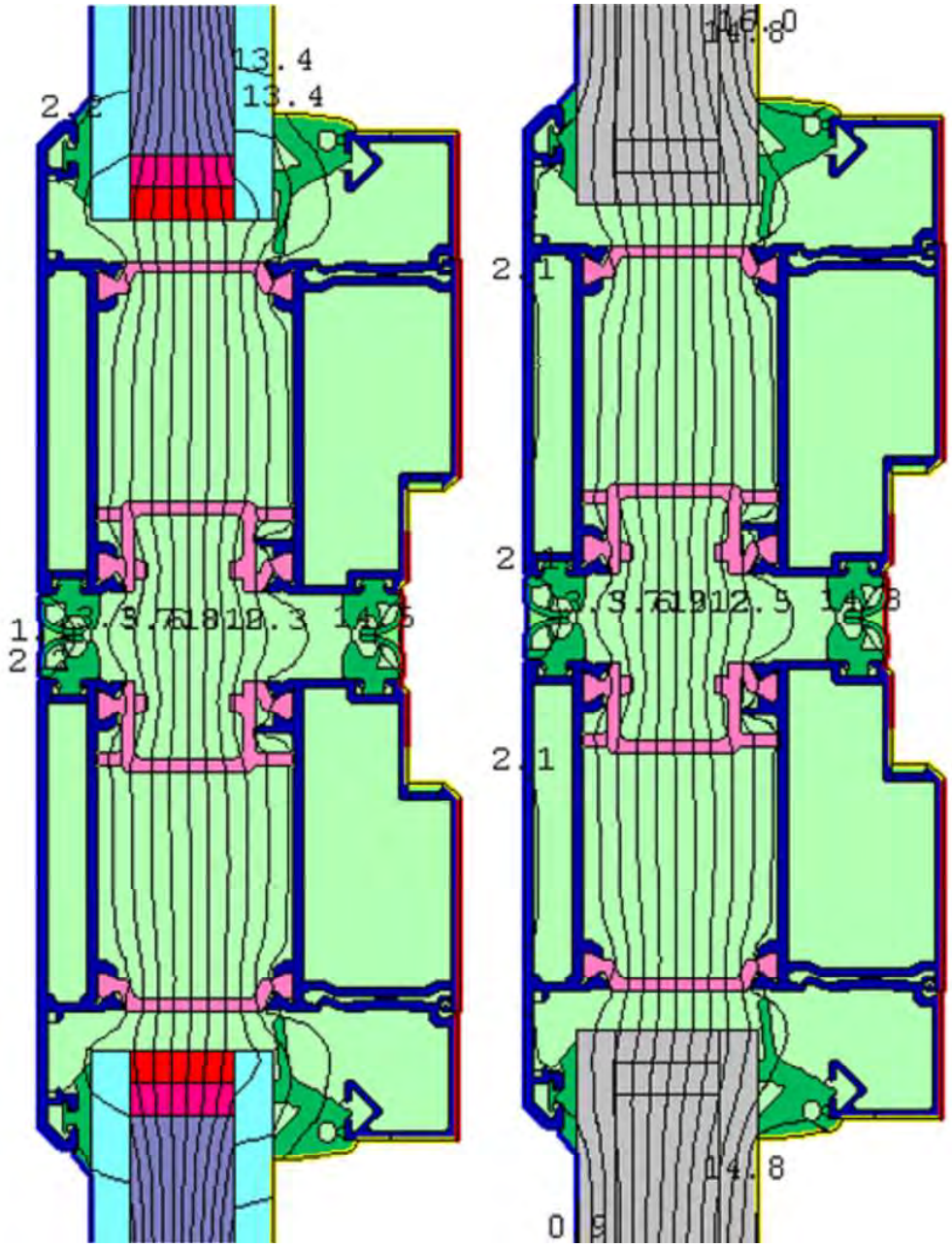
Hinged jamb models – SCE010 Dualframe 75mm Dualfold Door



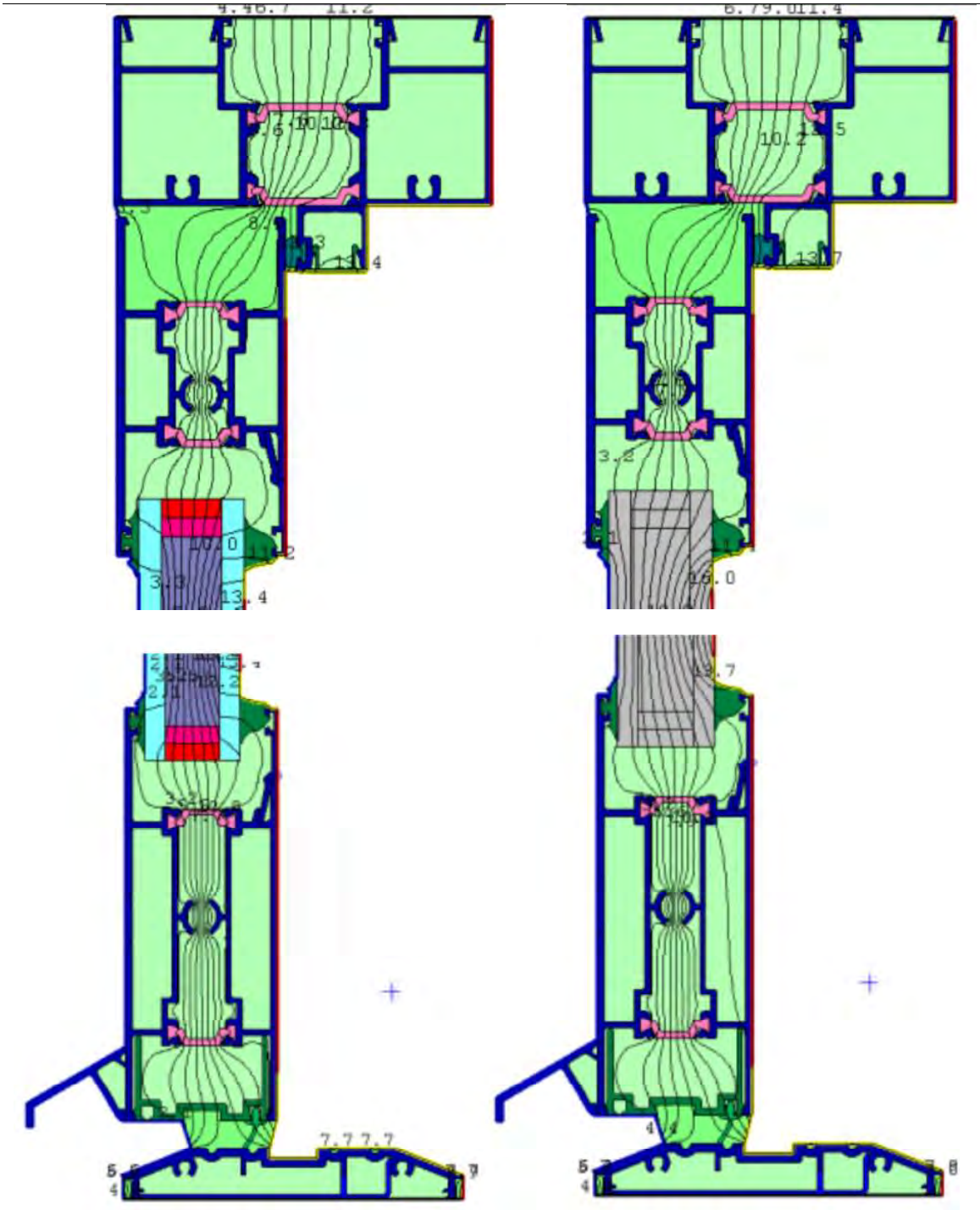
Locking jamb models – SCE010 Dualframe 75mm Dualfold Door



