USER GUIDE TO

REFERENCE PROCEDURE FOR SIMULATING SPANDREL U-FACTORS

Fenestration Association of BC (FENBC)
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Acknowledgements

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Preface

This *Reference Procedure for Simulating Spandrel U-Factors* was developed for voluntary use by fenestration manufacturers and building designers.

Design standards such as ASHRAE 90.1 and NECB require building designers to determine the effective U-factor of opaque wall assemblies clad with spandrel products. Building designers commonly rely on fenestration manufacturers to provide U-factor data for the products they supply.

FENBC member companies found there was insufficient guidance in NFRC 100 for simulating spandrels, and particularly the narrow and interrupted spandrels that are common in large buildings today. The lack of a recognized reference methodology was identified as an impediment to evaluating competing performance claims.

This Reference Procedure was created to allow spandrel U-factor performance claims to be objectively evaluated in a similar way as window U-factor performance claims that are based on NFRC 100 procedures.

While various methods are currently employed to determine spandrel U-factors, including physical testing, 2D simulation and 3D thermal modelling, it was felt that a simulation method based on NFRC 100 and using LBL THERM software would allow industry participants to produce consistent and comparable results more quickly and more economically than using other methods.

The objective of this Reference Procedure differs from the objective of NFRC fenestration product simulations. The Reference Procedure limits itself to the concerns of building designers who are need to determine effective U-factors for opaque walls. The NFRC approach includes the determination of two additional properties that are significant for fenestration assemblies: Solar Heat Gain Coefficient and Condensation Resistance.

The Reference Procedure differs from NFRC 100 in three respects:

1) It increases the panel edge distance from the 63.5 mm (2.5 in.) used for transparent glass to 152.4 mm (6 in.), a dimension found to be more accurate for spandrels

2) It offers three spandrel product configurations, one of which is identical to the curtain wall configuration in NFRC 100. The additional configurations address window wall spandrels interrupted by floor slabs

3) It utilizes an Excel worksheet to perform area-weighting calculations in place of the LBL WINDOW software

Reference Publications

Name and Version of Publication	Name Used in this Document
ANSI/NFRC 100-2014 [E0A1], Procedure for Determining Fenestration Product U-factors *Published by the National Fenestration Rating Council Inc.*	NFRC 100
THERM 7/WINDOW 7 NFRC Simulation Manual, (Publication Version: July 2017) *Published by the National Fenestration Rating Council Inc.*	NFRC Simulation Manual

1 Introduction

1.1 Statement of Intent

This user guide is a companion document to the Reference Procedure for Simulating Spandrel U-Factors.

The purpose of the Reference Procedure is to provide a consistent methodology for determining spandrel U-factors. The use of a consistent methodology in construction specifications makes it possible to compare the relative performance claims of proposed assemblies under identical standard conditions that include standard sizes. The proposed methodology also allows values to be scaled to more closely represent project values once specific assemblies have been selected.

This user guide provides additional information to aid the user in applying the procedure and provides background information regarding the development of the procedure.

1.2 Procedure Objective

Provide a reference methodology that prioritizes consistency, comparability, and ease of use for product rating that allows for a more accurate assessment of the performance of different spandrel configurations.

1.3 Motivation

While the thermal simulation procedures of glazed fenestration products and doors is well documented by the National Fenestration Rating Council (NFRC), the simulation procedures for opaque spandrels are not similarly documented. Furthermore, spandrel assemblies are substantially different from conventional opaque wall assemblies (i.e., concrete, steel stud, wood stud, etc.). To address this lack of uniform guidance, a Reference Procedure has been developed to document a standardized approach for the determination of spandrel U-factors.

1.4 Scope

The approach presented here provides a U-factor comparable to an NFRC U-factor for vision glazing. Determination of optical properties (SHGC, and VT) and condensation resistance are outside the scope of this procedure. These limits in scope do not impact the ability of this procedure to provide relevant U-factors for product comparisons.

Specific construction practices, or ancillary details such as deflection headers can have a significant impact on the U-factor of the fenestration system and the overall thermal performance of a building. Neglect of these impacts is a gap currently present in most North American building energy codes. The methodology developed here is not intended to address this gap, rather it is intended to provide a methodology for spandrels which is consistent with current industry practice for fenestration systems. The thermal bridging of transition details between systems is outside the scope of the Reference Procedure and can be addressed separately using linear transmittance values (Ψ-Values).

1.5 Overview of Simulation Approach

NFRC simulation techniques and associated two-dimensional thermal simulation tools such as THERM are widely accepted and adopted within the North American fenestration industry for the thermal simulations of vision glazing areas, and many fenestration manufacturers have in-house capability to provide these calculations. As spandrel assemblies are provided by fenestration manufacturers and are more similar to vision glazing than to opaque walls, they lend themselves to a similar simulation approach. That said, spandrel systems, and in particular spandrels which bypass a floor edge such as a concrete slab, often feature more complex configurations than vision glazing areas and consequently a modification of existing methodologies is required.

In recognition of the tools and methods currently employed by the fenestration industry, the proposed methodology uses a two-dimensional thermal simulaton approach to determine spandrel U-factors. Three-dimensional modelling or physical measurements have the potential to provide improved accuracy; however, these approaches are, in different measures, complex, time consuming, costly, and lacking widespread industry adoption and thus were not utilized for the FENBC Reference Procedure for Simulating Spandrel U-factors.

1.6 Organization

This user guide outlines the methodology in Section 2 and provides a worked example in Section 3. Section 4 is a summary of issues encountered while developing the procedure with some guidance on how to overcome them. Section 5 discusses additional considerations for thermal simulation of spandrels.

2 Methodology

The proposed methodology features two distinctive modifications to the existing NFRC simulation procedure:

1) Addition of two additional spandrel product configurations for a total of three standard configurations

2) Increased edge distance from 63.5 mm (2.5 in.) to 152.4 mm (6 in.)

