ATIR-2018-02

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AFRC Technical Interpretation

Please complete the highlighted fields and return to the AFRC.

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Interpretation Requested:
How should spandrel panels be simulated?

Date Requested:	*Initial Interpretation Date:*	*Final TAC Approval Date:*
16/2/18	9/10/18	27/03/2019

Pertinent Documents:	
NFRC 100 – 2010; Curcija, D.C. *Technical Note: Modeling Spandrel Systems for NFRC ratings, September 2010*; NFRC Technical Interpretations; ISO 15099:2003; Baker, Michael. *Proposed Spandrel Simulation Methodology*, G. James. Personal communication, May 2017.	
Referenced Sections:	*Referenced Pages:*

Interpretation :
A 'spandrel panel' or 'spandrel system' is defined as the opaque part of a façade that is commonly adjacent to, and integrated with, surrounding transparent or translucent glazed areas ('vision areas'). Historically, spandrels have been a neglected issue; in the NCC they are defined to be external walls, while in reality they have more in common with windows. Consequently they have been neglected by organisations dealing with both. This Technical Interpretation brings spandrels into the orbit of the AFRC. When analysed as walls, overly simplistic approaches lead to serious over-estimation of spandrel thermal performance (expressed as U- or R-values). Spandrels are effectively windows that have zero visible transmittance and zero solar transmittance. They typically include many of the materials and componentry of framed windows and are fabricated at the same time as windows by the same contractor. However, they are rarely modelled or certified with the same procedures or rigour as the adjacent glazed areas. This TI presents a methodology for calculating the thermal transmittance (U-value) and total thermal resistance (R-value) of spandrel systems in building facades. This TI is based on a procedure that has been accepted by the Australian Building Codes Board for addition to NCC 2019 (Volume One – Commercial).

Figure 1 shows a typical spandrel system.

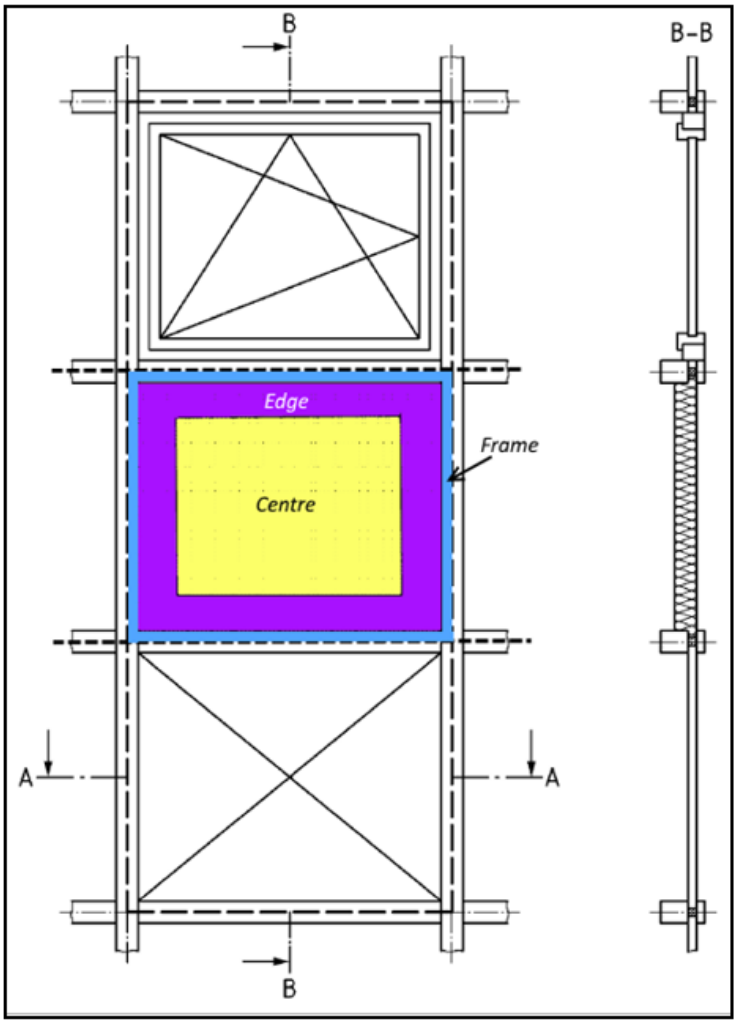

Figure 1: Boundaries of a representative spandrel system in a façade (adapted from ISO 12631:2012, Figure 4). Spandrel system, with framing shared with adjacent vision panels, is divided into frame (blue), edge (mauve) and centre (yellow) regions.

