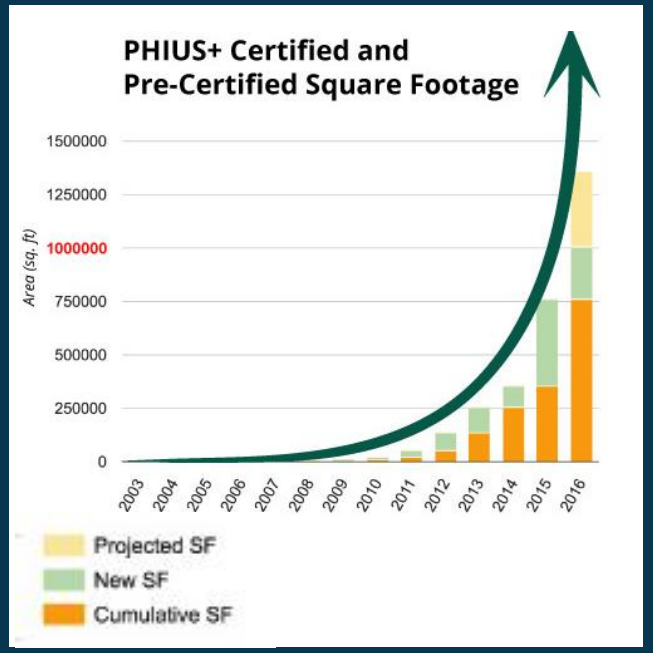
PHIUS and PHI Certifications:

Lessons Learned by North American Window Manufacturers

Alpen High Performance Products
and
Cascadia Windows and Doors

Passive house and the window industry

Since 2009, passive house growth in US exponential



Significant increase in European window imports

Influencing North America & US efficiency standards

DOE ZERH Lender Program

PFHA Low Income Housing Tax Credit (LIHTC)

12 states in 2015

Local government efficiency mandates

This blending of standards and influx of import products creates challenges in identifying and using appropriate criteria for window comparison and selection.

Cascadia Windows & Doors and Alpen High Performance Products

First (and only) North American window manufacturers with all the important fenestration certifications.

ALPEN HIGH PERFORMANCE PRODUCTS

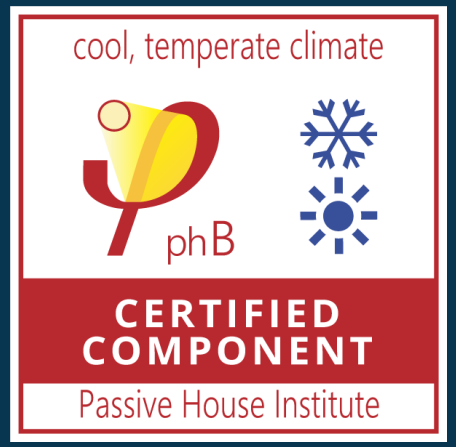
- NFRC
- PHIUS
- PHI (Tyrol Series™, 12/2017)
- Extensive air, water and structural testing

CASCADIA WINDOWS AND DOORS

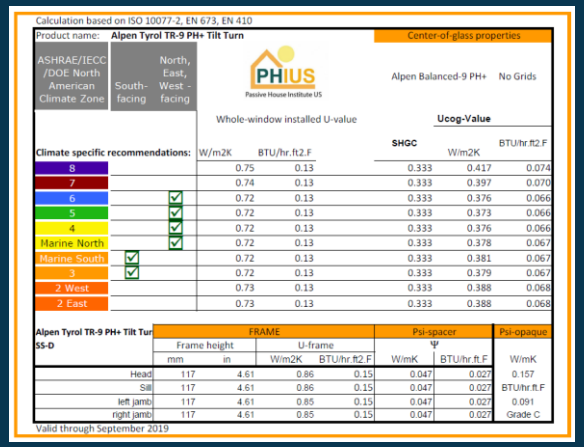
- NFRC
- PHIUS
- PHI (Universal Series™, 3/2018)
- Extensive air, water and structural testing