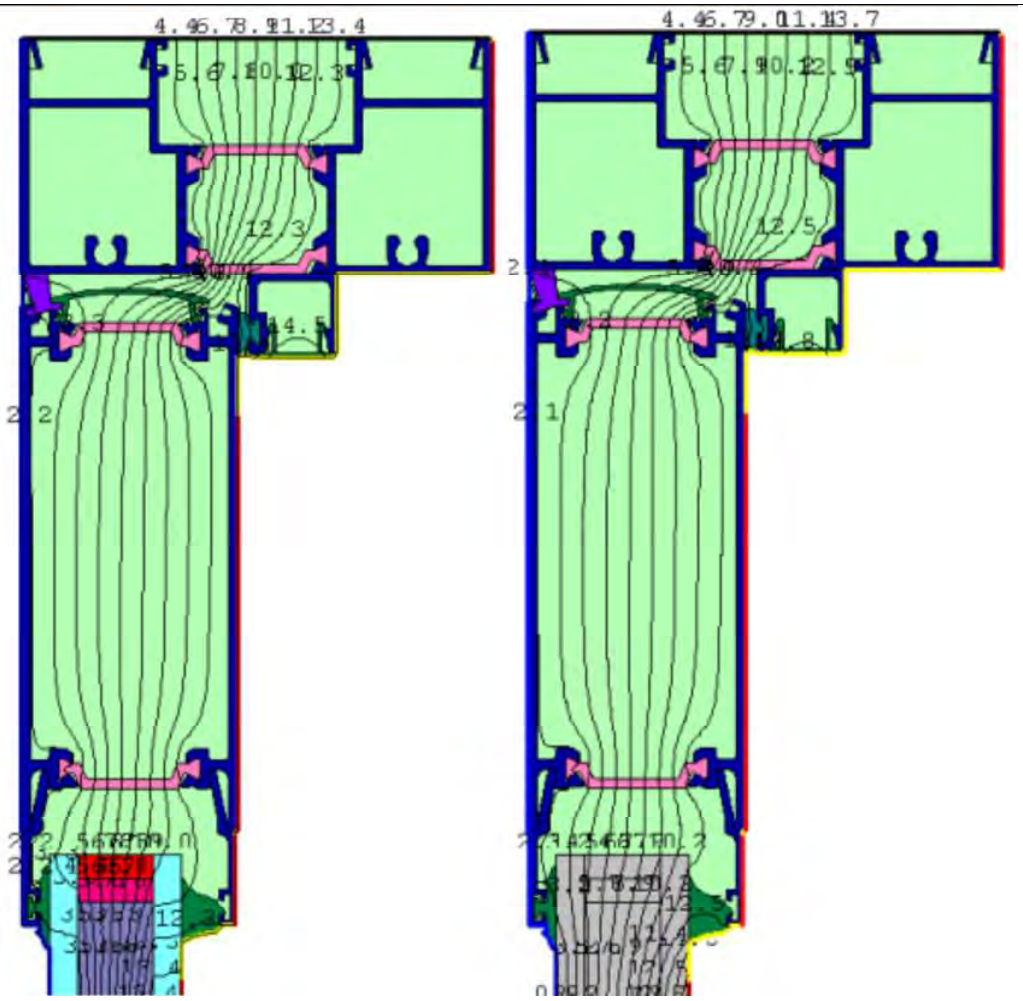
Meeting stile models – SCE010 Dualframe 75mm Dualfold Door



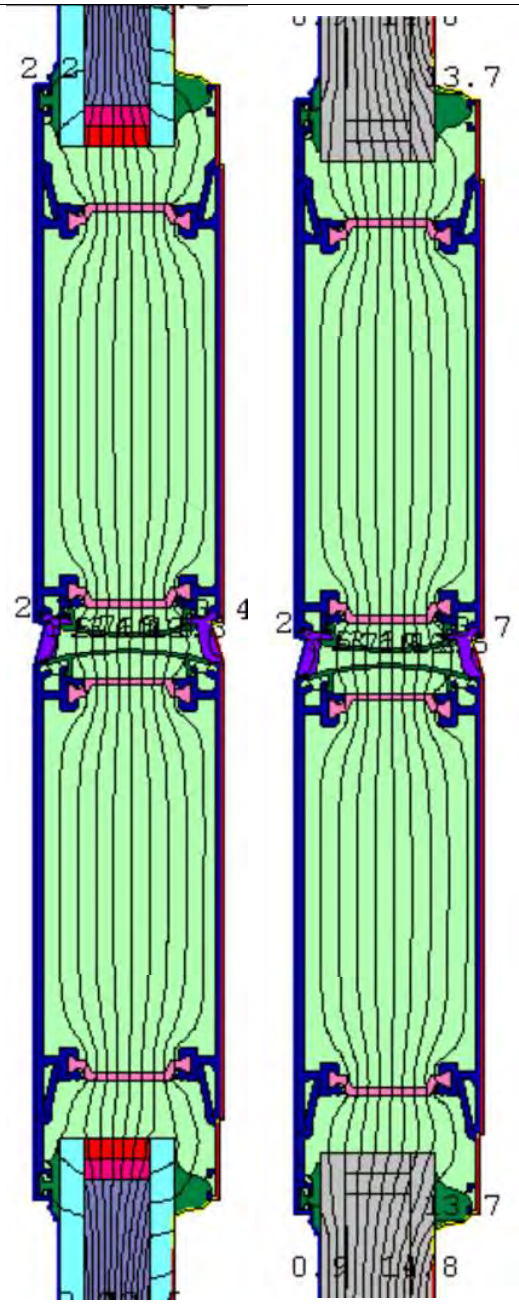
Head & sill models - SCE011 ST Commercial Door