Section 2 of this user guide describes these modifications and provides a rationale for these adjustments. For specific details, please refer to the Reference Procedure document.

2.1 Configurations

Spandrels, like other fenestration products, are sold in many sizes and configurations. Currently, a single standard product size is recognized in NFRC 100. The standard size is 2,000 mm wide by 1,200 mm high and the spandrel is simulated with two lites divided by a vertical mullion.

In practice, spandrel areas are often minimized to preserve vision glazing area and are located to conceal opaque interior building elements such as floor slabs. This results in spandrels which are significantly smaller and often interrupted by floor slabs, significantly impacting their effective thermal performance.

To illustrate this impact, three spandrel configurations with similar nominal R-values are shown in Table 2.1. The U-factors are based on a single full cross section.

1) Uninterrupted

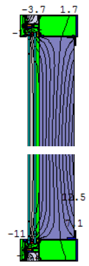
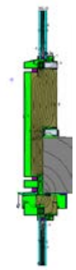
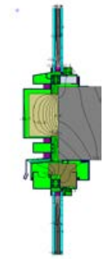
2) Partially Interrupted

3) Fully Interrupted

The first configuration (uninterrupted) is simulated to the standard product size in NFRC 100 (i.e., 2000 mm x 1200 mm) and has an RIP-value of 8.3 hr·ft^2·°F/Btu. The second configuration (partially interrupted) shows the reduction U-factor due to a reduction in back pan depth at the slab and a decrease in the center-of panel to frame ratio, R_{IP}-3.9. The third configuration (fully interrupted) shows the impact of a very large decrease in the center of panel to frame ratio, R_{IP}-2.3.

The large range in simulated U-factors, from R-8 to R-2, shows the potentially large errors inherent in applying a simulated NFRC 100 spandrel U-value to an interrupted spandrel configuration.

Table 2.1 Effect of Spandrel Configuration on U-factor and R-value

	Uninterrupted	**Partially Interrupted**	**Fully Interrupted**
THERM Models			
U-Factor ($W/m^2 \cdot K$)	U_{SI}-0.70	U_{SI}-1.46	U_{SI}-2.42
U-Factor ($Btu/hr \cdot ft^2 \cdot {}^\circ F$)	U_{IP}-0.12	U_{IP}-0.26	U_{IP}-0.43
R-Value ($m^2 \cdot K/W$)	R_{SI}-1.46	R_{SI}-0.67	R_{SI}-0.41
R-Value ($hr \cdot ft^2 \cdot {}^\circ F/Btu$)	R_{IP}-8.3	R_{IP}-3.9	R_{IP}-2.3
R-Nominal ($hr \cdot ft^2 \cdot {}^\circ F/Btu$)	R_{IP}-21	R_{IP}-21	R_{IP}-20

It is worth noting that while NFRC 100 reports U-factors at predefined reference sizes to allow for products to be compared on the basis of performance, the standard also provides a method for adjusting simulated U-factors to project specific sizes. While many professionals elect to adjust the simulated performance values to match project sizes, doing so is optional in NFRC 100, which is primarily focused on providing comparable product ratings. The decision to use project specific values is at the discretion of the design team and may also be an energy code requirement.

While project specific sizing provides a more accurate performance value for energy simulation, it does not allow for product comparisons, which is a key benefit of the NFRC approach of using standard sizes. The mix of standard and project size values in the industry has introduced challenges for manufacturers, specifiers, and design teams to set and meet performance criteria.

To address the need for more realistic performance values, while still allowing for product comparisons, the Reference Procedure divides spandrels into three configurations:

→ Configuration 1: Uninterrupted Spandrels
(i.e. curtain wall spandrel bypasses slab edge and no insulation is installed to the interior side of the back pan)

→ Configuration 2: Partially Interrupted Spandrels
(i.e. window wall spandrel notched over slab edge)

→ Configuration 3: Entirely Interrupted Spandrels
(i.e. window wall spandrel limited to slab edge)

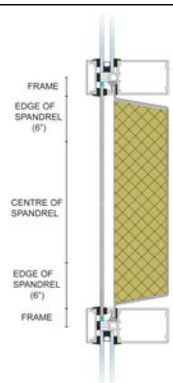
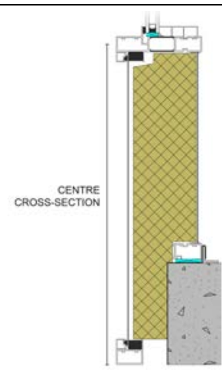
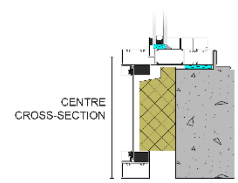
A summary of these configurations and sizes is presented in Table 2.2.

2.2 Excel-based Calculation Tool

To aid in the determination of overall product U-factors, a Microsoft Excel-based calculation tool was developed for use with this procedure. The calculator is designed to accept project-specific or reference-standard dimensions and to perform area-weighted calculations to obtain the overall product U-factor.

Disclaimer: Every reasonable effort has been made to ensure the accuracy of this tool. However, RDH does not warrant its accuracy and use of the tool is at the user's discretion.

Table 2.2 Spandrel Types and Simulation Sizes

<table>
<tr><th>Configuration 1</th><th>Configuration 2</th><th>Configuration 3</th></tr>
<tr><td>Uninterrupted Spandrel</td><td>Partially Interrupted Spandrel</td><td>Fully Interrupted Spandrel</td></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
<tr><td>2000 mm x 1200 mm
(79 in x 47 in)</td><td>2000 mm x 1200 mm
(79 in x 47 in)</td><td>2000 mm x 203 mm
(79 in x 8 in)</td></tr>
</table>

2.3 Increased Edge Distance

The NFRC simulation method for determining fenestration U-factors involves simulating 2D cross sections, obtaining U-factors for frame, edge-of-glass, and center-of-glass and weighting these values by their respective areas. NFRC specifies a standard edge distance of 63.5 mm (2.5 in.), which defines the edge and center-of-glass areas and is used by simulators to determine the U-factor.