A Closer Look at Certification Paths

NFRC



PHI



Calculation based on ISO 10077-2, EN 673, EN 410

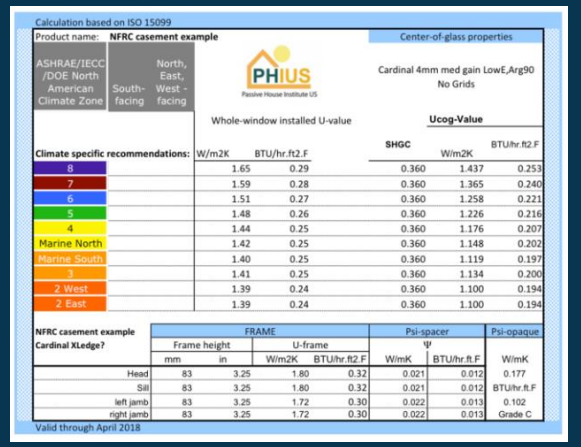
Product name: **Alpen Tyrol TR-9 PH+ Tilt Turn** — Center-of-glass properties: Alpen Balanced-9 PH+ No Grids

ASHRAE/IECC /DOE North American Climate Zone	South-facing	North, East, West - facing	Whole-window installed U-value W/m2K	BTU/hr.ft2.F	Ucog-Value SHGC	W/m2K	BTU/hr.ft2.F
Climate specific recommendations:							
8			0.75	0.13	0.333	0.417	0.074
7			0.74	0.13	0.333	0.397	0.070
6		☑	0.72	0.13	0.333	0.376	0.066
5		☑	0.72	0.13	0.333	0.373	0.066
4		☑	0.72	0.13	0.333	0.376	0.066
Marine North		☑	0.72	0.13	0.333	0.378	0.067
Marine South	☑		0.72	0.13	0.333	0.381	0.067
3	☑		0.72	0.13	0.333	0.379	0.067
2 West			0.73	0.13	0.333	0.388	0.068
2 East			0.73	0.13	0.333	0.388	0.068

Alpen Tyrol TR-9 PH+ Tilt Tur SS-D	FRAME Frame height mm	in	U-frame W/m2K	BTU/hr.ft2.F	Psi-spacer Ψ W/mK	BTU/hr.ft.F	Psi-opaque W/mK
Head	117	4.61	0.86	0.15	0.047	0.027	0.157
Sill	117	4.61	0.86	0.15	0.047	0.027	BTU/hr.ft.F
left jamb	117	4.61	0.85	0.15	0.047	0.027	0.091
right jamb	117	4.61	0.85	0.15	0.047	0.027	Grade C

Valid through September 2019

PHIUS
Orange Path



Calculation based on ISO 15099

Product name: **NFRC casement example** — Center-of-glass properties: Cardinal 4mm med gain LowE,Arg90 No Grids

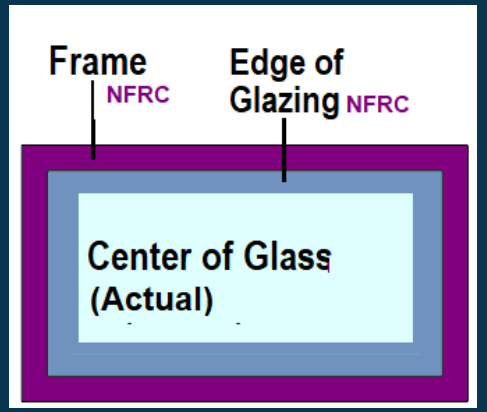
ASHRAE/IECC /DOE North American Climate Zone	South-facing	North, East, West - facing	Whole-window installed U-value W/m2K	BTU/hr.ft2.F	Ucog-Value SHGC	W/m2K	BTU/hr.ft2.F
Climate specific recommendations:							
8			1.65	0.29	0.360	1.437	0.253
7			1.59	0.28	0.360	1.365	0.240
6			1.51	0.27	0.360	1.258	0.221
5			1.48	0.26	0.360	1.226	0.216
4			1.44	0.25	0.360	1.176	0.207
Marine North			1.42	0.25	0.360	1.148	0.202
Marine South			1.40	0.25	0.360	1.119	0.197
3			1.41	0.25	0.360	1.134	0.200
2 West			1.39	0.24	0.360	1.100	0.194
2 East			1.39	0.24	0.360	1.100	0.194

