

# THERMAL SIMULATION REPORT

|                               |   |
|-------------------------------|---|
| Report Number:                | TCL2014-SWA-002   |
| Prepared For:                 | Steel Window Association<br>42 Heath Street<br>Tamworth<br>Staffordshire<br>B79 7HJ |
| Window System Identifier:     | W30   |
| Fixed Outer Frame Identifier: | WX7 (Fixed)   |
| Transom Frame Identifier:     | W7 (Fixed)  |
| Vent Frame Identifier:        | WX7 (Moving)  |
| Glazing System:               | 4mm Pilkington Optiwhite –<br>10 mm 90% Krypton – 4 mm<br>Pilkington KS             |
| Spacer Bar:                   | 10mm Edgetech Super<br>Spacer Standard  |
| Notes:                        |   |

## Results

|   |      |                      |
|---|------|----------------------|
| Thermal Transmittance<br>( $U_{window}$ ) | 2.0  | W/(m <sup>2</sup> K) |
| Solar Factor<br>( $g_{window}$ )          | 0.58 |                      |
| Air Leakage Factor ( $L_{factor}$ )       | 0.00 | W/(m <sup>2</sup> K) |
| BFRC Energy Rating Index                  | -10  |                      |
| BFRC Energy rating Band                   | B    |                      |

(Window Configuration as per GGF Document 2.2)  
(1230mm wide x 1480mm high –vent next to fixed light)

Report Prepared By Dr Gary Morgan

Therm

Consulting

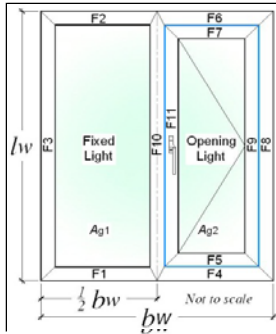
Signed: *G Morgan*

Date: 18<sup>th</sup> February 2014

The simulations in this report were performed using Therm 5.2.14  
according to EN ISO 10077 – 2.  
The Therm files generated are attached to this report as appendices



**BFRC Certified  
Simulator 016**



**Sample Style:**  
**Casement**  
**Fixed Light / Side Hung**

Blue line illustrates opening light length (air leakage)

Frame offset:  No  Yes

|   |             |       |                       |
|---|-------------|-------|-----------------------|
| Nominal 4mm etc to <b>0DP</b> , others <b>1DP</b> |             |       |                       |
| <b>Glazing dimensions and properties:</b>         |             |       |                       |
| Thickness of pane 1                               | 4           | mm    |                       |
| Pane 1/2 distance                                 | 10          | mm    |                       |
| Gas fill (1/2)                                    | Krypton 90% |       |                       |
| Thickness of pane 2                               | 4           | mm    |                       |
| Complete next 3 cells for TG IGU                  |             |       |                       |
| Pane 2/3 distance                                 |             | mm    |                       |
| Gas fill (2/3)                                    |             |       |                       |
| Thickness of pane 3                               |             | mm    |                       |
| Glazing Trans. - <b>3DP</b>                       | $U_g$       | 1.122 | W/(m <sup>2</sup> ·K) |
| g -value - <b>2DP</b>                             | $g_{\pm}$   | 0.75  |                       |

|   |  |                       |
|---|--|-----------------------|
| Thermal transmittance of window from hot box test |  |                       |
| $U_w - 2DP$                                       |  | W/(m <sup>2</sup> ·K) |