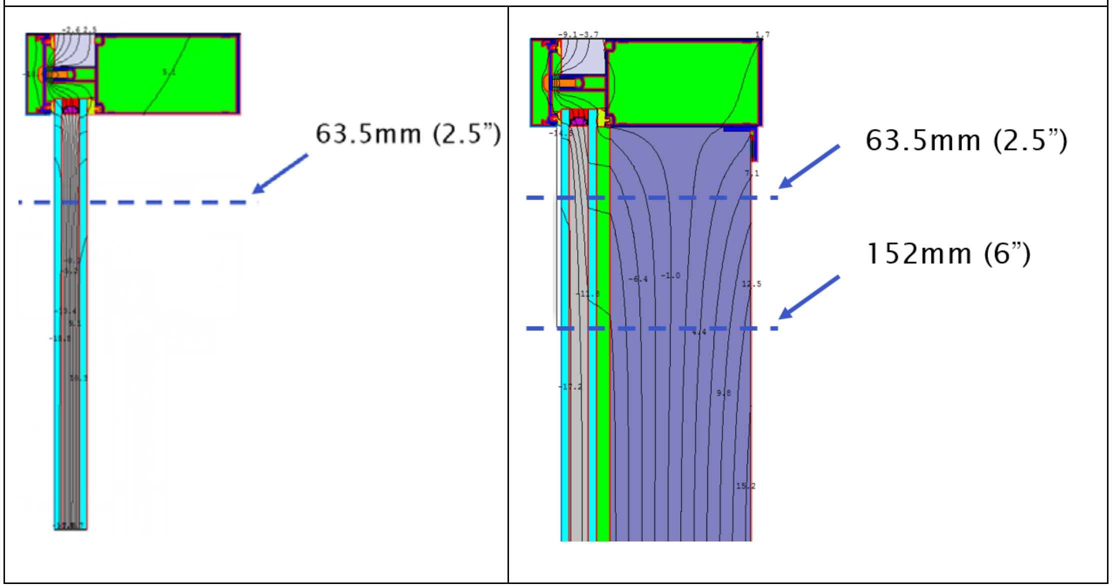
The concept behind an edge distance is that beyond a certain distance from the frame, two-dimensional edge effects diminish and the heat flow through the fenestration product acts more like 1D heat flow. This can be illustrated with the help of 2D isotherms, which are lines of constant temperature. Where the isotherms are parallel to each other and to the plane of the glass or panel, this indicates a region where heat flow is behaving one dimensionally and hence like the center-of-glass or -panel.

For vision glass products, an edge distance of 63.5 mm (2.5 in.) has been determined to meet this criterion. However, this is not the case for spandrels.

Figure 2.1 shows a standard curtain wall window profile on the left and the same profile with an added spandrel back pan on the right. In the case of the spandrel, two-dimensional heat flow is still observed at a distance of 63.5 mm (2.5 in.) from the frame. In this example, the center of panel performance is achieved at a distance of 152 mm (6 in.). One of the reasons for the increased edge distance is the metal back pan, which acts as a thermal bridge, as well as the increased insulated thickness.

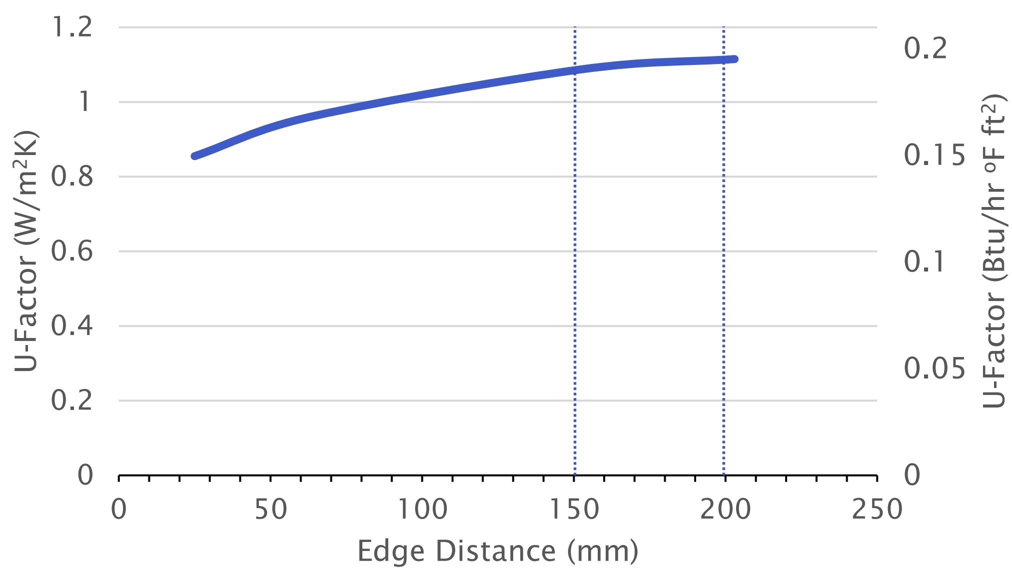
Figure 2.1: 2D simulations of a typical double glazed curtain wall IGU (left) and spandrel (right).

Where the isotherms converge to become parallel the center of glass/panel performance is achieved. For spandrels, similar to the simulation shown, this condition often occurs at a greater edge distance than is specified for glass infill.