NFRC casement example Cardinal XLedge?	FRAME Frame height mm	in	U-frame W/m2K	BTU/hr.ft2.F	Psi-spacer Ψ W/mK	BTU/hr.ft.F	Psi-opaque W/mK
Head	83	3.25	1.80	0.32	0.021	0.012	0.177
Sill	83	3.25	1.80	0.32	0.021	0.012	BTU/hr.ft.F
left jamb	83	3.25	1.72	0.30	0.022	0.013	0.102
right jamb	83	3.25	1.72	0.30	0.022	0.013	Grade C

Valid through April 2018

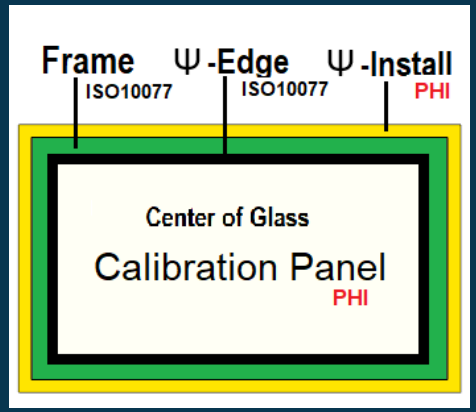
PHIUS
Blue Path

Methods



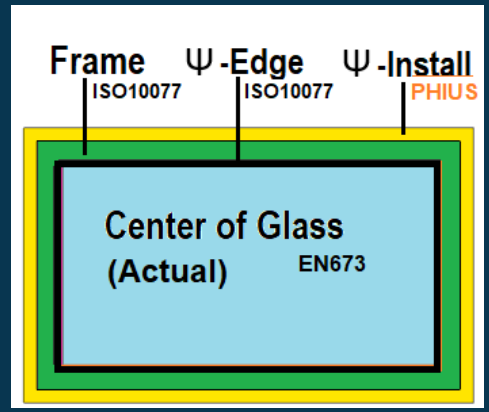
NFRC

1. ISO 15099/ NFRC 100
2. **Δ 70° F** (Δ38° C)
   Outside: 0° F
   Inside: 70° F
3. $U_{w\ NFRC}$ = **area weighted average**



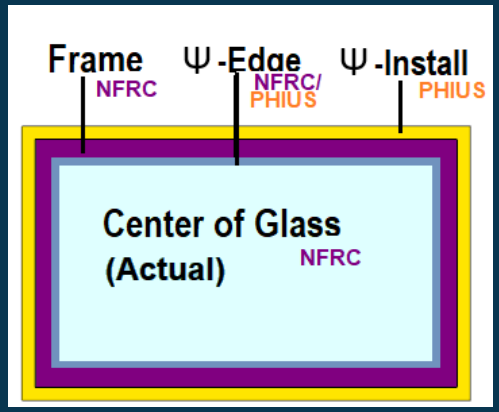
PHI

1. ISO 10077/EN673
2. **Δ 54° F**
   Outside: 14° F
   Inside: 68° F
3. U_w with **calibration panel** (U- 0.13)



PHIUS ORANGE

1. ISO 10077/EN673
2. **Component: Δ 70° F**
   Published **Uw : *Δ varies***
3. U_w per ISO 10077 w/ actual glass and PHIUS climate zones



PHIUS BLUE

1. ISO 15099 + Ψ conversion
2. **Component: Δ 70° F**
   Published **Uw : *Δ varies***
3. U_w per ISO 10077 w/ actual glass and PHIUS climate zones

Comparing the data

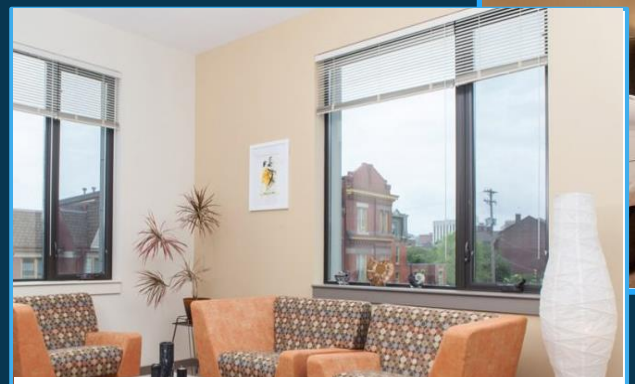
Certification	Alpen		Cascadia		Alpen (extras)	
	Tyrol PH+ Series "Balanced-9"	Zenith Series	Universal Series "A" 2 Low-E	Universal Series "B" 3 Low-E	Tyrol "Standard"	Tyrol (Cert. frame)
NFRC*	0.12	0.15	0.15	0.14	?	?
PHIUS Blue Path□			366-clear-180	366-180-i89		
U_f	**0.18**	—	**0.18**	**0.20**	**0.21**	—
U_g	0.065	—	0.13	0.106	0.08	—
$U_{w\ NFRC}$	0.13	—	0.16	0.15	0.15	—
PHIUS Orange Path□						
U_f	**0.15**	0.21	—	—	—	—
U_g	0.066	0.076	—	—	—	—
$U_{w\ INSTALLED}$	0.13	0.14	—	—	—	—
PHI‡					**41mm oa**	**47mm oa**
U_f	**0.13**	—	**0.15**	**0.15**	0.14	0.13
U_g	0.133	—	0.123	0.123	0.066	0.066
$U_{w\ PHI\ CALIB.\ PANEL}$	0.14	—	**0.14**	**0.14**	0.15	0.14
$U_{w\ ACTUAL\ GLASS}$	0.095	—	**0.13**	**0.12**	0.11	—