For each individual rectangular framed spandrel panel, the governing equations follow those in ISO 15099:2003; Equation 10. We distinguish between the centre-of-spandrel, edge-of-spandrel and spandrel frame components of the system. Accordingly, the area-weighted, spandrel system U-value, U_{sp} , is expressed as:

$$U_{sp} = \frac{U_{cs}A_{cs} + \sum U_{es}A_{es} + \sum U_{fs}A_{fs}}{A_{cs}+\Sigma A_{es}+\Sigma A_{fs}} \quad (1)$$

where

A denotes area of each element (m^2)

cs denotes centre of spandrel (yellow in Figure 1)

es denotes edge of spandrel (mauve in Figure 1), **127mm wide**

fs denotes frame of spandrel (blue in Figure 1)

To evaluate Equation 1, the component U-values must calculated using currently approved versions of THERM (for edge and frame) and Berkeley Lab WINDOW (for centre-of-spandrel). These component U-values were then combined in an AFRC spreadsheet to calculate the overall spandrel system U-value. Note that the edge-of-spandrel dimension is **127mm**, which is twice that used for windows. This is because spandrels are much thicker than windows. This results in the 2D region for heat flow extending further into the spandrel infill panel, compared to a typical glazing unit.

Example: spandrel panel with no thermal break

INTRODUCTION

The overall U-value of a spandrel panel system depends both on its size and the relative contributions of the spandrel's constituent components. We present an analysis of a systems that is typical of spandrels currently used in Australian buildings.

CENTRE REGION OF SPANDREL

Table 2. Centre region of spandrel panel (infill) used in system with no thermal break. System modelled with software tool Berkeley Lab WINDOW 7 at standard NFRC 100-2010 environmental conditions. Final system U-value includes effect of outdoor and indoor air films.

EDGE AND FRAME PARTS OF SPANDREL

THERM 7 was used to model CAD drawings for the head, jambs and sill of the thermally unbroken spandrel frame assembly. The spandrel panel in Table 1 above was used in all four frame components; THERM results are shown in Figures 3 - 7. As mentioned above, the edge-of-spandrel dimension was set to 127mm in order to capture all 2D heat transfer. This is shown in Figures 4 - 7.

Layer no.	Description	Thickness (mm)
1	Clear float glass	6.0
2	Airgap	100.5
3	Aluminium alloy shadow box, painted	3.0
4	Airgap	1.0
5	Fibreglass insulation, k = 0.04 W/(mK)	75.0
6	Airgap	1.0
7	Aluminium alloy or steel, painted	1.0
	U-value, W/(m²•K)	**0.437**