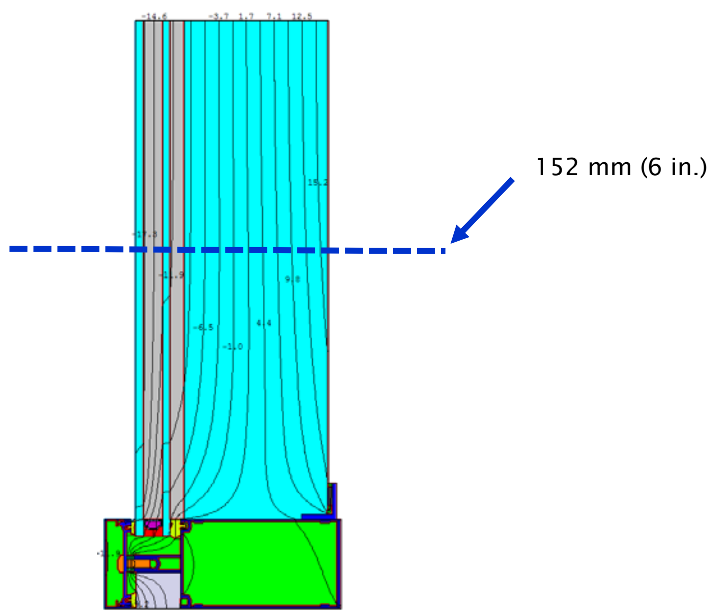
The edge distance is intended to represent the point at which the isotherm lines become parallel. Based on thermal simulation, an edge distance of 152 mm (6 in.) was selected to more accurately capture the two-dimensional heat flows observed for typical spandrels. Furthermore, simulation of typical spandrels has shown that using edge distances larger than 152 mm (6 in.) has a diminishing impact on the simulated product U-factor.

Figure 2.2: Simulated Product U-factor vs. Spandrel Edge Distance



The edge distance was investigated using the WINDOW import method with very similar results.

Figure 2.3: 2D model of a typical spandrel imported into THERM from WINDOW.
This figure shows a similar trend of increased edge distance.



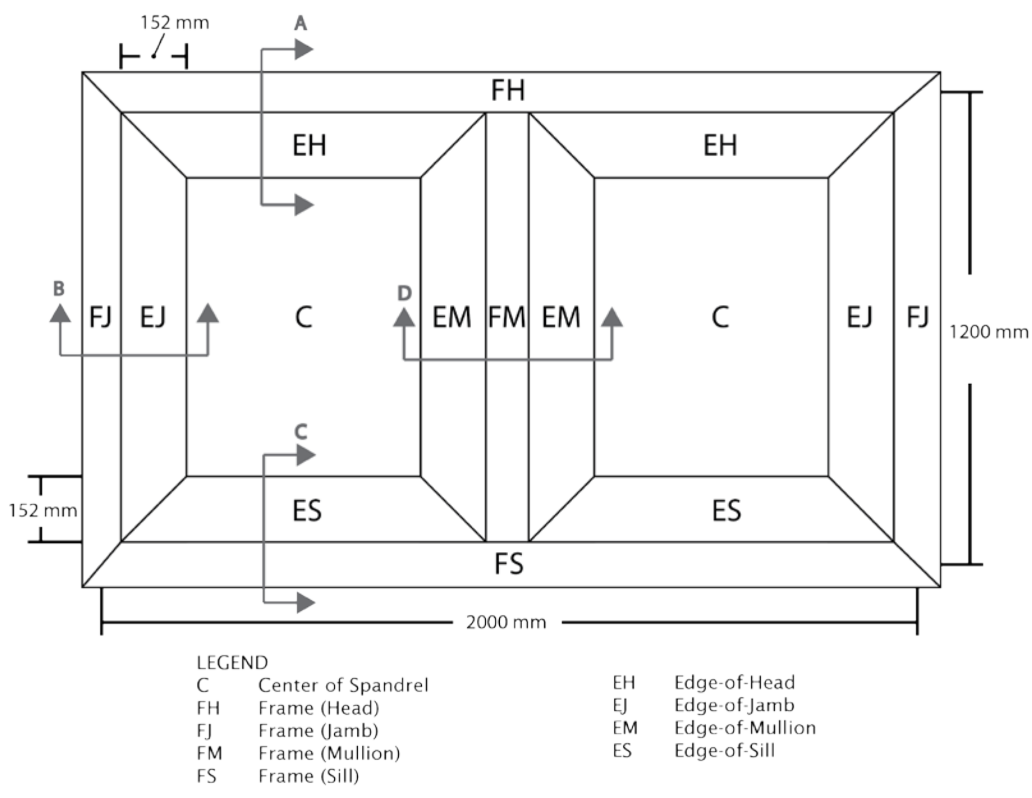
3 Examples

This Section provides an example of how to follow the Reference Procedure to simulate Configuration 1, followed by comments on how to address configurations 2 and 3.

3.1 Configuration 1: Uninterrupted Spandrel, Curtain Wall

Description: A spandrel with two lites and a center mullion, 2000 mm wide by 1200 mm high, identical to the configuration described in NFRC 100. Height and width are measured to the center line of the mullions.

Figure 3.1: Schematic diagram showing the areas and cross sections required to simulate a spandrel per Configuration 1 (uninterruted spandrel).



3.1.1 Step 1: Determine the Center of Panel U-factor

The center of panel U-factor of an uninterrupted spandrel in the NFRC 100 configuration may be determined either one-dimensionally using WINDOW or two-dimensionally using THERM. [1]

[1] The WINDOW procedure illustrated here is based on the work of Dr. Charlie Curcija, a scientist at the Lawrence Berkeley National Laboratory, as presented in an NFRC Technical Note dated October 20, 2010.

Center of Panel Performance Using WINDOW

1. Create the spandrel in WINDOW as if it were a glazing system.
    a. Use material properties (conductivity, emissivity, absorptivity) from NFRC 101.
    b. Where radiative properties are not known, assume default properties.
        i. Transmittance = 0
        ii. Absorptivity = 0.5 for insulated systems
2. Insert non-glazing materials (e.g., insulation, back pan, etc.) as individual glass layers. These layers can be defined as new records in the glass library.
3. Separate multiple layers in direct contact with a very small (0.001 mm), highly conductive (9999 W/m^2K) gap.
4. Use NFRC 100 boundary conditions.
5. Run the simulation to obtain the U-factor for the center of spandrel.

