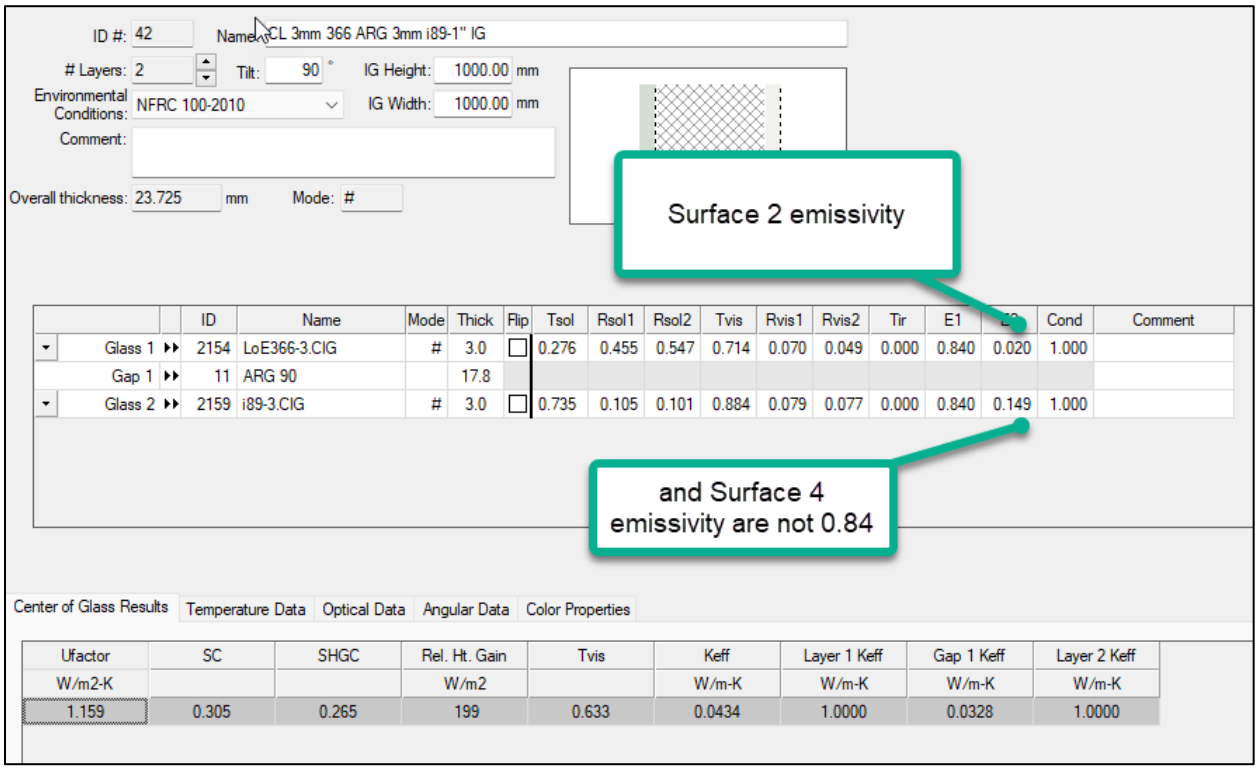
WINDOW and THERM fixes that change results

The following describe fixes to THERM 7 that result in small changes to the results.

1. Divider results are better in 7.8 (u, shgc, and edge) than in 7.4 [Issue #1278]

<u>This fix will change results in THERM if a frame cavity with an imported IGU is in the model</u>

The emissivity of glass surfaces were not picked up when importing a glazing system from WINDOW into THERM. For a given record in WINDOW:



When importing this IGU in THERM 7.4 the emissivities do not match what is shown in WINDOW:

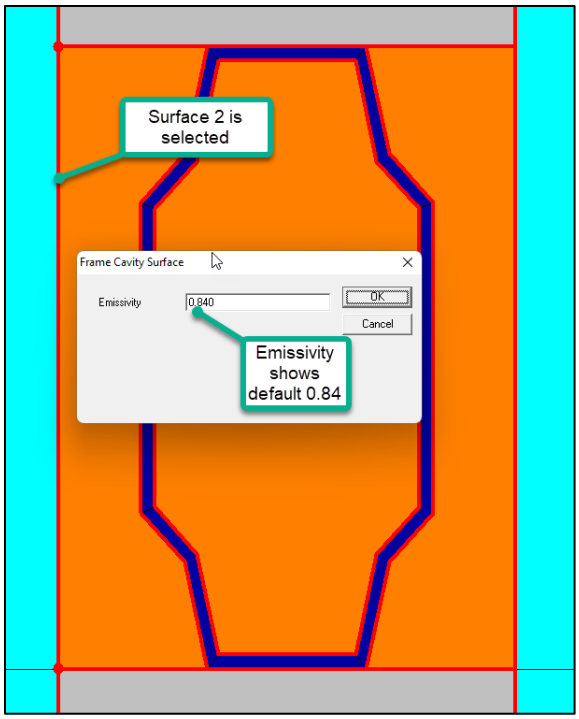


Figure 1: THERM 7.4 imported IGU

Importing the same IGU in THERM 7.8 picks up the emissivities correctly:

