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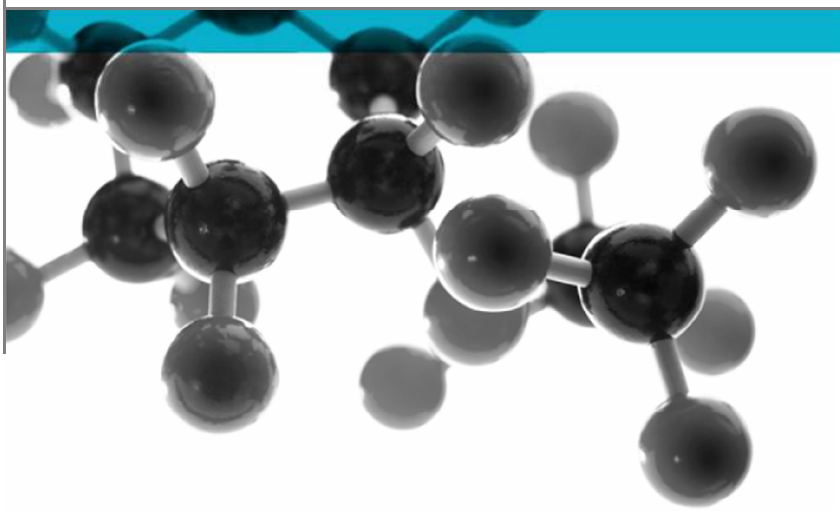
BS EN ISO 10077-1:2006



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

A Report To: Central Extrusions Ltd

Document Reference: WIL 331840

Date: 11/11/2013

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Issue No.: 1

Testing
Advising
Assuring

CONCLUSIONS

Drawings of:
Manufacturer Central Extrusions
Product Aluminium Window
Model SPW600e window opening casement window & opening/fixed window

Have been submitted for U-value calculation in accordance with BS EN ISO 10077-1:2006.
By Mark West, a BFRC certified simulator (No. 055) of Exova Warringtonfire Willenhall, 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_W value $W/(m^2.K)$
Window 1: Single opening casement window	**1.8**
Window 2: Opening/fixed casement window	**2.0**

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 1st November 2013

For and on behalf of Exova Warringtonfire

Report authorised by: Ian Keeling, Operations Manager

Signed 

Date 11th November 2013

For and on behalf of Exova Warringtonfire

Report issued: 11 November 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

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CALCULATION DETAILS

CLIENT DETAILS

Company name	Central Extrusions
Address	Unit 7 Charlton Drive Cradley Heath West Midlands
Postcode	B64 7BJ
Contact	Sue Harper

ORDER DETAILS

Order number	1701
Dated	31/07/2013

PRODUCT DETAILS

Product	Aluminium Window
Model	SPW600e window opening casement window & opening/fixed window
Manufacturer	Central Extrusions
Material	Aluminium

CALCULATION DETAILS

Specification	BS EN ISO 10077-1:2006
Clauses	N/a
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. Exova BS EN 673 Ug spreadsheet TR099 version 2 Exova BS EN ISO 10077 window U-value spreadsheet TR096

PROCEDURE

Introduction

This 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 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

Drawings in DXF format were submitted for calculation of thermal transmittance in accordance with BS EN ISO 10077-1.

Instruction

The calculations were conducted on the 25th – 9th August 2013 on behalf of Central Extrusions

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 shown in equation 8, plus the edge effect of the glazing perimeter Ψ_g.

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 glazing junction 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.

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.

Values used for the design thermal conductivity of materials in this calculation were taken from Annex A of BS EN ISO 10077-2:2012 unless specified otherwise, and are listed in Annex C of this report.

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 as provided by the client were subjected to thermal performance calculations in accordance with BS EN ISO 10077-1
Observations & comments	