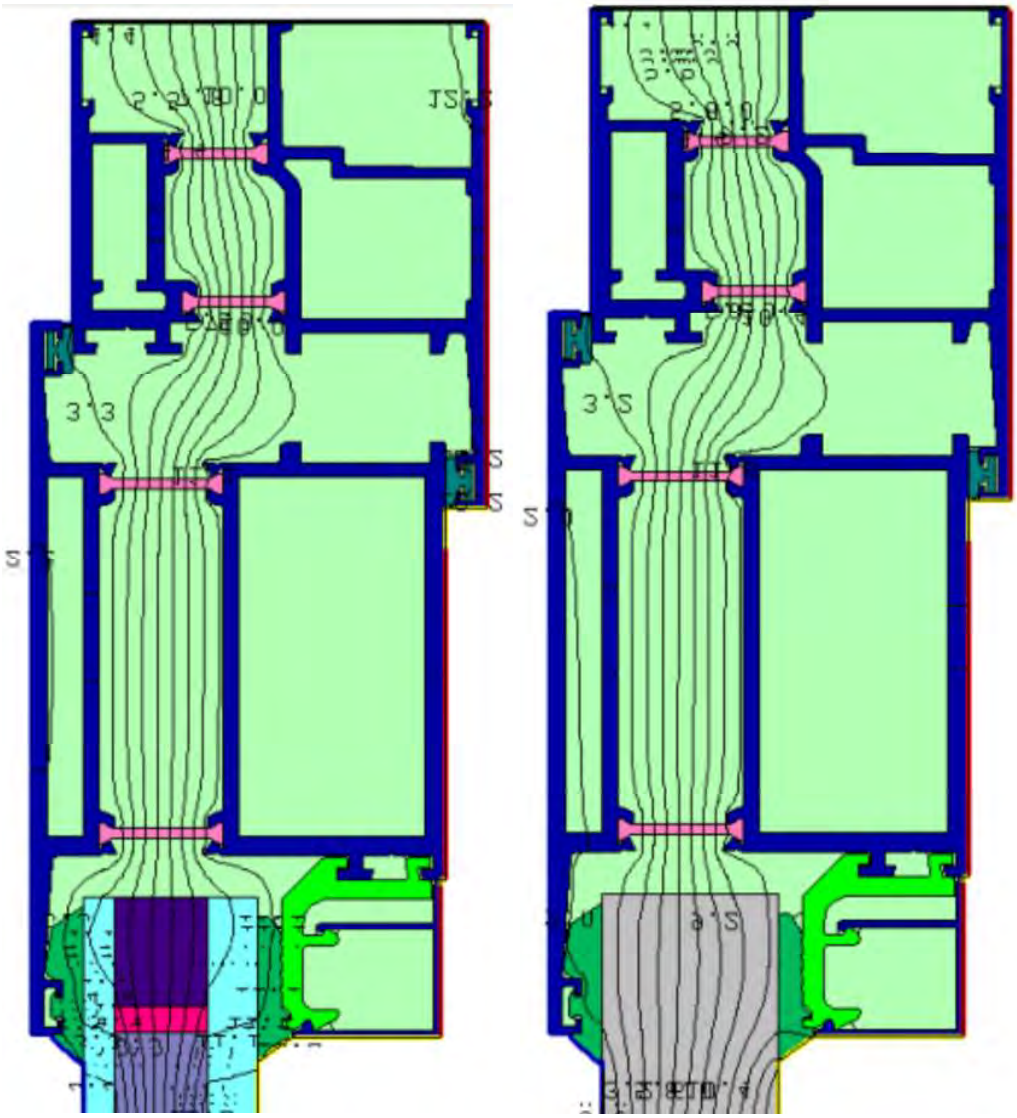
Jamb models - SCE011 ST Commercial Door



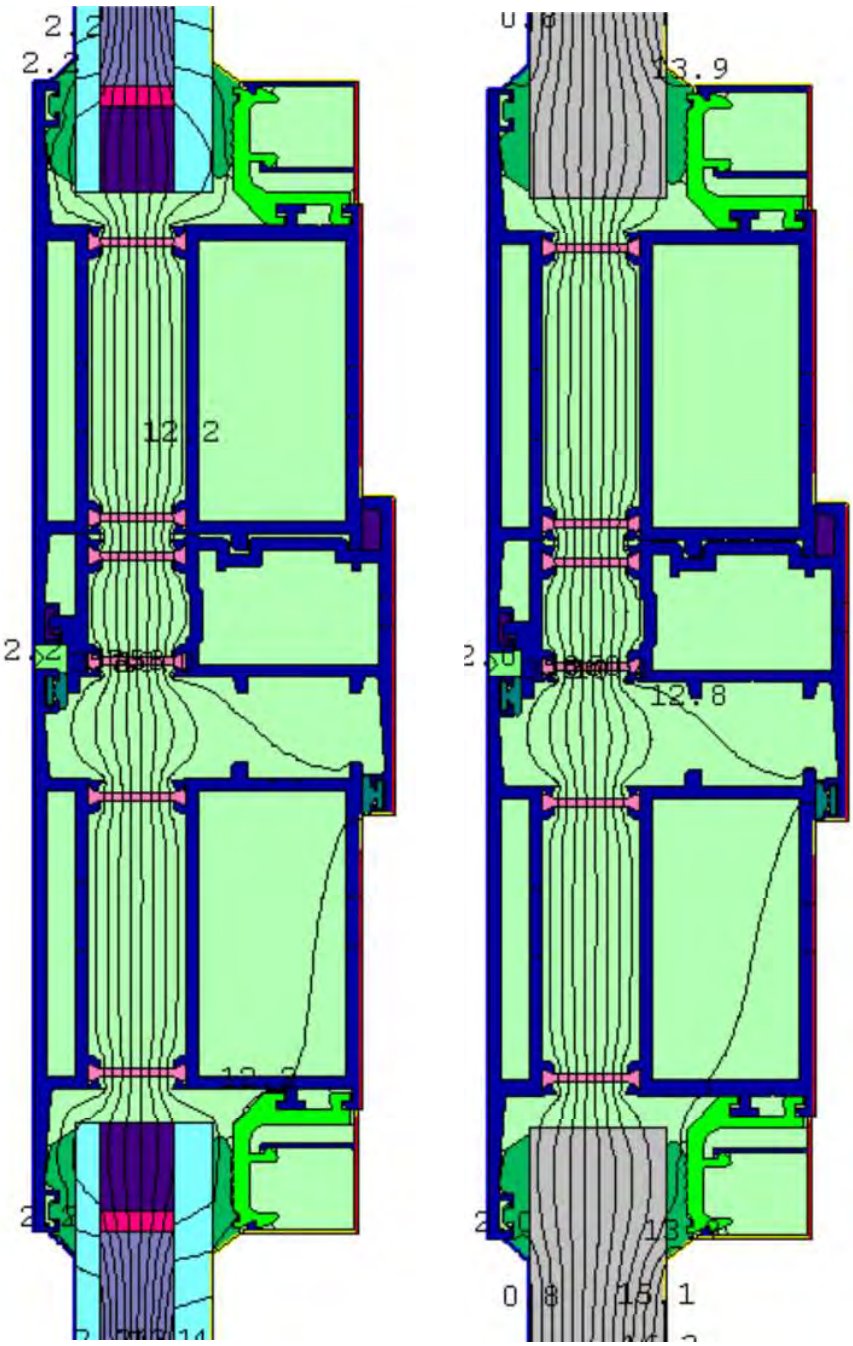
Meeting stile models - SCE011 ST Commercial Door



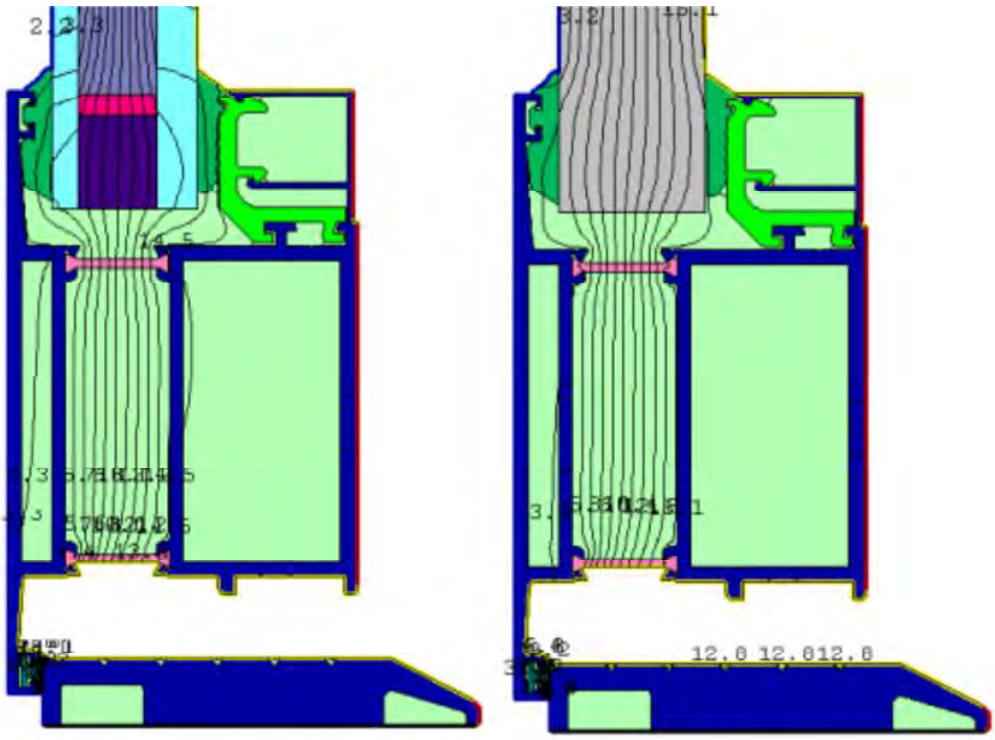
Head/jamb models - SCE012 Powerframe 80 Door



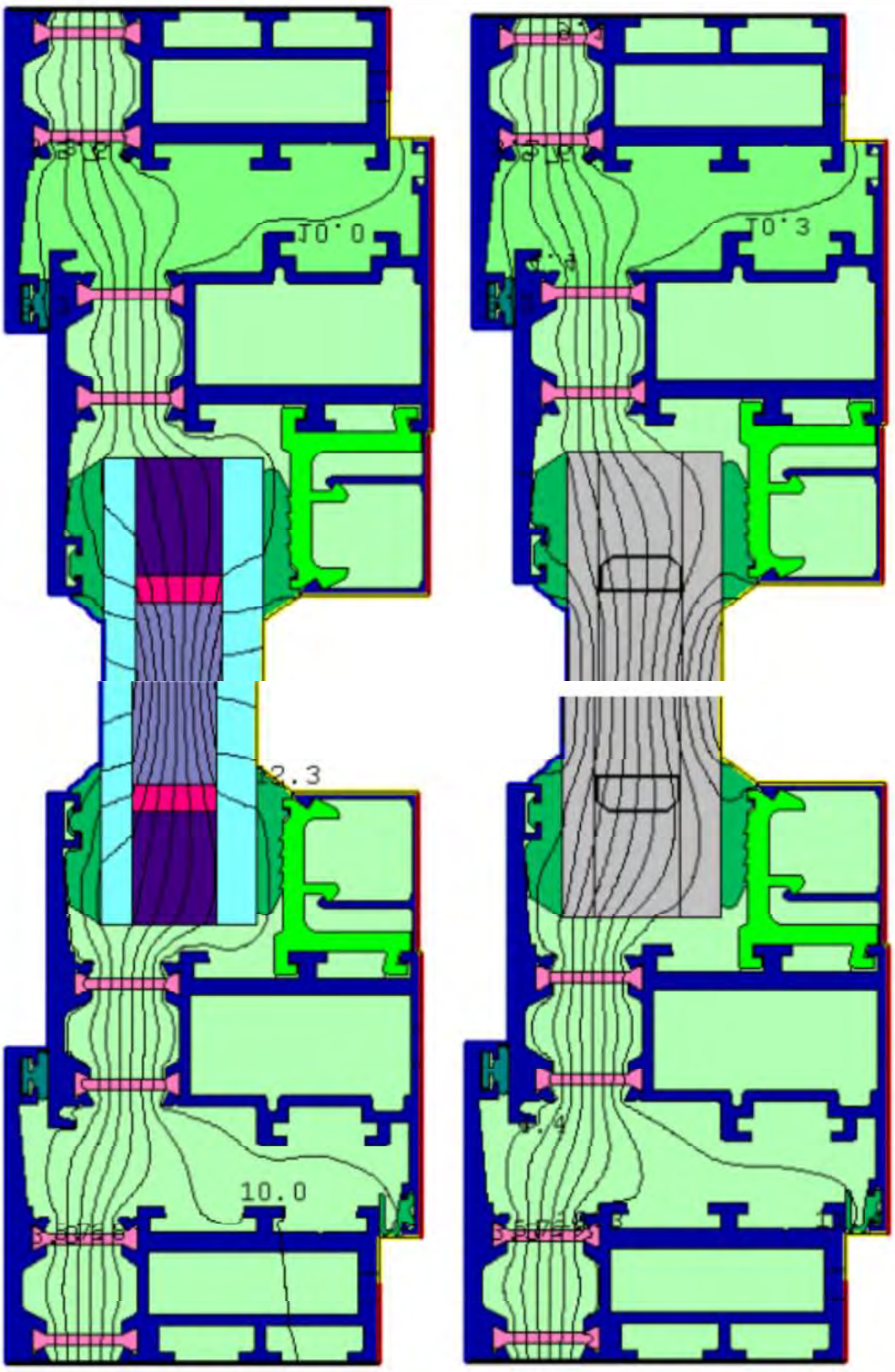
Meeting stile models - SCE012 Powerframe 80 Door