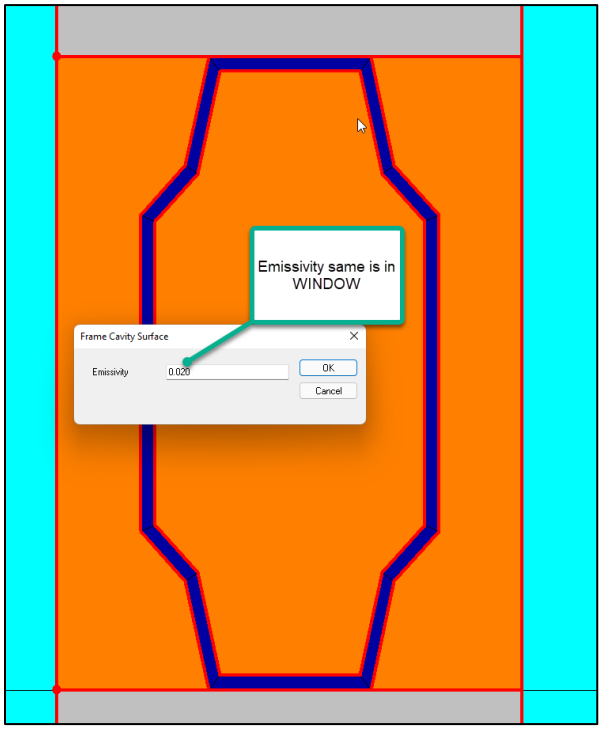


Figure 2: THERM 7.8 Emissivity

Emissivity is correctly picked up for the surface four.

2. Angular dependence calculations [Issue #1367]

Routines for angular calculations which was causing certain inaccuracies were fixed. Here is a document with information about this change:

https://docs.google.com/document/d/1vpcxEO-Nq7W9ui_wzAulouByOc-fV7U87nJLeir6OIQ/edit#

This applies to intermediate equations used when calculating angular properties for the glass (Transmittance, Reflectance and Absorptance). The issue was happening only for coated glass calculations where polynomials are used to estimate transmittance of the glass as if it would perform without coating. If for example, we provide transmittance of the coated glass to be 0.9 then the polynomial equation will calculate transmittance to be -0.0015 at 90 degrees of incidence and transmittance is calculated to be 1.0023 if angle of incidence is 0 degrees. These values will trigger this fix and cause a difference in optical results. Because this is happening in spectral calculations, and transmittance needs to have certain values, we did see differences in the fourth decimal place in optical properties and SHGC (which depends on Tsol) which makes around 0.01% of the difference.

3. Revision to slat shade thermal openness (A_h) equation [Issue #348]

The front openness coefficient is used in airflow calculations and this change is performed based on the research done by Robert Hart at LBNL. He measured several Venetian blind constructions in the laboratory and came up with new correlations for the front openness multiplier that will be used in the thermal calculations in WINDOW. This change has been updated in WINDOW 7.6 and therefore will produce difference between 7.8 and 7.4 as well.

In the worst case, it impacts U-factor by 0.6%. And this is only when slats are fully tilted. The impact is essentially zero for all other cases. It also has a very minor impact on SHGC since solar dominates there (0.2% in worst case). More details on this can be found here:

https://windows.lbl.gov/publications/experimental-validation-and-model-development-thermal-transmittances-porous-window

4. New blinds correlation coefficients [Issue #395]

New airflow coefficients for Venetian blinds (both vertical and horizontal) were implemented. Note that this is done in WINDOW 7.6 so results between WINDOW 7.4 and 7.8 will be different as well.

Horizontal Blinds

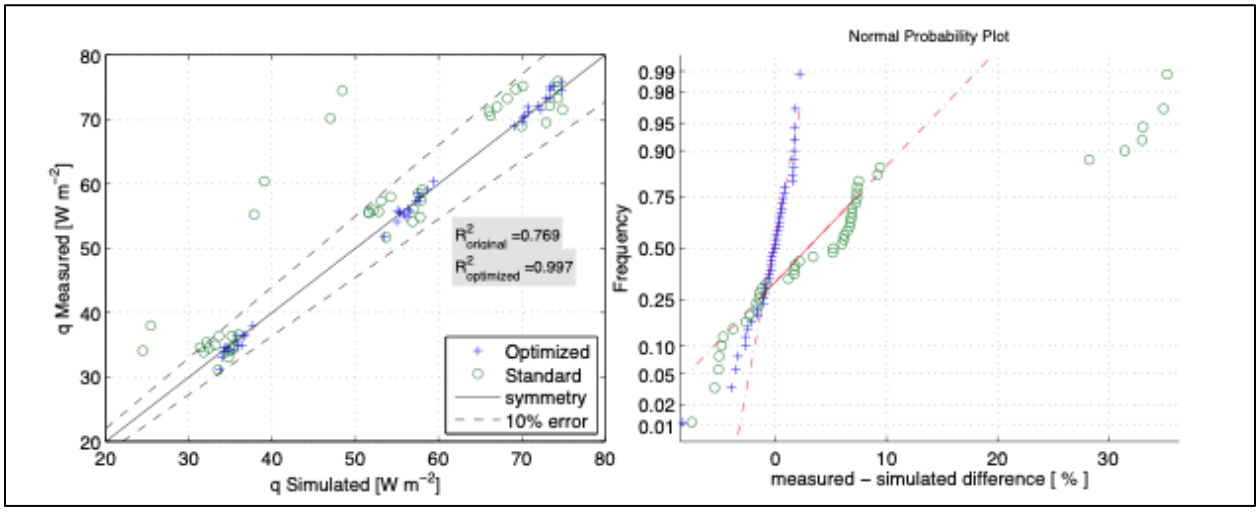
More details on differences in horizontal blinds can be found here:

https://windows.lbl.gov/publications/experimental-validation-and-model-development-thermal-transmittances-porous-window

Vertical Blinds

Updated results from Horizontal blinds with this change:

	VB original	VB optimized
C1	0.016	0.041
C2	-0.63	0
C3	0.53	0.27
C4	0.043	0.012



5. Update airflow coefficients for other shades [Issue #1334]

Airflow calculation for all shades except Venetian blinds now have updated shade coefficients that correspond to the paper published by Robert Hart, LBNL. This change will affect U-factor and SHGC values.

Differences produced by this change can be found here:

https://www.tandfonline.com/doi/full/10.1080/19401493.2018.1436192

some description is also given here:

https://windows.lbl.gov/publications/experimental-validation-and-model-development-thermal-transmittances-porous-window

6. Awning absorptance calculations [Issue #1331]

Awnings were introduced in WINDOW 7.8 and there are no differences in the results between 7.7 and 7.8. There are result differences between the latest and earlier versions of WINDOW 7.8. The absorptance calculations were off when doing thermal calculations and that will produce significant differences in SHGC calculations.

7. Frame cavities rectangularization [Issue #1301]

Two frame cavities placed next to each other in the model were causing incorrect emissivity calculations in finite element model.

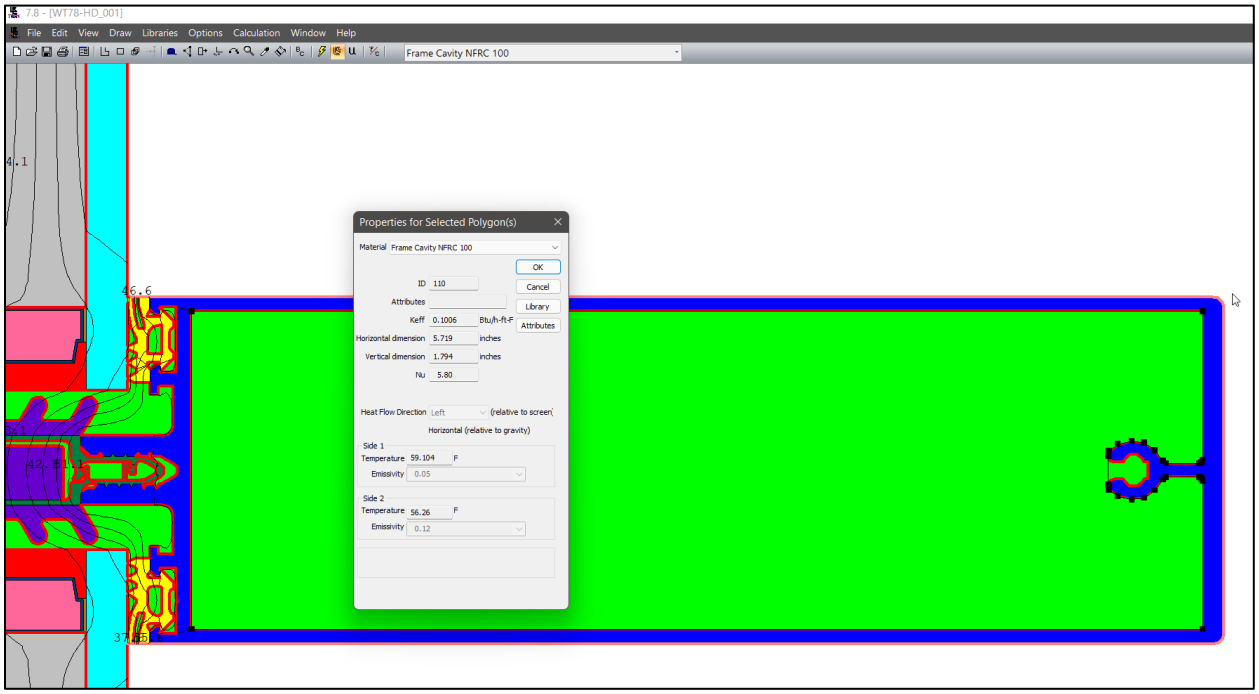


Figure 3. Example of two frame cavities next to each other

This was confirmed to be the problem in THERM 7.4 and it is fixed in THERM 7.8. How much results will be affected depends on the size of connected frame cavities in a model.