LIMITATIONS

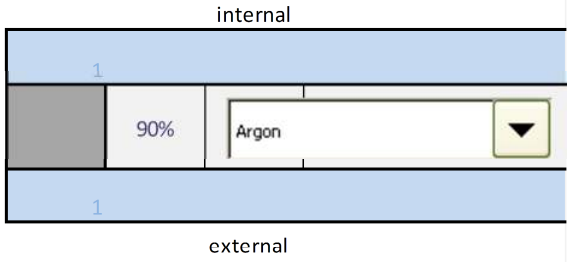
Limitations	The results relate only to the behaviour of the specimens of the element of construction under the particular conditions of the calculation. They are not intended to be the sole criteria for assessing the potential performance of the element in use, nor do they reflect the actual behaviour in use.
Range of assemblies covered by this report	Table E1 of BS EN 14351-1:2006 +A1:2010 states that the range of direct application (providing similar design) of window assemblies covered by this report is limited to the following: ▪ Windows with overall area ≤ 2.3m^2 for windows simulated at 1.23m x 1.48m ▪ Windows with overall area > 2.3 m^2 for windows simulated at 1.48m x 2.18m ▪ All windows for windows simulated at 1.23 x1.48m with U_g ≤1.9 W/m^{2}K
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: SIMULATION RESULTS & CALCULATIONS

Results

Title:	**Exova Warringtonfire Willenhall**		
	BS EN 673 Thermal transmittance of glazing spreadsheet		
Reference :	**TR099**		
Standard issue:	**BS EN 673:2011**		
Author:	**Mark West**	Client:	**Central Extrusions**
Version:	**1.1**	Inclination of glazing:	**Vertical**
Issue date:	**24th January 2013**	Calculation date:	**9th August 2013**

	thickness (mm)	ε normal	
internal pane (d_j2) =	6	0.89	uncoated
		0.05	
air space (s1) =	16		
external pane (d_j1) =	6	0.89	uncoated
		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**

Title:	Exova Warringtonfire Willenhall U-value calculation for single light window	**Carried out for :**	Central Extrusions
		Product :	Aluminium Window
Reference:	TR096	**Model :**	Single Opening Casement
Standard issue:	BS EN ISO 10077-2:2012	**Glazing config :**	6-16-6 Argon filled (e=0.05 pos3)
Author:	Mark West		
Version:	1.2	**Calculation date :**	9th August 2013
Issue date:	1st July 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Head	0.4903	1.0309	0.1900	0.0960	3.0669
2 LHS jamb	0.4903	1.0309	0.1900	0.0960	3.0669
3 RHS jamb	0.4903	1.0309	0.1900	0.0960	3.0669
4 Sill	0.4903	1.0309	0.1900	0.0960	3.0669

U of insulating panel = 1.0309

Glass thickness = 0.028 m

Centre pane U-value Ug = 1.19

Section detail	Lψ2d	Uf	bf	Ug	bd	ψi
1 Head	0.5611	3.0669	0.0960	1.1900	0.1900	0.0406
2 LHS jamb	0.5611	3.0669	0.0960	1.1900	0.1900	0.0406
3 RHS jamb	0.5611	3.0669	0.0960	1.1900	0.1900	0.0406
4 Sill	0.5611	3.0669	0.0960	1.1900	0.1900	0.0406

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	0.1089	3.0669	0.3339
2 LHS jamb	0.1329	3.0669	0.4075
3 RHS jamb	0.1329	3.0669	0.4075
4 Sill	0.1089	3.0669	0.3339
Σaf=	0.4835	ΣAf.Uf=	1.4827

Frame width bf		
1 Head	0.096	m
2 LHS jamb	0.096	m
3 RHS jamb	0.096	m
4 Sill	0.096	m

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

Panel length	lg	ψg	lg.ψg
1 Head	1.0380	0.0406	0.0421
2 LHS jamb	1.2880	0.0406	0.0523
3 RHS jamb	1.2880	0.0406	0.0523
4 Sill	1.0380	0.0406	0.0421
Σlg=	4.6520	$\Sigma lg._{\psi}g$ =	0.1888

	Ag	Ug	Ag.Ug
Glass	1.3369	1.1900	1.5910

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

$$U_W = \frac{1.4827 + 1.5910 + 0.1888}{1.8204}$$

$$U_W = 1.792 \ W / m^2 \cdot K$$

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

Title:	Exova Warringtonfire Willenhall	**Carried out for :**	Central Extrusions
	U-value calculation for opening/fixed window	**Product :**	Aluminium Window
Reference:	TR096	**Model :**	Single opening casement & fixed
Standard issue:	BS EN ISO 10077-2:2012	**Glazing config :**	6-16-6 Argon filled (e=0.05 pos3)
Author:	Mark West		
Version:	2.1	**Calculation date :**	9th August 2013
Issue date:	30th July 2013	**Carried out by :**	Mark West