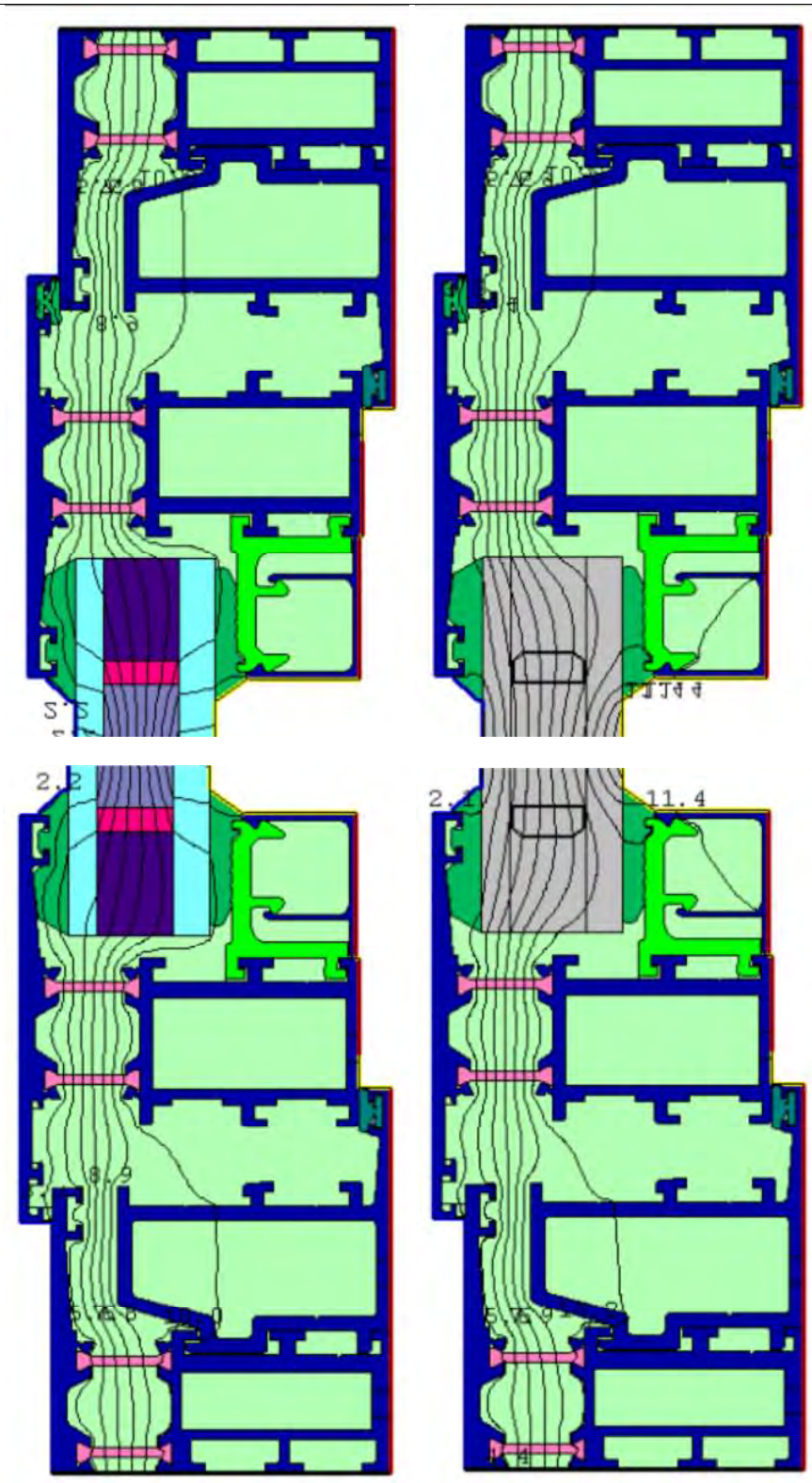
Sill stile models - SCE012 Powerframe 80 Door



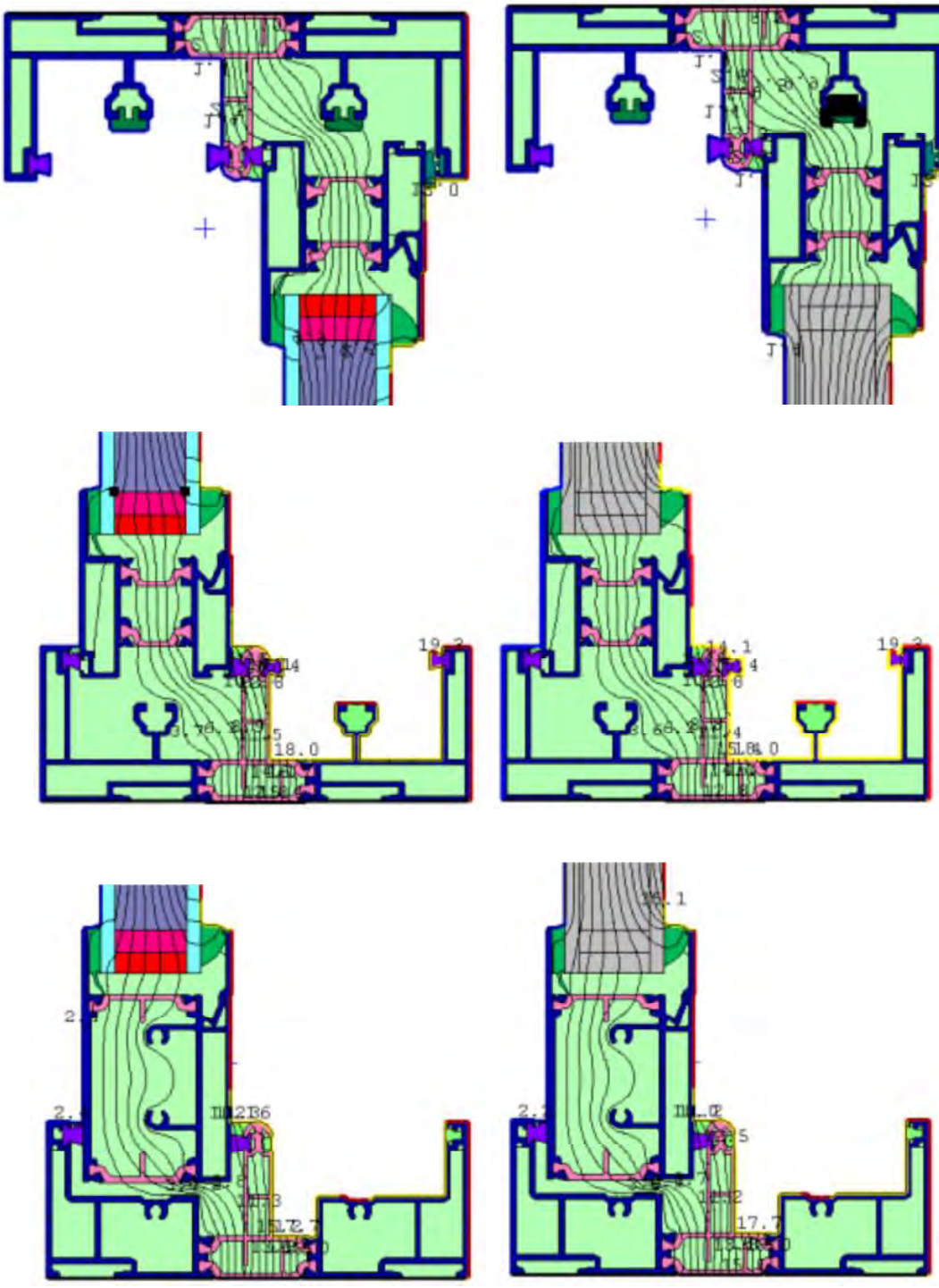
Head & jamb/sill models – SCE013 Powerframe tilt before turn window