YOUR TAKE-HOME MESSAGE #1

Know that different standards exist

- Is your project outside of “European” ISO climate conditions (Δ 54° F)?
- Do you need NFRC Certification for Building Code or Tax Credits?
- **What performance criteria are most important for your project?**

Mostly frames?



Average amount of both?

Mostly glass?

Be prepared to train and market effectively

Tyrol PH+

NFRC

Tilt-Turn U- 0.17

Fixed U- 0.16

Optimized for passive house:

- 3-chamber center seal
- 3 pieces insulation
- 41 mm (1-5/8”) glazing pocket **(Uf- 0.14)**
- 2x 18mm (11/16”) argon gaps **(Ug- 0.095)**

Tyrol Standard

NFRC

Tilt-Turn U- 0.17

Fixed U- 0.15

Optimized for NFRC:

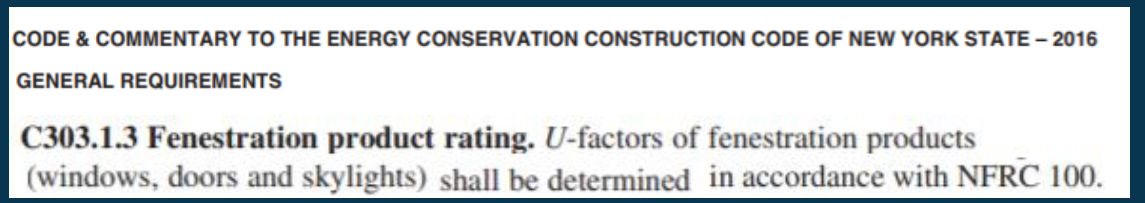
- 2 pieces insulation
- 1-3/8 mm (1-3/8”) glazing pocket **(Uf- 0.15)**
- 2x 14mm (9/16”) argon gaps **(Ug- 0.123)**

Is NFRC Important?

Absolutely.

- You should demand it **as well as** Passive House Certified Data.
- NFRC provides evidence of quality, independent physical testing and assurance the glass units have also be tested for gas retention and durability.
- Compare the NFRC numbers to Passive House whole window numbers. If dramatically different, ask why.