| Window Dimensions:                  |            | Area      |                             |                               |
|-------------------------------------|------------|-----------|-----------------------------|-------------------------------|
| Section                             | Length (m) | Width (m) | No gasket (m <sup>2</sup> ) | With gasket (m <sup>2</sup> ) |
| Fixed Light                         | 1.4320     | 0.5725    | 0.8198                      | 0.8118                        |
| Opening light                       | 1.4040     | 0.5425    | 0.7617                      | 0.7539                        |
| Total glazing, $A_g$                |            |           | 1.5815                      | 1.5657                        |
| Frame                               | (m)        | (m)       | (m <sup>2</sup> )           | (m <sup>2</sup> )             |
| F1                                  | 0.6150     | 0.0240    | 0.0143                      | 0.0154                        |
| F2                                  | 0.6150     | 0.0240    | 0.0143                      | 0.0154                        |
| F3                                  | 1.4800     | 0.0240    | 0.0349                      | 0.0378                        |
| F4                                  | 0.6150     | 0.0220    | 0.0131                      | 0.0131                        |
| F5                                  | 0.5745     | 0.0160    | 0.0089                      | 0.0100                        |
| F6                                  | 0.6150     | 0.0220    | 0.0131                      | 0.0131                        |
| F7                                  | 0.5745     | 0.0160    | 0.0089                      | 0.0100                        |
| F8                                  | 1.4800     | 0.0220    | 0.0321                      | 0.0321                        |
| F9                                  | 1.4360     | 0.0160    | 0.0227                      | 0.0255                        |
| F10                                 | 1.4800     | 0.0370    | 0.0539                      | 0.0568                        |
| F11                                 | 1.4360     | 0.0160    | 0.0227                      | 0.0255                        |
| Total Frame                         |            |           | 0.2389                      | 0.2547                        |
| Total Window, $A_w$                 |            |           | 1.8204                      | 1.8204                        |
| Percentage fixed light glass area   |            |           | 45.04%                      | 44.60%                        |
| Percentage opening light glass area |            |           | 41.84%                      | 41.41%                        |
| Percentage glass area (total)       |            |           | 86.88%                      | 86.01%                        |

|                        |  |       |      |
|------------------------|--|-------|------|
| Solar Factor, g-value: |  | $F_w$ | 0.9  |
|                        |  | $g_w$ | 0.58 |

|              |                            |      |                       |
|--------------|----------------------------|------|-----------------------|
| $U_{window}$ | No bars; or attached bars  | 1.99 | W/(m <sup>2</sup> ·K) |
|              | Single cross bar in IGU    | 2.1  |                       |
|              | Multiple cross bar in IGU  | 2.2  |                       |
|              | Glazing bar (Georgian bar) | 2.4  |                       |

| BFRC Rating kWh/(m <sup>2</sup> ·yr) | Label index | EWER Rating Scale | Window Rating |
|--------------------------------------|-------------|-------------------|---------------|
| ≥10                                  |             | A+                | B             |
| 0 to <10                             |             | A                 |               |
| -10 to <0                            | ←           | B                 |               |
| -20 to <-10                          |             | C                 |               |
| -30 to <-20                          |             | D                 |               |
| -50 to <-30                          |             | E                 |               |
| -70 to <-50                          |             | F                 |               |

Report Number: **TCL2014-SWA-002** Issue No 22.1: 11/03/2013  
 Report Date: **18 February 2014**  
 Project Details: **4 10 4 Pilkington Optiwhite - 90% Krypton - Pilkington KS with Edgtech Super Spacer Standard**

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**Input Values:**  
 Yellow input, green intermediary, blue finals X DP is no. of decimal places to enter

| Parameter                      | Symbol | Units   |
|--------------------------------|--------|---------|
| Total window height <b>0DP</b> | $l_w$  | 1480 mm |
| Total window width <b>0DP</b>  | $b_w$  | 1230 mm |

| Frame dimensions:  | (b <sub>f</sub> )   | Frame width, b <sub>f</sub> | Frame offset, b <sub>oF</sub> | Gasket protrusion, b <sub>g</sub> | Frame & gasket widths |       |
|--|---------------------|-----------------------------|-------------------------------|-----------------------------------|-----------------------|-------|
|  |                     | (mm)                        | (mm)                          | (mm)                              | (mm)                  |       |
| All frame values round to nearest 1mm, gaskets to <b>1DP</b> | F1 fixed sill       | 24                          | 2                             | 2.0                               | 26.0                  | Total |
|  | F2 fixed head       | 24                          | 2                             | 2.0                               | 26.0                  |       |
|  | F3 fixed jamb       | 24                          | 2                             | 2.0                               | 26.0                  |       |
| F4 + F5 sash sill  | F4 fixed sash sill  | 22                          | n/a                           | n/a                               | 22.0                  | 40.0  |
|  | F5 moving sash sill | 16                          | 2                             | 2.0                               | 18.0                  |       |
| F6 + F7 sash head  | F6 fixed sash head  | 22                          | n/a                           | n/a                               | 22.0                  | 40.0  |
|  | F7 moving sash head | 16                          | 2                             | 2.0                               | 18.0                  |       |
| F8 + F9 sash jamb  | F8 Fixed sash jamb  | 22                          | n/a                           | n/a                               | 22.0                  | 40.0  |
|  | F9 moving sash jamb | 16                          | 2                             | 2.0                               | 18.0                  |       |
| F10 + F11 mullion  | F10 fixed mullion   | 37                          | 2                             | 2.0                               | 39.0                  | 57.0  |
|  | F11 moving mullion  | 16                          | 2                             | 2.0                               | 18.0                  |       |
| Total gasket area  |                     |                             |                               | 0.015772                          | m <sup>2</sup>        |       |