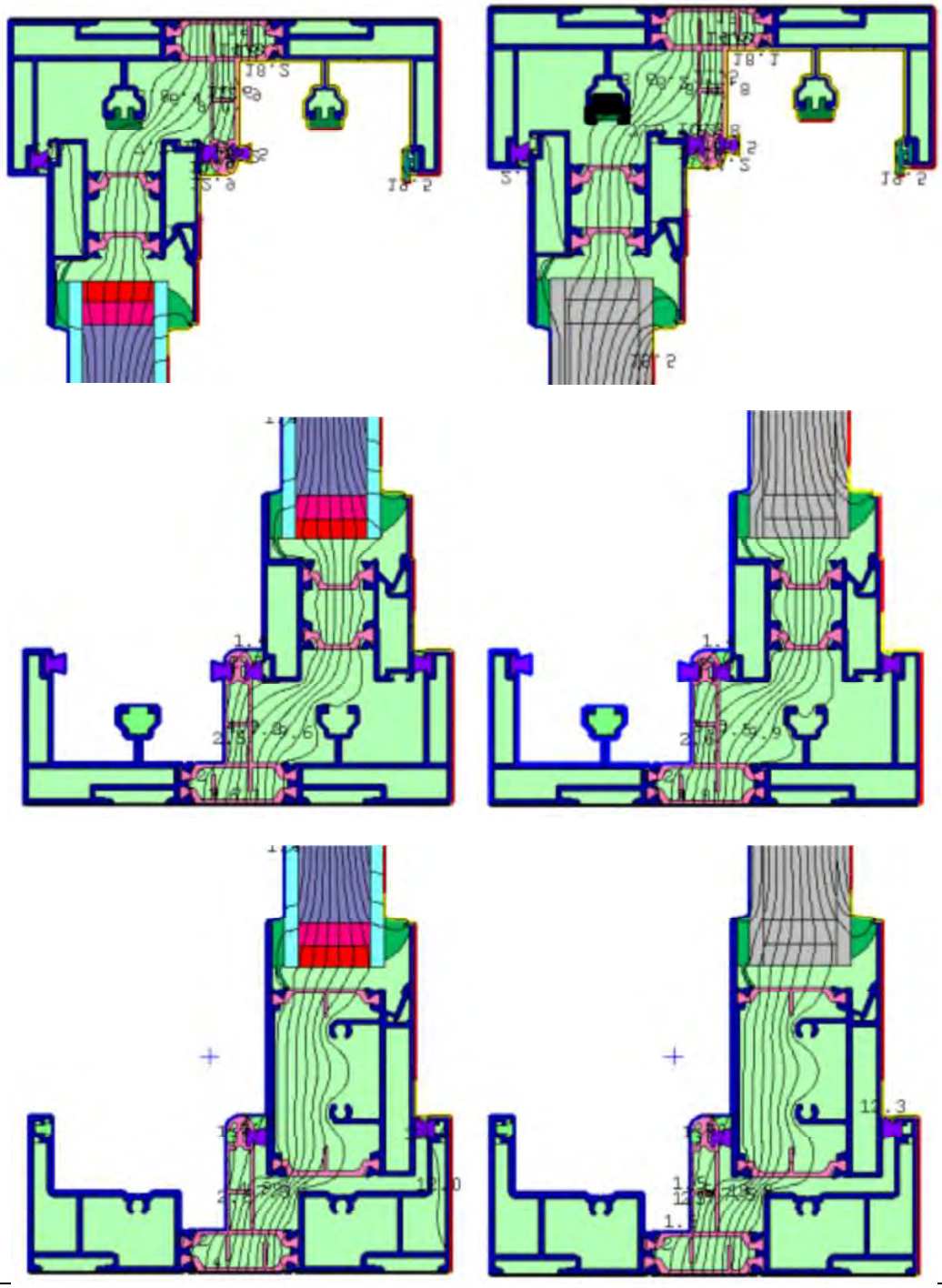
Jamb/head & sill models – SCE014 Powerframe casement window



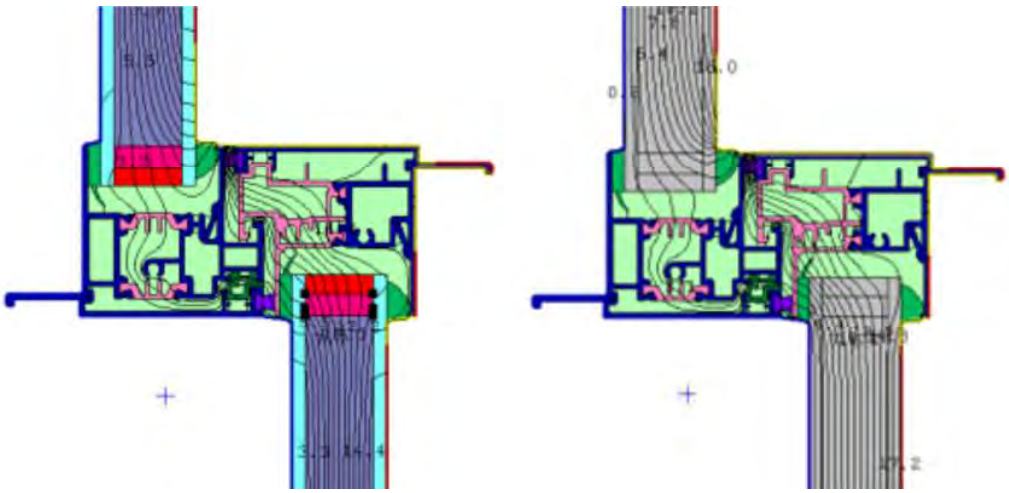
Cill, head & jamb outer models – SCE015 Dualslide Sliding Window



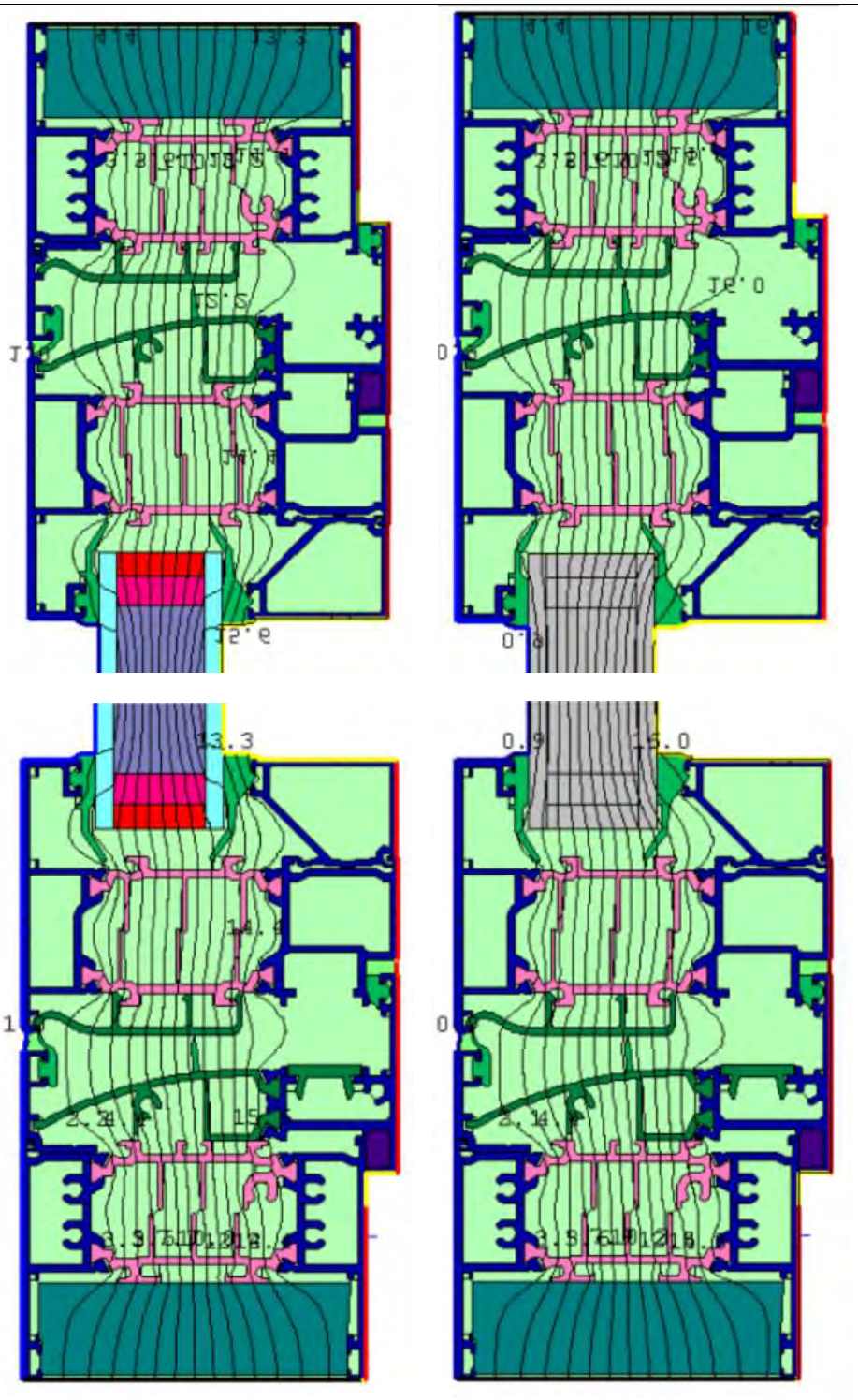
Head, sill & jamb inner models – SCE015 Dualslide Sliding Window