If this approach is used, then the spandrel may be inserted into the 2D THERM simulation when determining the frame and edge of spandrel U-factors.

Center of Panel Performance Using THERM

An alternative to using WINDOW is to simulate the center of spandrel in THERM. This approach has the benefit of not requiring the use of fictitious layers and the subsequent construction can readily be incorporated into the frame cross sections.

This approach will require the simulator to perform U x A calculations outside of WINDOW, a procedure which is outlined in NFRC 100 and in the Reference Procedure.

Comparison of WINDOW vs. THERM for Center of Panel Performance

To evaluate the impact of simulating the center of spandrel U-factor in WINDOW versus in THERM, both approaches were used to simulate a typical spandrel as shown below.

Figure 3.2: Screenshot of a 2D thermal modelling in THERM

2D thermal modelling of a spandrel featuring 101.6 mm mineral wool, a ½ in. air space, and an IGU (U_{SI}-0.268).

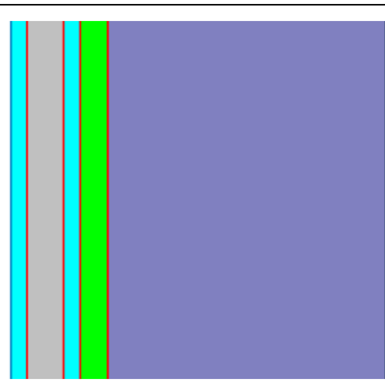
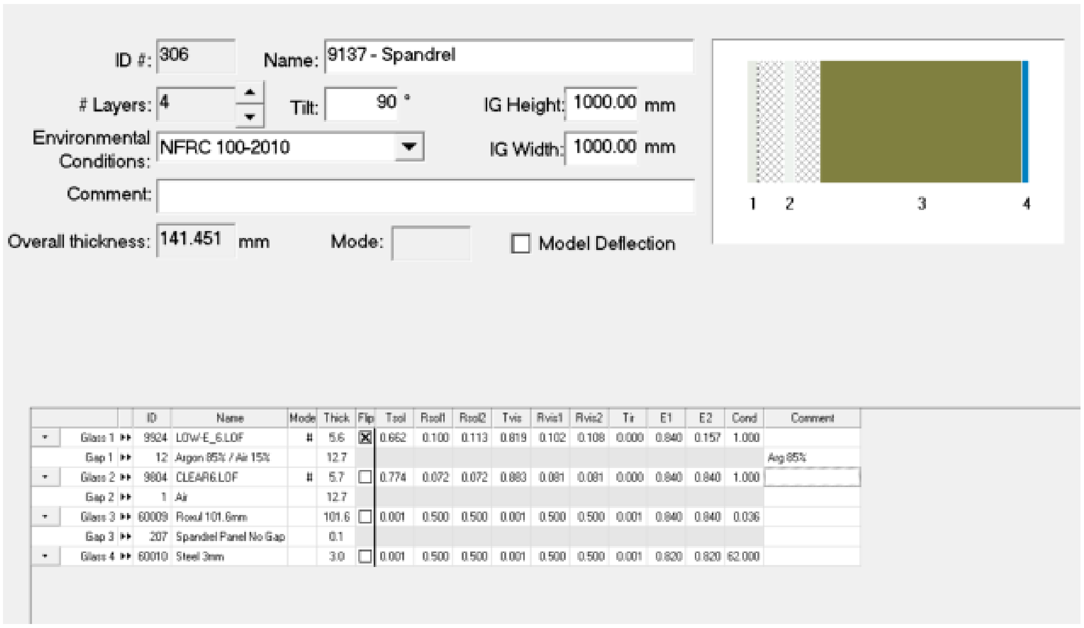


Figure 3.3: Screenshot of a 1D thermal simulation in WINDOW

Thermal simulation of a spandrel featuring 101.6 mm mineral wool, an air space, and an IGU (U_{SI}-0.265).



The results of this exercise are summarized in the table below.

Table 3.1 Simulated U-factors for the center of spandrel using WINDOW and THERM

Methodology	**U_{SI}-Factor (W/m²K)**	**U_{IP}-Factor (Btu/hr · ft² · °F)**
WINDOW (1D)	0.265	0.0467
THERM (2D)	0.268	0.0472
% Difference	1.1%	

In summary, there is very little difference anticipated or observed in this example between using the two methods and either method can be used to determine the center of spandrel U-factor for an uninterrupted spandrel.

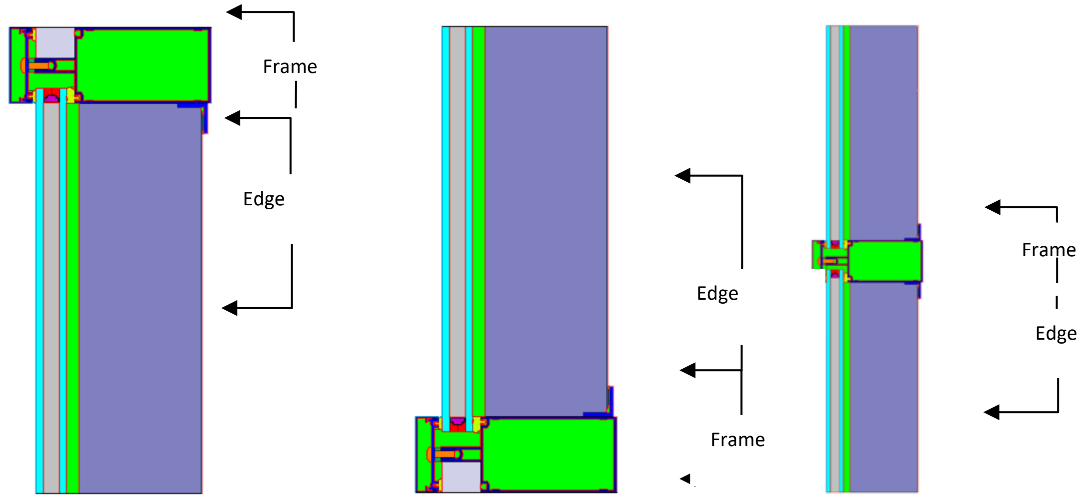
3.1.2 Step 2: Determine Frame and Edge of Spandrel Performance Using THERM