Section detail	Lf2d	Up	bp	bf	Uf
1 Fixed head	0.4225	1.0309	0.1900	0.0810	2.7978
2 Fixed jamb	0.4225	1.0309	0.1900	0.0810	2.7978
3 Fixed sill	0.4225	1.0309	0.1900	0.0810	2.7978
4 Casement head	0.4903	1.0309	0.1900	0.0960	3.0669
5 Casement jamb	0.4903	1.0309	0.1900	0.0960	3.0669
6 Casement sill	0.4903	1.0309	0.1900	0.0960	3.0669
7 Mullion	0.8917	1.0309	0.3800	0.1530	3.2676

U of insulating panel =	1.0309	
Glass thickness =	0.028	m
Centre pane U-value Ug =	1.19	
Overall width =	1.23	m
Overall height =	1.48	m
Overall area A_W =	1.8204	m2

Section detail	L_ψ2d	Uf	bf	Ug	bd	ψi
1 Fixed head	0.4951	2.7978	0.0810	1.1900	0.1900	0.0424
2 Fixed jamb	0.4951	2.7978	0.0810	1.1900	0.1900	0.0424
3 Fixed sill	0.4951	2.7978	0.0810	1.1900	0.1900	0.0424
4 Moving head	0.5611	3.0669	0.0960	1.1900	0.1900	0.0406
5 Moving jamb	0.5611	3.0669	0.0960	1.1900	0.1900	0.0406
6 Moving sill	0.5611	3.0669	0.0960	1.1900	0.1900	0.0406
7 Mullion	1.0242	3.2676	0.1530	1.1900	0.3800	0.0721

	Frame width bf	
1 Fixed head	0.081	m
2 Fixed jamb	0.081	m
3 Fixed sill	0.081	m
4 Moving head	0.096	m
5 Moving jamb	0.096	m
6 Moving sill	0.096	m
7 Mullion	0.153	m

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

Frame area	Af	Uf	Af.Uf
1 Fixed head	0.0434	2.7978	0.1215
2 Fixed jamb	0.1133	2.7978	0.3170
3 Fixed sill	0.0434	2.7978	0.1215
4 Moving head	0.0508	3.0669	0.1557
5 Moving jamb	0.1329	3.0669	0.4075
6 Moving sill	0.0508	3.0669	0.1557
7 Mullion	0.2129	3.2676	0.6957
Σaf=	0.6475	ΣAf.Uf=	1.9746

Panel length	lg	ψg	lg.ψg
1 Fixed head	0.4575	0.0424	0.0194
2 Fixed jamb	1.3180	0.0424	0.0559
3 Fixed sill	0.4575	0.0424	0.0194
4 Moving head	0.4425	0.0406	0.0180
5 Moving jamb	1.2880	0.0406	0.0523
6 Moving sill	0.4425	0.0406	0.0180
7 Mullion	1.3030	0.0721	0.0939
Σlg=	5.7090	Σlg.ψg =	0.2767

	Ag	Ug	Ag.Ug
Fixed glass	0.6030	1.1900	0.7176
Casement glass	0.5699	1.1900	0.6782
Σag=	1.1729	ΣAg.Ug=	1.3958

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

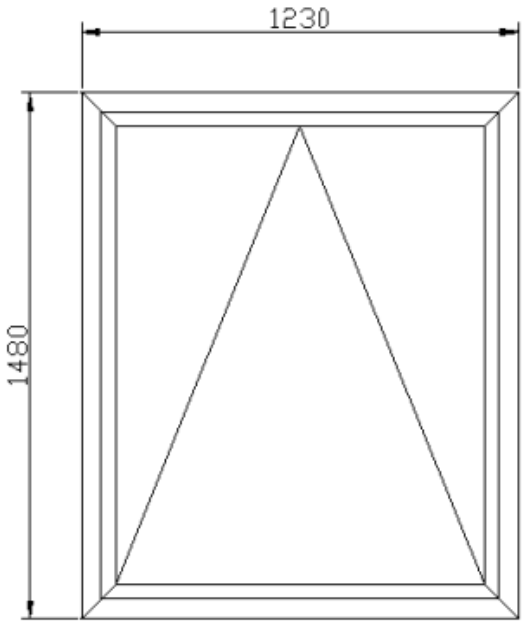
$$U_W = \frac{1.9746 + 1.3958 + 0.2767}{1.8204}$$