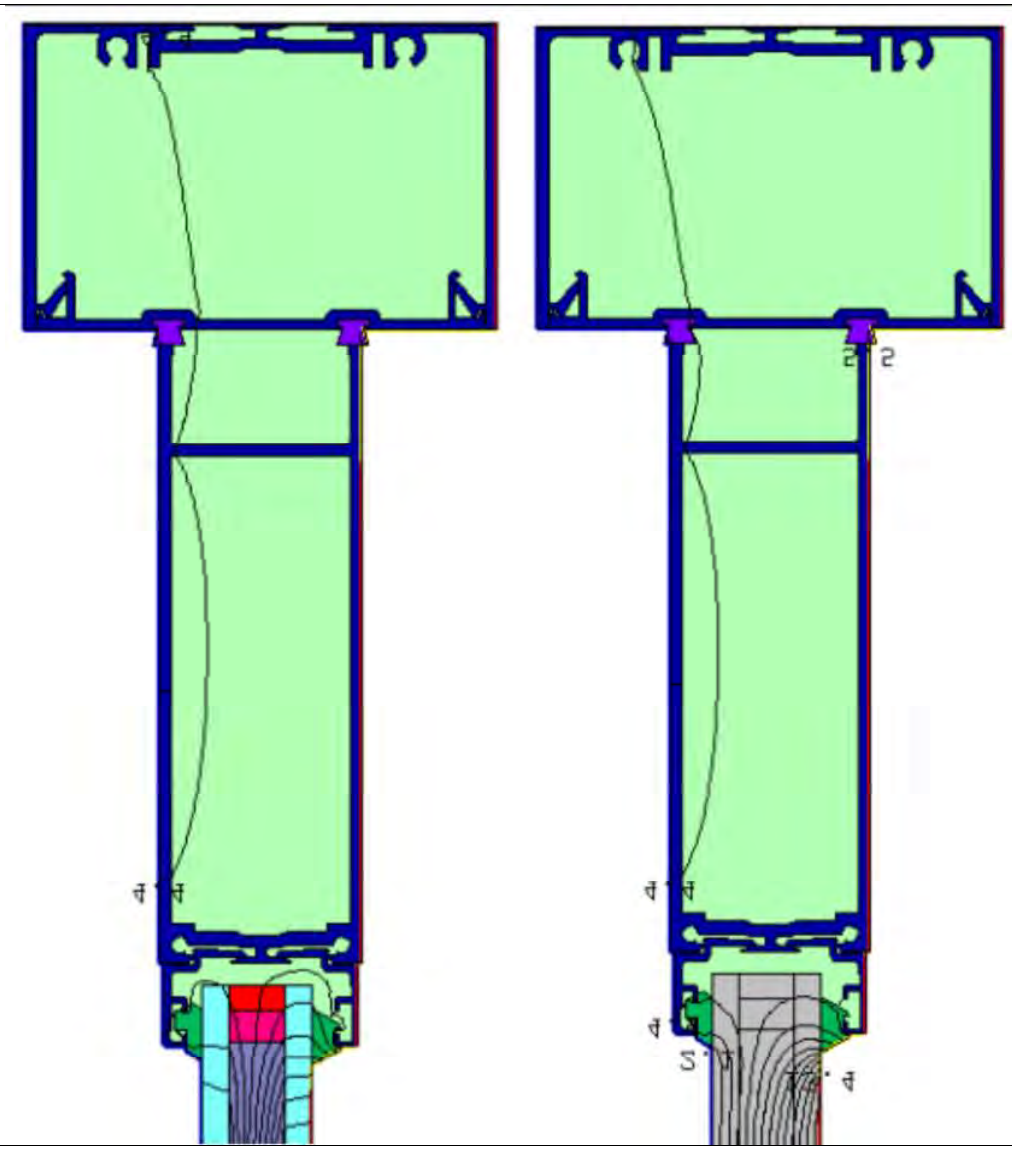
Interlock models – SCE015 Dualslide Sliding Window



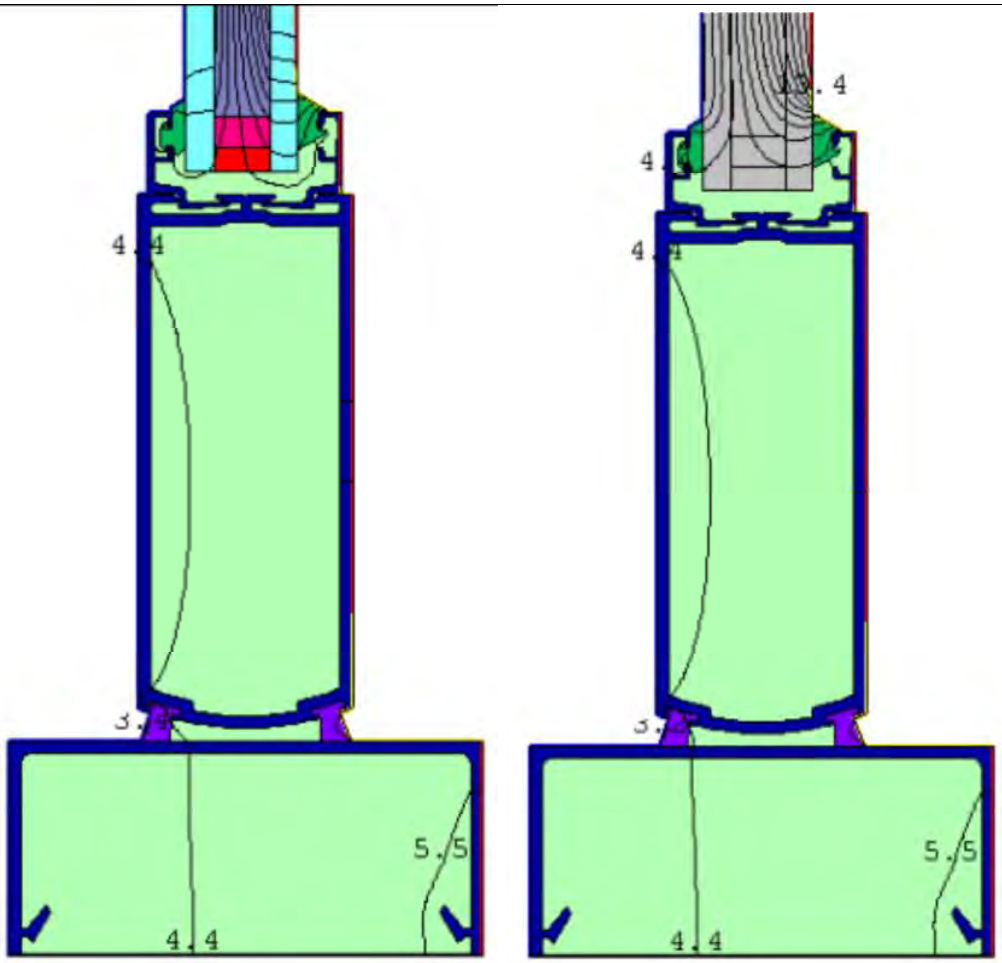
Head/left jamb & sill/right jamb model - SCE016 Dualframe 75mm Si Pivot Window