The frame and edge-of-panel values are determined by simulating the cross sections in THERM. The procedure is summarized at a high level below:

1) Create the frame profile in THERM (Head, Sill, Jamb, etc.).
2) Create the spandrel either a) by modelling it directly in THERM or b) by inserting the previously created spandrel from WINDOW as a glazing system.
3) Assign U-factor tags for the frame and edge of panel, see Figure 3.4.

Figure 3.4: Head, sill, jamb (same as sill), and center mullion profiles for an example spandrel system.

The profiles shown here are for calibration against physical test data.



3.1.3 Step 3: Calculate the Overall Product U-Factor

The final step in this procedure is to determine the overall product U-factor per the Reference Procedure. A spreadsheet-based calculation tool was created as part of the Reference Procedure development to assist with this calculation.

3.2 Configurations 2 and 3

The methodology for Configurations 2 and 3 is similar, with a few differences in cross sections and areas as noted in the Reference Procedure. However it is not possible to use WINDOW to determine the center-of-spandrel U-factors of the interrupted spandrels in these configurations.

The following two figures show the U-factor tags for Configurations 2 and 3:

Figure 3.5: Sill/Head cross section for an example spandrel Configuration 2.

U-factor tags are shown for reference. Center of panel performance is obtained using 1D calculations.

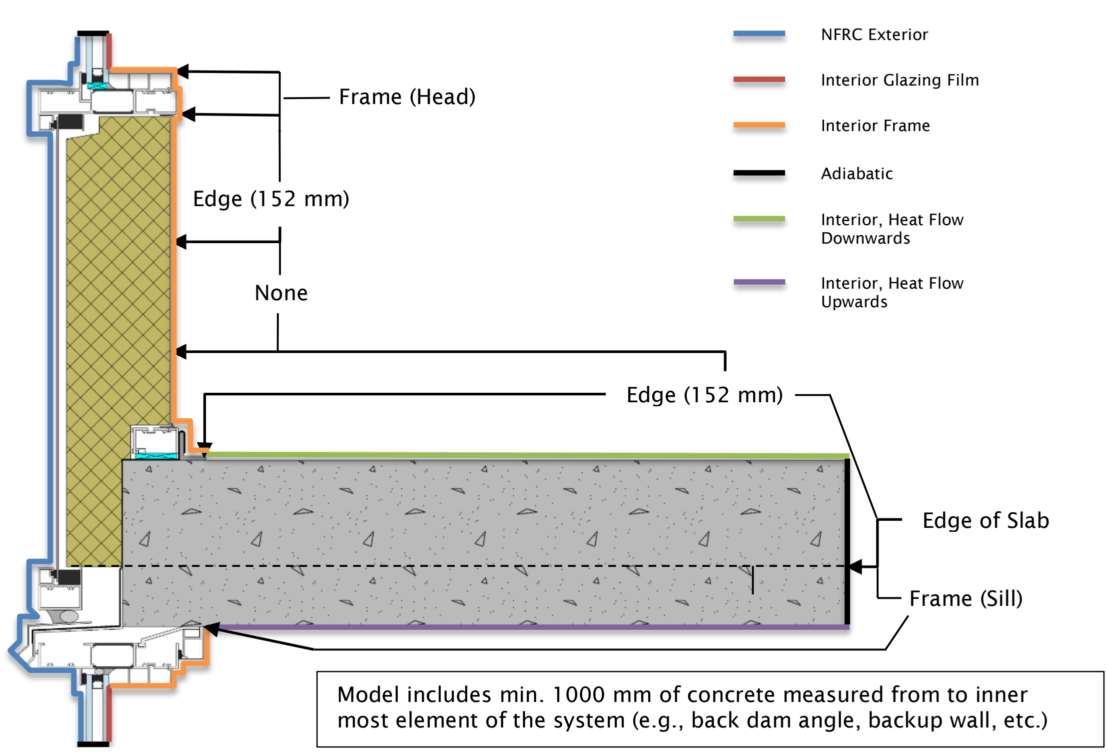
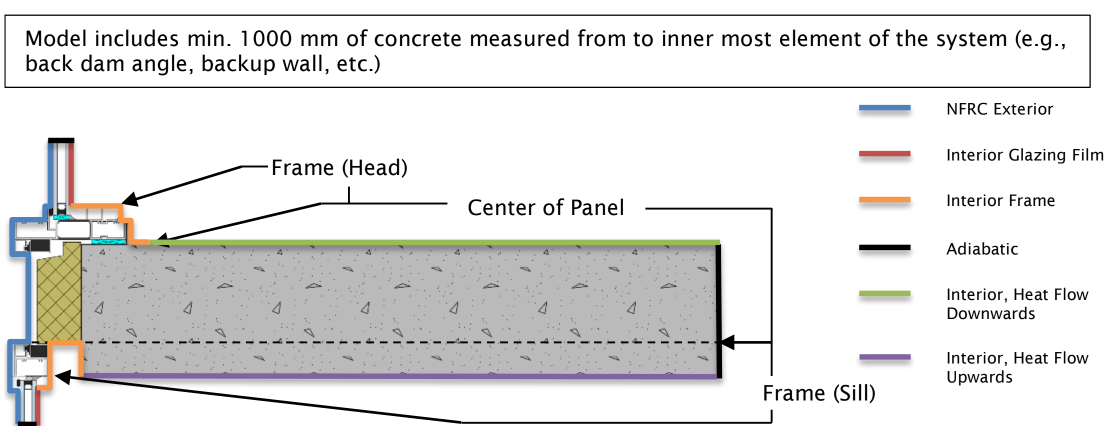


Figure 3.6: Sill/Head cross section for an example spandrel Configuration 3.