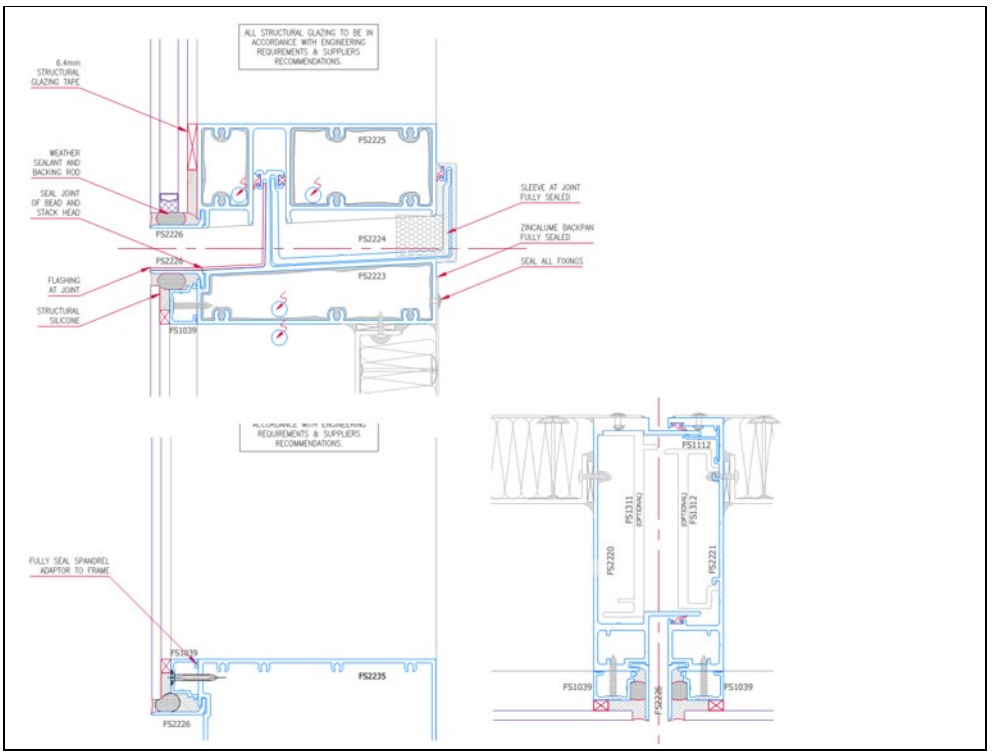

Figure 1: HEAD, SILL and JAMB sections from manufacturer's drawings.

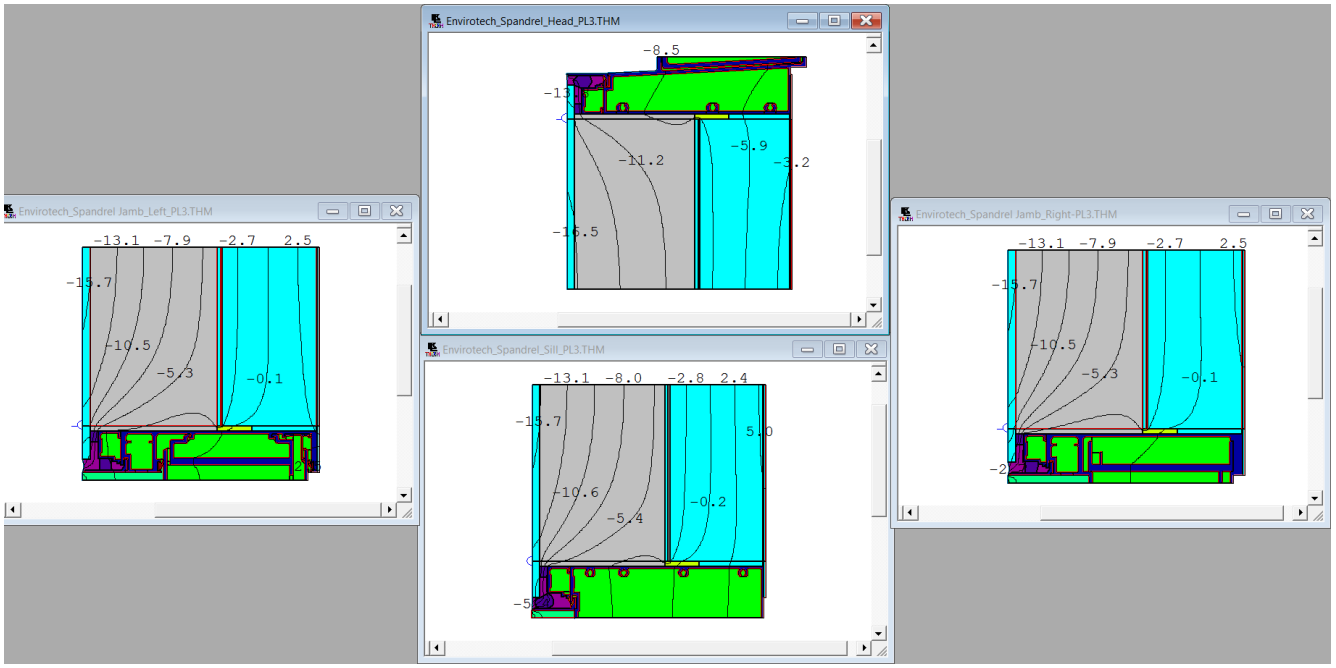

Figure 2: All four sections modelled in THERM 7 as per AFRC procedures. Top: head; left: left jamb; right: right jamb; bottom: sill.