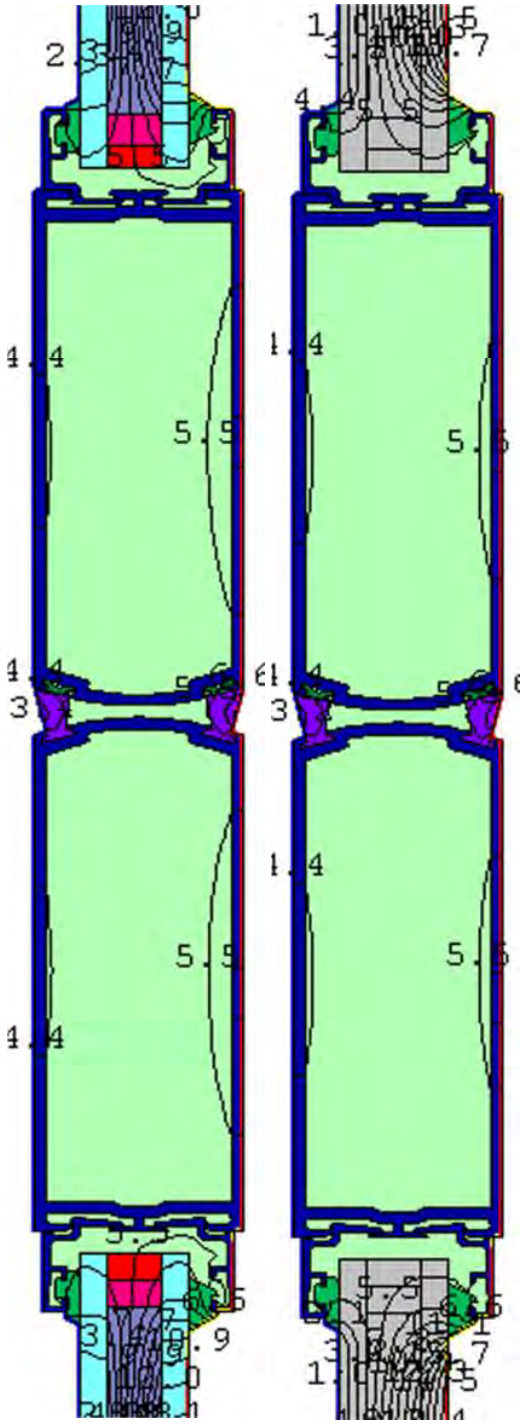
Head models - SCE017 202 Commercial Door



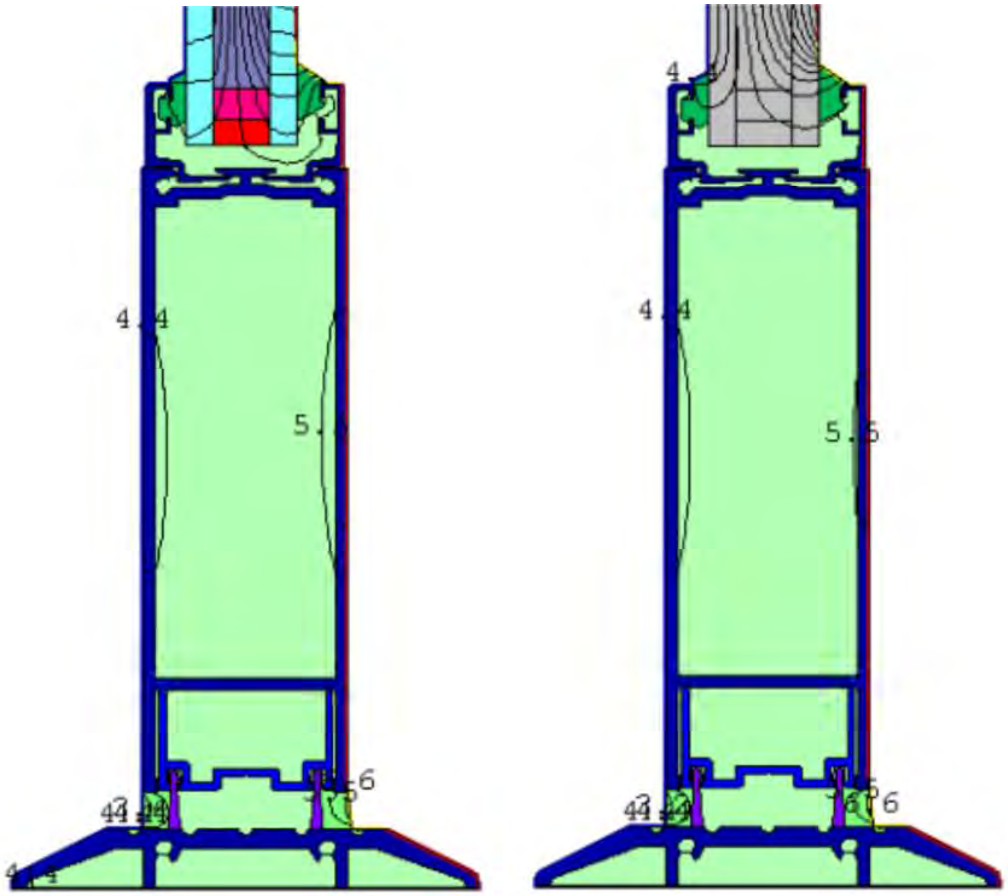
Jamb models - SCE017 202 Commercial Door



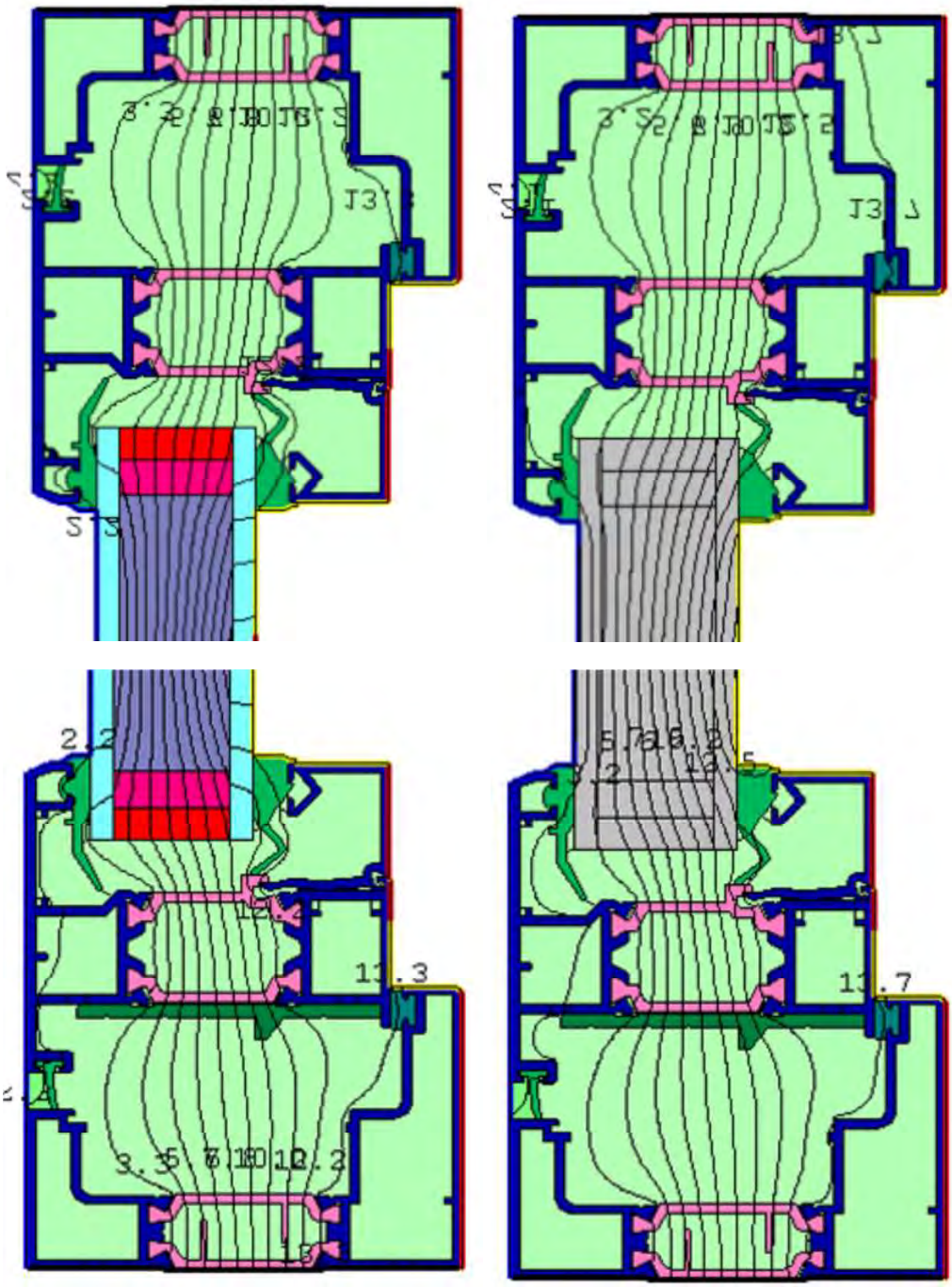
Meeting stile models - SCE017 202 Commercial Door