U-factor tags are shown for reference. Note, the center of panel U-factor is obtained from the cross section simulation and not using 1D approaches as is the case for Configurations 1 and 2.



4 Troubleshooting

4.1 Mesh Size in THERM

Due to the complexity of the model, and specifically the introduction of fine (frame) details, coarse (wall) details, and the use of larger cross sections, it will often be necessary to run the simulations with a higher Quadtree Mesh Parameter. When this is unsuccessful at resolving simulation difficulties, complete the following steps in order:

1) Break up the highlighted polygons into smaller polygons.
2) Simplify the geometry with reference to Section 6.6.1 of the NFRC Simulation Manual.

4.2 Potential Errors using WINDOW

Errors may occur when using WINDOW to determine the center of panel performance of a spandrel. These errors are likely the result of errors in the properties of the glass or gap layers used in the glazing system representing the spandrel. WINDOW will warn the user of some potential errors, while others may only be discoverable once the spandrel is inserted into THERM.

→ When creating the fictitious air gap, it is recommended to copy the default air gap record and to modify only the conductivity coefficients. An error may occur if the other properties are out of range.

NOTE: For obtaining overall product U-factors according to the Reference Procedure, use of WINDOW is not required.

4.2.1 Conductivity

WINDOW uses the following formula to determine conductivity

→ $Conductivity = A + B \cdot T + C \cdot T^2$, where T is in degrees Kelvin and the coefficients are obtained from ISO 15099

In the case of defining the fictitious air gap layer, use of ISO 15099 properties is not required. Instead, the following coefficients shall be entered.

a. A = 9999
b. B = 0
c. C = 0

→ These coefficients will provide a conductivity of 9999 W/m·K for all temperatures.

4.2.2 Emissivity

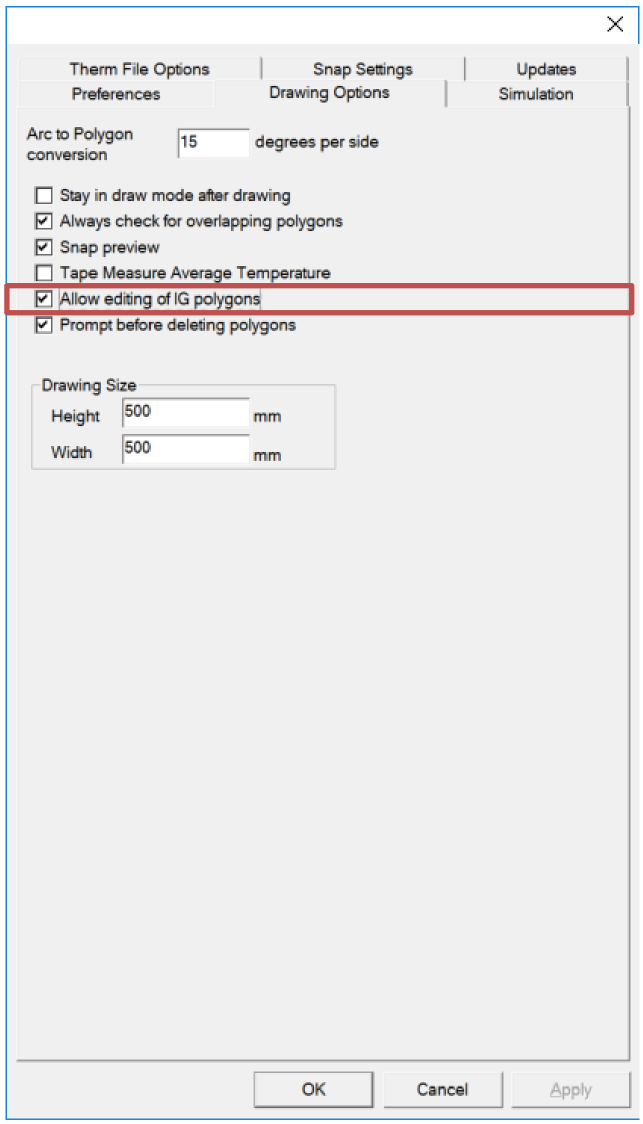
Material properties such as emissivity shall be realistic. For example, entering values of 0 instead of more realistic defaults such as 0.82 in the case of emissivity can lead to non-convergence of the solution in THERM.

4.2.3 Inserting a Spandrel from WINDOW

A spandrel created in WINDOW can be imported like other glazing systems. The geometry of the spandrel may require enabling editing of IG polygons, which is turned off by default. To change this setting, go to Options → Preferences → Drawing Options and make sure the "Allow editing of IG polygons" is checked.

Figure 4.1: Screen capture of the Preferences → Drawing Options settings in THERM.

Turning on the "Allow editing of IG polygons" setting may be necessary to complete the 2D model.



5 Additional Considerations

The NFRC energy performance rating system was designed to allow independent entities to objectively and accurately evaluate product performance. NFRC ratings are used to compare the performance of competing products and for compliance with the energy performance requirements of building codes and regulations. To do so, all products are evaluated under standardized conditions.

These standardized conditions include standard sizes at which products are evaluated, and isolation of the window products from installation-related conditions and from adjacent products. While the presence and nature of adjoining assemblies can affect the heat flow and energy performance of the individual product being simulated, NFRC provides conventions to simplify the analysis. For these reasons, NFRC performance values do not reflect actual installed product performance at project sizes and under climate conditions prevalent at many building sites.