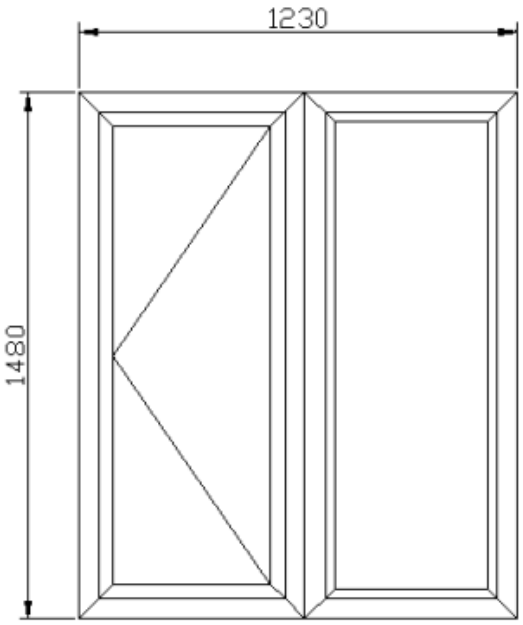
$$U_W = 2.003 \text{ W / m}^2\text{·K}$$

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

ANNEX B: WINDOW ELEVATIONS

Single opening casement window & opening/fixed window





ANNEX C: SOURCE DATA

Materials used

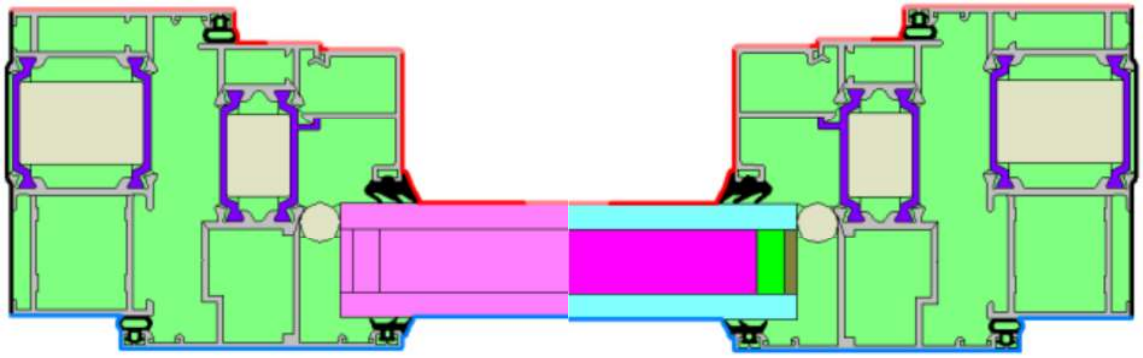
Design thermal conductivity of materials used in the simulation

Material		Conductivity (W/ m.K)	Emissivity	Source
Aluminium alloy (painted) *Frame & casement sections*		160	0.9	ISO 10077-2:2012 Table A.1 & A.4
Glass *Glazing*		1.00	0.9	ISO 10077-2:2012 Table A.1
Polysulphide *Spacer bar secondary sealant*		0.40	0.9	ISO 10077-2:2012 Table A.1
Polyamide 6.6 with 25% glass fibre *Thermal breaks*		0.30	0.9	ISO10077-2 Table A.1
Butadiene *Weatherseals*		0.25	0.9	ISO 10456:2007 Table 3
Swissspacer V Equivalent thermal conductivity *Spacer bar*		0.175	0.9	IFT Rosenheim Test Report no: 10-000414-PB02-K10-06-en-02
Polystyrene *Frame infill*		0.16	0.9	ISO 10456:2007 Table 3