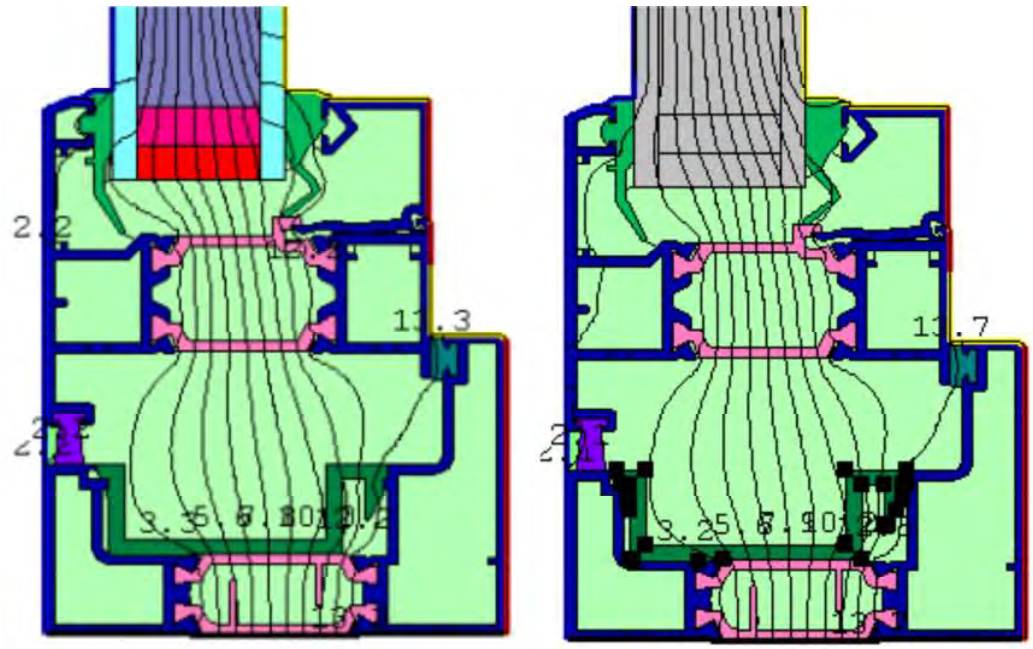
Threshold models - SCE017 202 Commercial Door



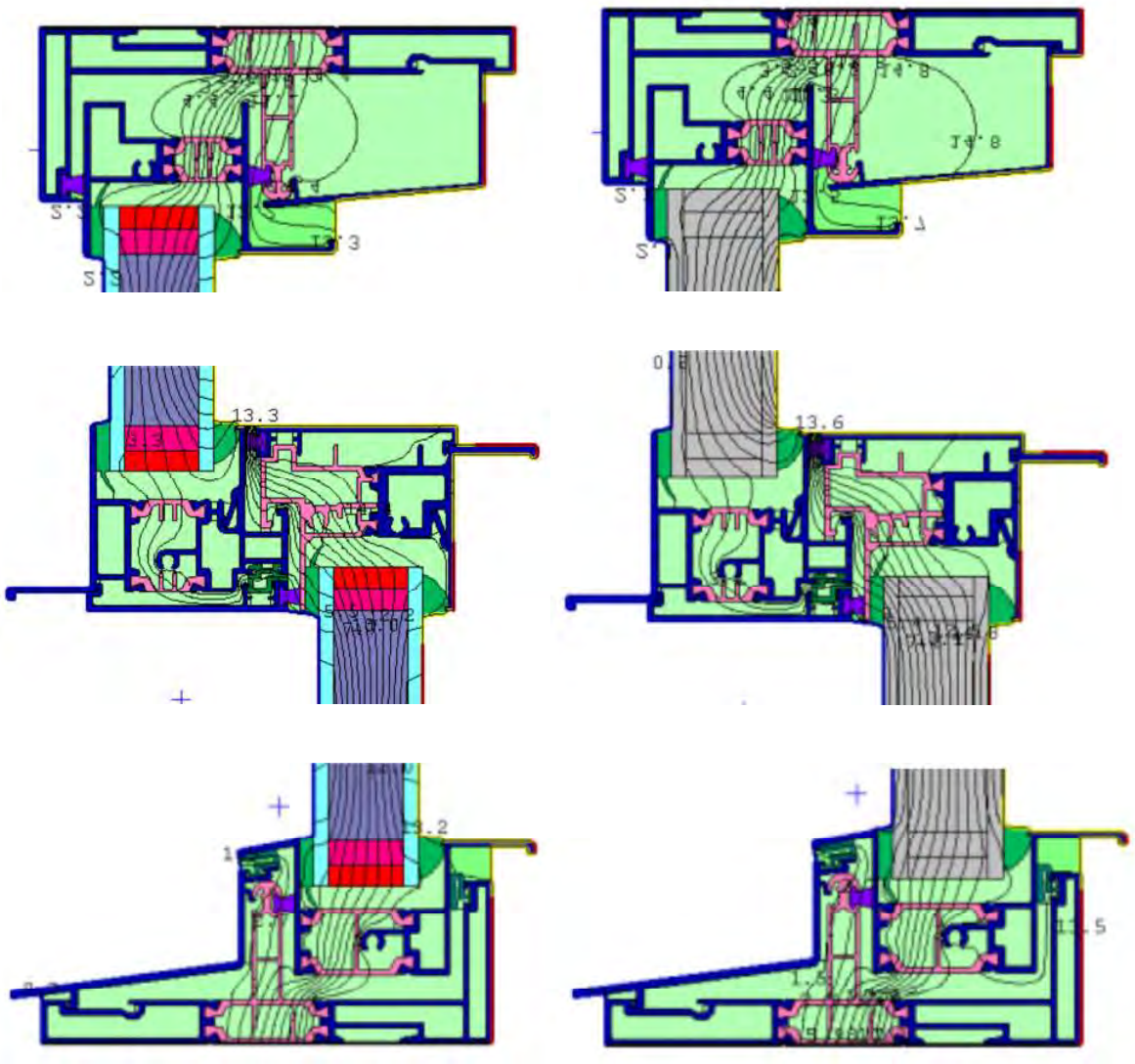
Head & sill models - SCE018 Dualframe 75mm Reversible Window



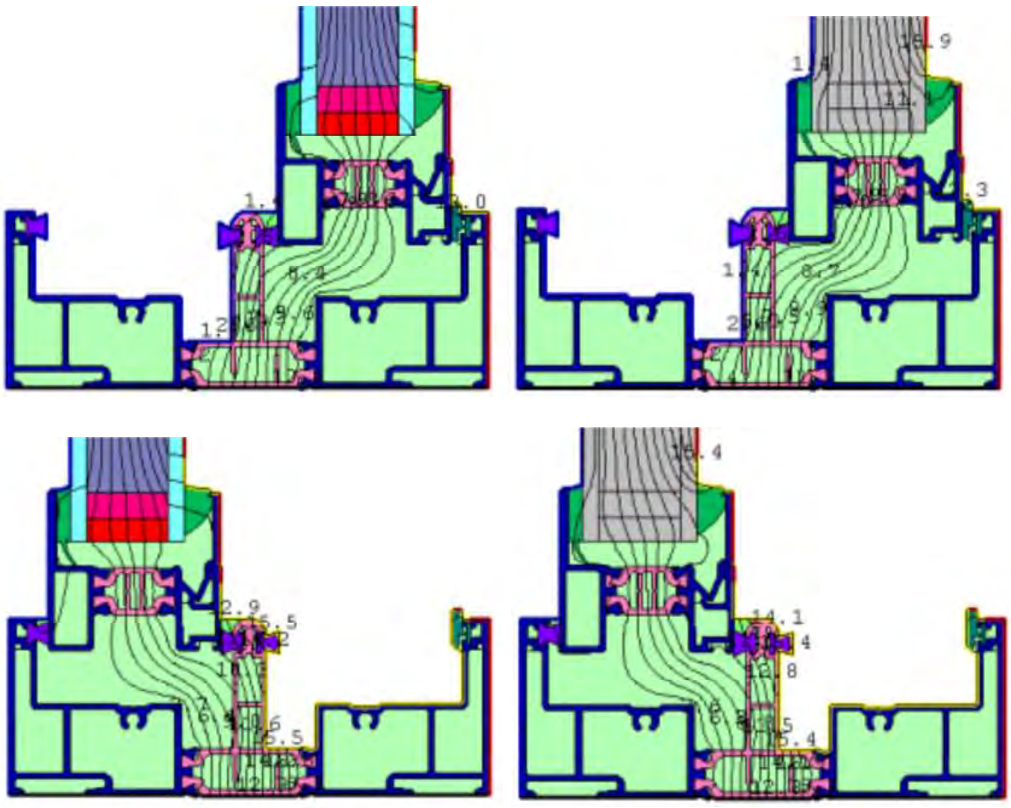
Jamb models - SCE018 Dualframe 75mm Reversible Window



Head, interlock & sill models - SCE019 Dualslide Sliding Windows



Jamb inner & jamb outer models - SCE019 Dualslide Sliding Windows



REVISION HISTORY

Issue No :	**Re - Issue Date :**
Revised By:	**Approved By:**
Reason for Revision:	

Issue No :	**Re - Issue Date :**
Revised By:	**Approved By:**
Reason for Revision:	

END OF REPORT