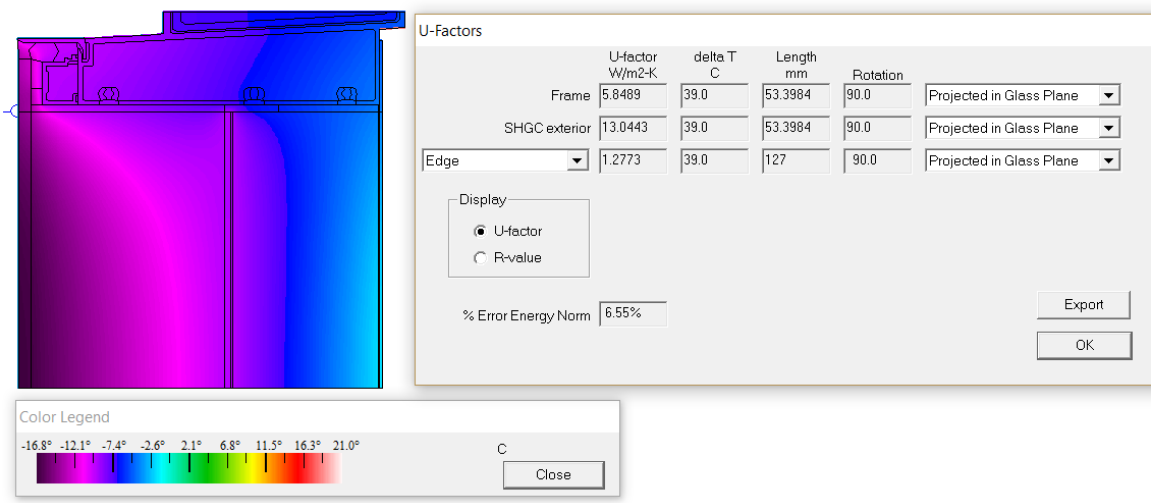

Figure 3: Head section of the thermally unbroken frame. Note edge length is set to 127mm.

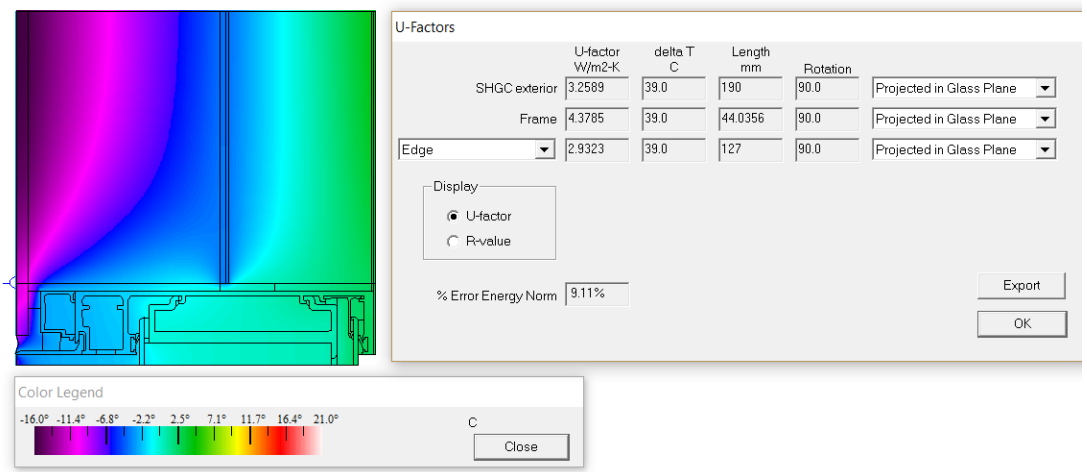

Figure 5: Left Jamb section. Gravity (down) is into the page.