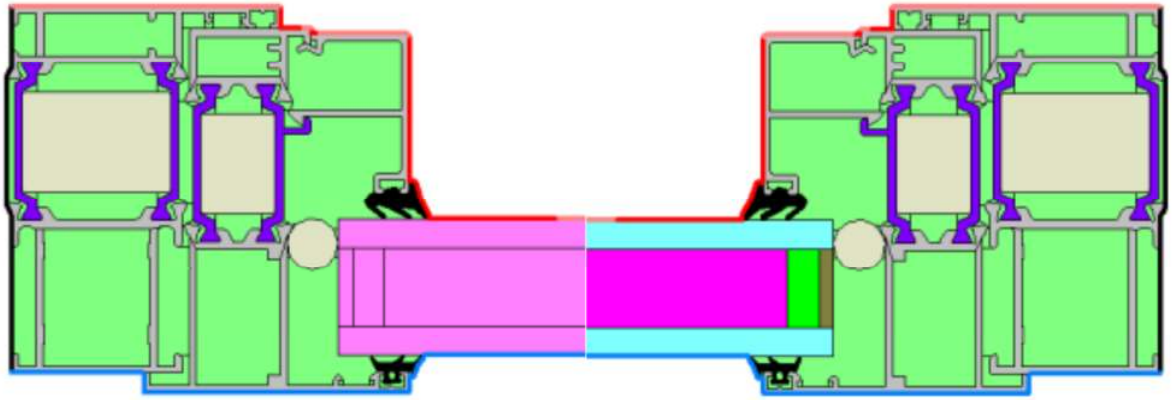
Cavities		Conductivity (W/ m.K)	Emissivity	Source
Unventilated cavity Slightly ventilated cavity		Various		ISO 10077-2:2012 Clause 6
λeff for 16mm cavity 6-16-6 argon filled unit, low e coating ε=0.05 at position 3		0.0243	0.90	By calculation according to BS EN 673:2011

ANNEX D: THERM MODELS

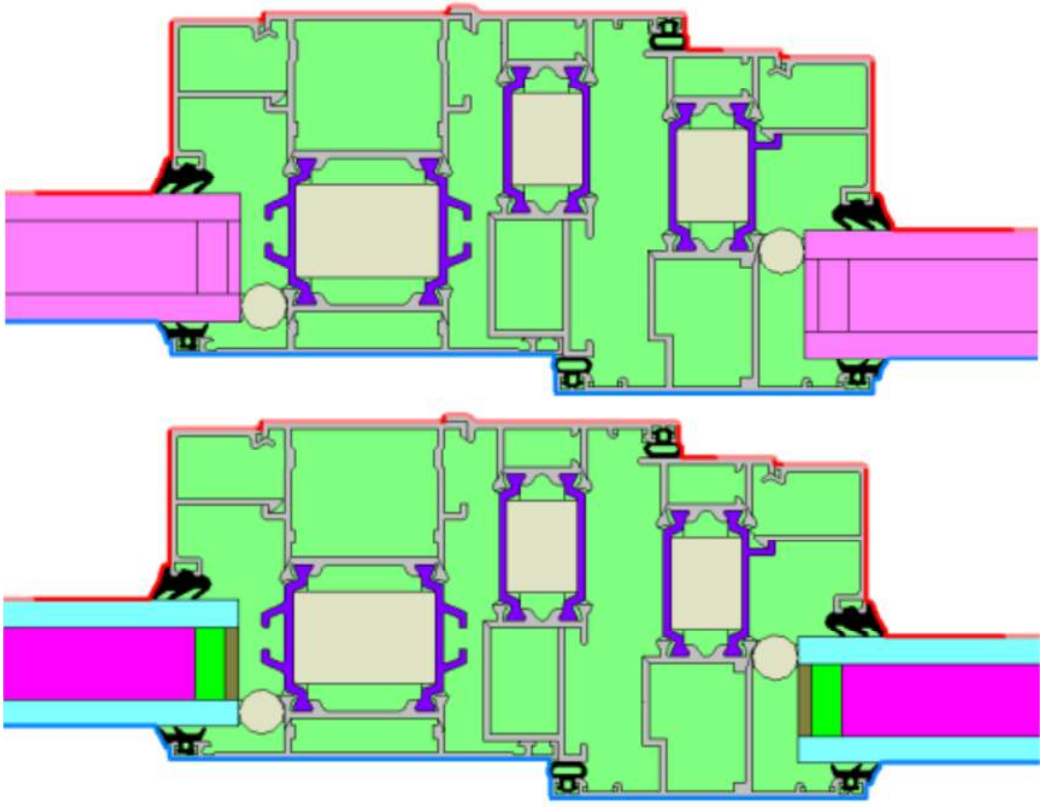
Opening head/jamb sill models (for L_f^{2d} and L_ψ^{2d} respectively)



Fixed head/jamb sill models (for L_f^{2d} and L_ψ^{2d} respectively)



Opening/fixed mullion models (for L_f^{2d} and L_ψ^{2d} respectively)



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