| Where a $U_w$ value from hot box testing is available, $nd_{\tau}^{2D}$ or $L_{\psi}^{2D}$ values need to be entered |                 |   |                     |                 |         |                     |
|--|-----------------|---|---------------------|-----------------|---------|---------------------|
| Frame conductance:   |                 | All L values to <b>4DP</b> . All b values to <b>0DP</b> |                     |                 |         |                     |
| Section  | $L_{\tau}^{2D}$ | W/(m·K)   | b <sub>p</sub> (mm) | $L_{\psi}^{2D}$ | W/(m·K) | b <sub>a</sub> (mm) |
| F1 fixed sill  |                 | 0.4191  | 190                 |                 | 0.3962  | 190                 |
| F2 fixed head  |                 | 0.4191  | 190                 |                 | 0.3962  | 190                 |
| F3 fixed jamb  |                 | 0.4191  | 190                 |                 | 0.3962  | 190                 |
| F4 + F5 sash sill  |                 | 0.5207  | 190                 |                 | 0.5000  | 190                 |
| F6 + F7 sash head  |                 | 0.5207  | 190                 |                 | 0.5000  | 190                 |
| F8 + F9 sash jamb  |                 | 0.5207  | 190                 |                 | 0.5000  | 190                 |
| F10 + F11 mullion  |                 | 0.9006  | 380                 |                 | 0.8581  | 380                 |

| Frame:            | Frame width, b <sub>f</sub> | Frame U-value, U        | Frame areas, A    | Frame heat flow, HU | Linear trans, $\psi$ | Linear length, l <sub>g</sub> | Junction heat flow, H <sub>ψ</sub> |
|-------------------|-----------------------------|-------------------------|-------------------|---------------------|----------------------|-------------------------------|------------------------------------|
| Section           | (m)                         | (W/(m <sup>2</sup> ·K)) | (m <sup>2</sup> ) | (W/K)               | (W/(m·K))            | (m)                           | (W/K)                              |
| F1 fixed sill     | 0.0240                      | 5.8933                  | 0.0143            | 0.0840              | 0.0416               | 0.5765                        | 0.0240                             |
| F2 fixed head     | 0.0240                      | 5.8933                  | 0.0143            | 0.0840              | 0.0416               | 0.5765                        | 0.0240                             |
| F3 fixed jamb     | 0.0240                      | 5.8933                  | 0.0349            | 0.2059              | 0.0416               | 1.4360                        | 0.0597                             |
| F4 + F5 sash sill | 0.0380                      | 6.3957                  | 0.0220            | 0.1408              | 0.0438               | 0.5465                        | 0.0239                             |
| F6 + F7 sash head | 0.0380                      | 6.3957                  | 0.0220            | 0.1408              | 0.0438               | 0.5465                        | 0.0239                             |
| F8 + F9 sash jamb | 0.0380                      | 6.3957                  | 0.0548            | 0.3505              | 0.0438               | 1.4080                        | 0.0616                             |
| F10 + F11 mullion | 0.0530                      | 6.5146                  | 0.0766            | 0.4992              | 0.0865               | 1.4220                        | 0.1230                             |
| Totals            |                             | 0.2389                  | 1.5052            |                     |                      | Total                         | 0.3401                             |

|   |  |   |
|---|--|---|
| <b>Air Leakage loss:</b>  |  |   |
| Air leakage at 50 Pa per hour & per unit length of opening light (BS 6375-1) <b>2DP</b> |  |   |
| Opening light length  | 4.0210 m                                 | 0.07 m <sup>3</sup> /(m·h)                |
| $L_{50}$  | 0.15 m <sup>3</sup> /(m <sup>2</sup> ·h) | Total air leakage 0.281 m <sup>3</sup> /h |
| Heat loss = 0.0165 $L_{50}$   |  | 0.00 W/(m <sup>2</sup> ·K)                |