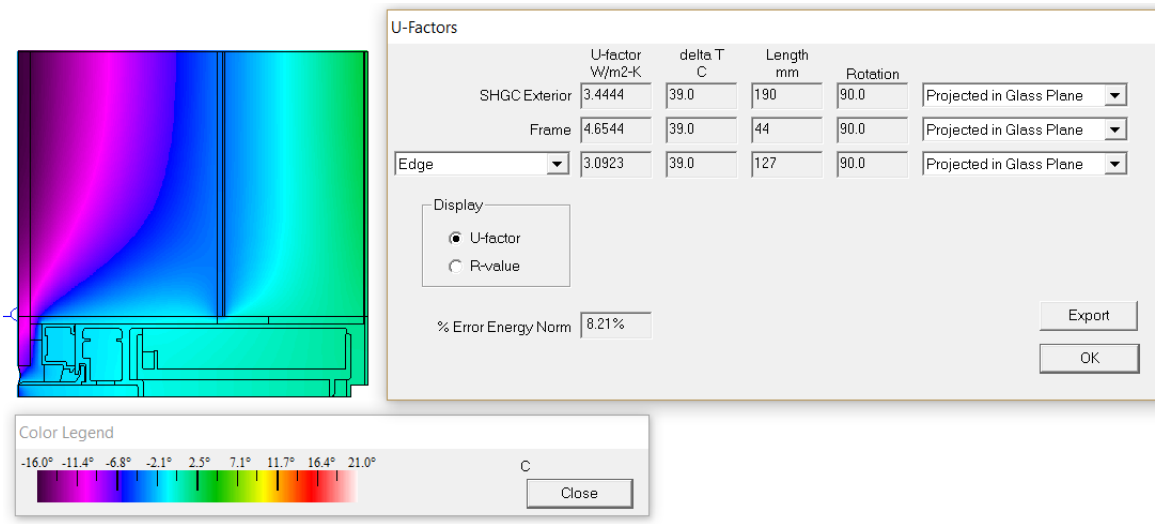

Figure 4: Right Jamb section.

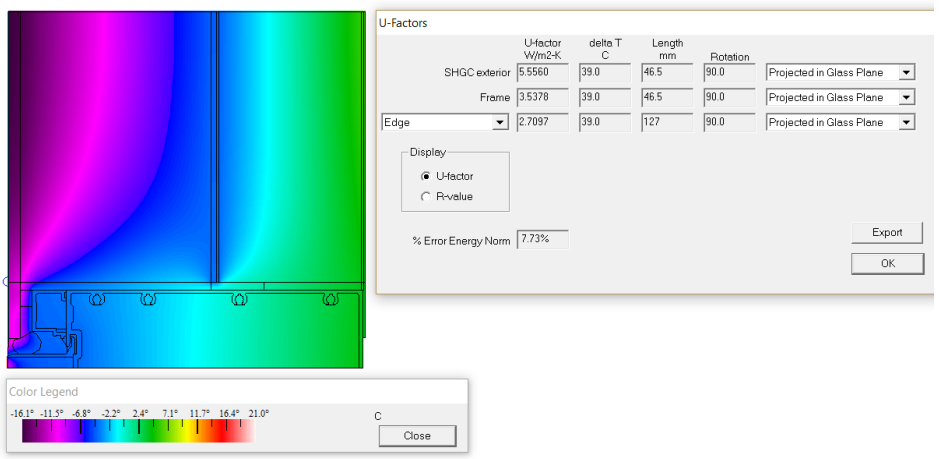

Figure 7: Sill section.

RESULTS FOR COMPLETE SPANDREL SYSTEM

As discussed above, when windows are modelled according to AFRC procedures, an edge-of-glass dimension of 63.5mm is used by default by the Berkeley Lab WINDOW 7 software when it calculates the final, system U-value. In the case of spandrel panels, the analogous parameter is the edge-of-spandrel dimension. *Because the edge dimension in WINDOW cannot be changed from 63.5mm*, a purpose-designed AFRC spreadsheet (attached to this report) was created to enable the area-weighted, whole-spandrel U-value to be calculated, based on a spandrel edge dimension of 127mm.

THERM 7.4.3 was used to model CAD drawings for the head, jambs and sill of the thermally unbroken spandrel frame assembly. The spandrel infill panel in Table 2 above was used in all four frame models, results for which are shown in Figures 4 - 7.

Table 2. Spandrel with no thermal break. Screenshot from calculation spreadsheet.

U-value Calculator for whole spandrel system, including frame

Enter known values in green cells. Whole-system spandrel results appear in cells B12 and B13

	HEAD		LEFT JAMB		RIGHT JAMB		SILL		CENTRE OF SPANDREL
	Frame	Edge	Frame	Edge	Frame	Edge	Frame	Edge	
Length, *m*	1.200	1.112	0.900	0.800	0.900	0.800	1.200	1.112	
U-value, *W/(m²K)*	5.849	3.923	4.379	2.932	4.654	3.092	3.538	2.710	0.437
Projected width in plane parallel to spandrel , *m*	0.0534	0.1270	0.0440	0.1270	0.0440	0.1270	0.0465	0.1270	

R-value, whole spandrel system, *m²K/W*	0.44
U-value, whole spandrel system, *W/(m²K)*	2.26