Whole building energy design standards such as ASHRAE 90.1 and NECB require energy performance values such as U-factors to be determined under NFRC 100 standardized conditions. The “standard” U-factors can be determined independently of project sizes and other variables that affect their “actual” performance. Project-specific performance data is simply not available at the design and building permit stages.

Many design teams however seek to determine actual product performance as accurately as can be practically accomplished. Sometimes this is because the desired products cannot achieve the required U-factors at standard sizes, but can when project sizes are used for the analysis. Other times it is because they wish to achieve an energy use intensity goal that requires a higher level of precision in the performance of critically important assemblies. To account for this, NFRC-100 provides a method to accommodate other-than-standard product sizes and the procedure outlined in this Reference Procedure is compatible with these NFRC methods.

This Section identifies several considerations not accounted for when determining NFRC 100 U-factors, and discusses how project teams can address them when they wish to do so.

5.1 Adjacent Systems

Studies have shown that adjacent systems have an impact on the thermal performance and surface temperatures of the system being evaluated. In a modern curtain wall system, the adjacent system may be another spandrel, but may also be an IGU, a different framings system, or a wall. Simulation of all these variations, while ideal from an accuracy point of view, is impractical for a rating procedure given the potentially limitless number of combinations.

In general, if the adjacent system performs worse, then it will draw more heat due to thermal bridging and result in the spandrel portion of the thermal model appearing to perform better thermally. The reverse may also occur if a higher performing system is adjacent to the spandrel being evaluated. The frame profile and details around the transition may also play a major role in the effect of the adjacent system.

5.1.1 Reference Procedure Approach

The approach adopted by the Reference Procedure assumes in the first and second configurations, that the adjacent system is another spandrel of the same type. This focuses on the spandrel performance and represents a common configuration. In the third configuration, a glazing system is assumed to be adjacent at the head and sill. For consistency when comparing spandrel systems, the glazing system is replaced by a material with the same shape, size and frame clearance as the IGU it is replacing. The replacement material is wood with a conductivity of 0.130 W/m·K. The purpose of this step is to limit the impact of variations in adjacent glazing system performance on the spandrel being assessed. This method was adapted from Section 8.9 of the NFRC Simulation Manual and aligns with the NFRC 100-2010 philosophy of providing a product rating rather than simulating the installed system performance.

Note that IGUs integral to the spandrel being evaluated are simulated per the standard procedures outlined in NFRC 100 and the use of a wood panel is reserved for adjacent systems where appropriate.

5.1.2 Alternative Approaches

Alternatives to this approach include treating the adjacent systems as another simulation parameter and simulating each variation in a similar manner to the approach used for other fenestration products. Simulating every possible adjacent system was considered unnecessary for a comparative product performance rating. The design team should consider whether the product rating value meets the needs and expectations for their specific project.

5.2 Project Size U-Factors

Depending on the project, U-factors simulated at the standard size may not capture the performance of the system to the desired level of accuracy. In these cases, the method outlined in section 4.6.3 of NFRC 100, as directed in Appendix A (Non-Mandatory Information) can be used.

5.2.1 Reference Procedure Approach

The Reference Procedure provides three common configurations that could apply to a window wall product, each having a specified size to allow for comparison with other products of the same configuration. The methodology identified in the Reference Procedure is compatible with the methodology outlined in Section 4.6.3 of NFRC 100 for obtaining U-factors for project specific sizes. This process is considered optional.

5.2.2 Alternative Approach

The alternative approach is to use project-specific spandrel sizes. Building energy modelling standards and guidelines like the 2017 City of Vancouver energy modelling guidelines may require project-specific sizes. Project teams should make themselves aware of the specific energy modelling requirements in effect in each jurisdiction.

In addition to using project sizes, accuracy may be further improved by simulating the actual project adjacent systems.

5.3 2D vs. 3D Simulation

Two- and three-dimensional simulations have been compared by several authors (e.g., Norris, et al.) with the general observation that three-dimensional simulations can more accurately reflect the results of physical testing. The advantage of three-dimensional thermal modelling is more apparent when additional details (adjacent systems, installation methods, configurations, etc.) are considered.

5.3.1 Reference Procedure Approach

The approach adopted by the Reference Procedure is to use 2D simulations. The principal reasons for doing so were to leverage the availability of existing product simulation data, industry standard simulation software, and trained technicians and professionals to perform the simulation.

5.3.2 Alternative Approach

An alternative to the 2D simulation approach is to incorporate physical testing (as is done in NFRC 100) to first calibrate the simulation results. The calibrated simulation can then be used as a starting point to add additional project specific details to increase accuracy of the simulated system where a need for higher accuracy warrants the additional simulation time. 3D modelling is also an option, but is outside the scope of the Reference Procedure.

5.4 Installed Thermal Performance

Current practice for rating window systems following NFRC 100 does not account for the impact of installing the fenestration product, which can reduce the overall system performance. While sometimes identified as a criticism of the NFRC approach, there are already several established methods for determining the installed performance of fenestration products. Introducing a requirement for manufacturers to report installed performance would result in potentially limitless variations and would be contrary to the intent of the Reference Procedure.

5.4.1 Reference Procedure Approach

The approach adopted by the Reference Procedure neglects installation details, similar to NFRC 100. Neglected components include accessories like deflection headers, seismic jambs, and adjacent flashings. Although these have a direct impact on the thermal performance of the spandrel, installed performance is best addressed on a project specific basis by following standards like ISO 10211.

5.4.2 Alternative Approach

An argument could be made to rate products based on a selection of standardized reference wall assemblies and installation details. However, this method would not capture all potential variations, and project specific simulations would likely still be required. As this approach was not consistent with the approach used in NFRC 100 for vision glazing, it was not adopted for the Reference Procedure.