|  |                          |                                      |                                      |
|--|--------------------------|--------------------------------------|--------------------------------------|
| Other parameters needed for calculation, taken from simulations: |                          |                                      |                                      |
| $\lambda_p = 0.035$ W/(m·K)                                      | $R_{se} = 0.04$ -K /W    | $d_p = d_g = 0.018$ m                | $R_{se} = 0.13$ m <sup>2</sup> ·K /W |
| $R_p = 0.5143$ m <sup>2</sup> ·K /W                              | $R_{tot} = 0.6843$ -K /W | $U_p = 1.4614$ W/(m <sup>2</sup> ·K) |                                      |

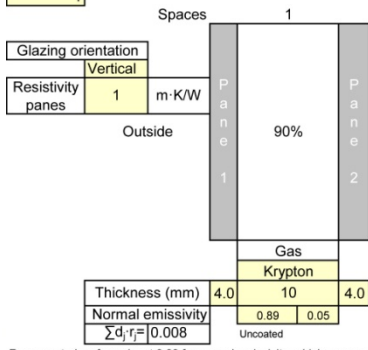
|  |                          |
|--|--------------------------|
| <b>BFRC Rating =</b>   |                          |
| 218.6g window - 68.5 x ( $U_{window}$ + Effective $L_{50}$ ) = | <b>-9.53</b>             |
| Climate zone is:   | <b>UK</b>                |
| Thermal transmittance, W/(m <sup>2</sup> ·K)                   | $U_{window}$ <b>2</b>    |
| Solar factor   | $g_{window}$ <b>0.58</b> |
| Window air leakage heat loss, W/(m <sup>2</sup> ·K)            | $L_{factor}$ <b>0.00</b> |



Simulator Name: **DR Gary Morgan** BFRC Certified Simulator **016**

Version 9 July 2010. Calculations according to BS EN 673:1998 (A1)

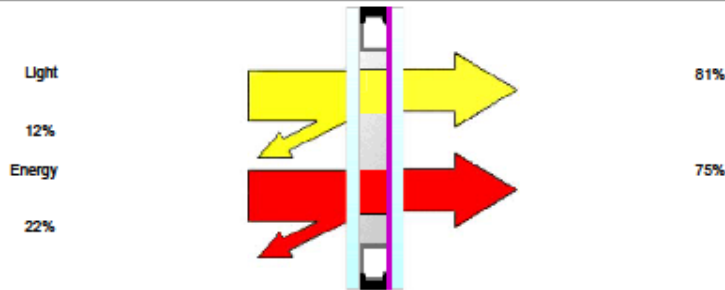
|                  |   |
|------------------|---|
| Number of spaces | 1 |
|------------------|---|



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

| Iteration number | U value           |                                     | $\text{A}_{\text{eff}}$ |            |
|------------------|-------------------|-------------------------------------|-------------------------|------------|
|                  | $W/(m^2 \cdot K)$ | $\sum 1/h_s$<br>( $m^2 \cdot K$ )/W | $W/(mK)$                | $\Delta T$ |
| 1                | 1.122             | 0.7147                              | 0.0140                  | 15         |
| 2                | 1.122             | 0.7147                              | 0.0140                  | 15         |





**Description**

| Position     | Product              | Process  | Thickness (nominal)<br>mm | Weight<br>kg/m <sup>2</sup> |
|--------------|----------------------|----------|---------------------------|-----------------------------|
| Glass 1      | Pilkington Ophwhite  | Annealed | 4                         | 10                          |
| Cavity 1     | Krypton (90%)        |          | 10                        |                             |
| Glass 2      | Pilkington K Glass S | Annealed | 4                         | 10                          |
| Product Code | 4w-10Kr-KS4          |          | 18                        | 20                          |

**Performance**

|                 |                               |                             |   |                              |                    |
|-----------------|-------------------------------|-----------------------------|---|------------------------------|--------------------|
| <b>Light</b>    |                               | <b>Sound Reduction</b>      |   | $R_w$ dB (C;C <sub>v</sub> ) | NPD                |
| Transmittance   | LT                            | 81%                         | Thermal Transmittance   |                              | W/m <sup>2</sup> K |
|                 | UV %                          | 44%                         |   |                              | 1.1                |
| Reflectance Out | LR out                        | 12%                         | <b>Ra</b>   |                              | 99                 |
| Reflectance In  | LR In                         | 12%                         | <b>Performance Code</b>   |                              |                    |
| <b>Energy</b>   |                               | <b>Direct Transmittance</b> |   | <b>U-value/Light/Energy</b>  |                    |
|                 | ET                            | 64%                         |   |                              | 1.1 / 81 / 75      |
|                 | ER                            | 22%                         | <b>The values of some of characteristics are displayed as NPD. This stands for No Performance Determined.</b> |                              |                    |
|                 | EA                            | 14%                         |   |                              |                    |
|                 | g                             | 75%                         |   |                              |                    |
|                 | Shading Coefficient Total     | 0.86                        |   |                              |                    |
|                 | Shading Coefficient Shortwave | 0.73                        |   |                              |                    |

Pilkington Spectrum allows you to combine a wide range of products available from Pilkington and determine their key properties such as light transmittance, g value and U value. The program includes restrictions that prevent some combinations being selected that may be considered unwise or impractical. Even with these restrictions, it is still possible to create product combinations that may not be available from your supplier. Please check with your supplier that your chosen product combination is possible, available in the sizes required and in a timescale appropriate to your project. Furthermore, it is essential that you check that your product combination is appropriate for satisfying local, regional, national and other project-specific requirements.

Calculations are made according to EN standards 410 and 673/12898

Pilkington Spectrum Version 4.0.0

18/02/2014



## Certificate of Test: Chilt/P10036

Steel Window Association  
42 Heath Street  
Tamworth  
Staffordshire  
B79 7HJ

This document confirms that performance testing was conducted on 8 April 2010. Testing was conducted to the following standard:-

- BS 6375 Part 1:2009 Performance of windows and doors - Part 1: Classification for weathertightness and guidance on selection and specification. The following results were achieved.

| Product tested                        | W-30 Side Hung Casement Window |                         |                   |
|---------------------------------------|--------------------------------|-------------------------|-------------------|
| Summary of testing and classification |                                |                         |                   |
|                                       | Test Standard                  | Classification standard | Result            |
| Air permeability                      | BS EN 1026: 2000               | BS EN 12207: 2000       | 600Pa (Class 4)   |
| Watertightness                        | BS EN 1027: 2000               | BS EN 12208: 2000       | 750Pa (E750)      |
| Wind resistance                       | BS EN 12211: 2000              | BS EN 12210: 2000       | 1600Pa (Class A4) |
| Exposure category                     | BS 6375: Part 1: 2009          |                         | 1600              |

Air leakage at 50pa was 0.2m<sup>3</sup>/h positive pressure and 0.3m<sup>3</sup>/h negative pressure. The perimeter length of opening light was 3.42m

The results relate only to the specimen tested, as detailed in technical specification document number Chilt/P10036/tec1

Paul Andrews –  
Head of Section Mechanical Testing  
Date:

Vincent Kerrigan -  
Technical Manager  
Date: 19-07-2010

### Chiltern Dynamics

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### Air leakage calculation

Chiltern Dynamics report number Chilt /P10036 gives the positive and negative airflows at 50 Pa as 0.2 m<sup>3</sup>/h and 0.3 m<sup>3</sup>/h respectively. The opening light length is given as 3.42 m

Thus the average air infiltration rate per m opening light length is given by:

$$((0.2 + 0.3) / 2) / 3.42 = 0.07 \text{ m}^3/(\text{m}\cdot\text{h})$$

| <b>Material</b>             | <b>Conductivity (W/mK)</b> | <b>Emissivity</b> |
|-----------------------------|----------------------------|-------------------|
| Mild Steel                  | 50                         | 0.9               |
| Aluminium                   | 160                        | 0.9               |
| Glass                       | 1.0                        | 0.9               |
| EPDM                        | 0.25                       | 0.9               |
| Butyl (Hot Melt)            | 0.24                       | 0.9               |
| Super Spacer Standard       | 0.13                       | 0.9               |
| PVC / PU Foam Elastomer     | 0.05                       | 0.9               |
| Glazing Gas Space Effective | 0.014                      | 0.9               |
| CEN Insulation Panel        | 0.035                      | 0.9               |