And, there may be times that standards overlap…

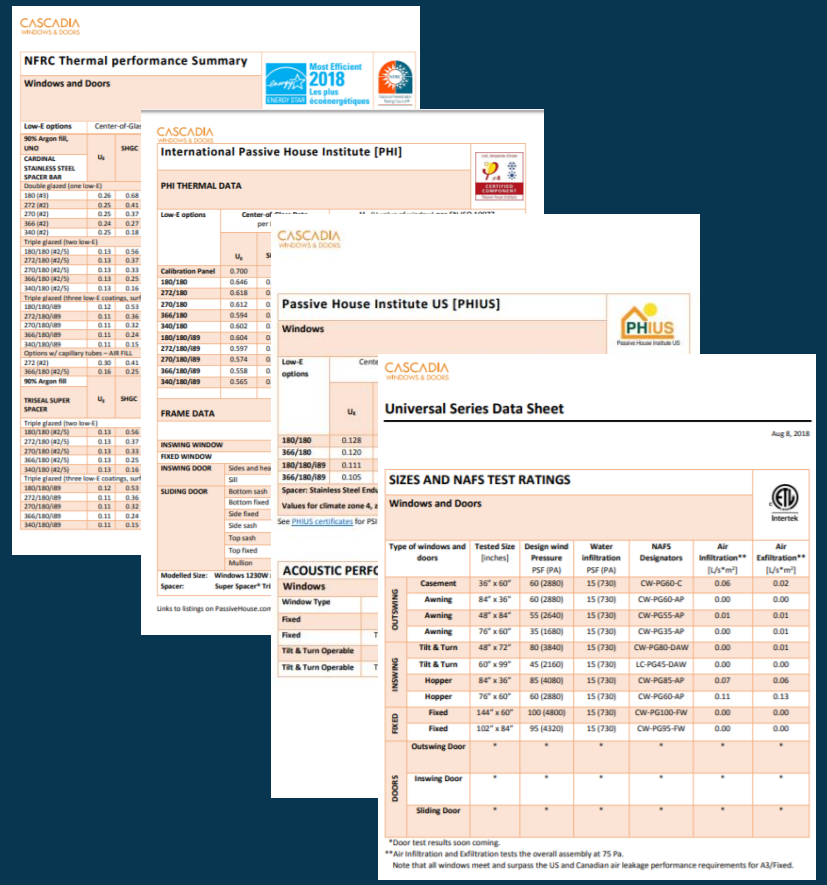

CODE & COMMENTARY TO THE ENERGY CONSERVATION CONSTRUCTION CODE OF NEW YORK STATE – 2016

GENERAL REQUIREMENTS

C303.1.3 Fenestration product rating. *U*-factors of fenestration products (windows, doors and skylights) shall be determined in accordance with NFRC 100.

Marketing Choices and Challenges

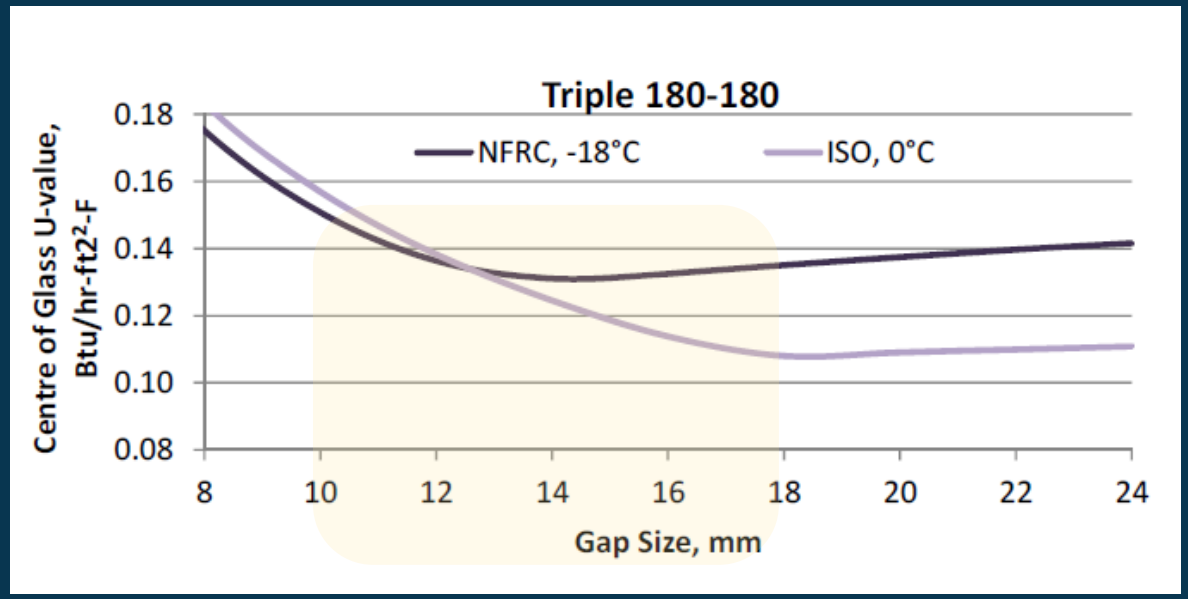
- What do you do when you have one window and many results?
- When it comes to marketing your new passive house window, how will you publish results?
  - What single value would you promote?
  - Is it accurate to what you build?
  - Can you game the system without lying? Would you?



“Myth” of Ug-0.088

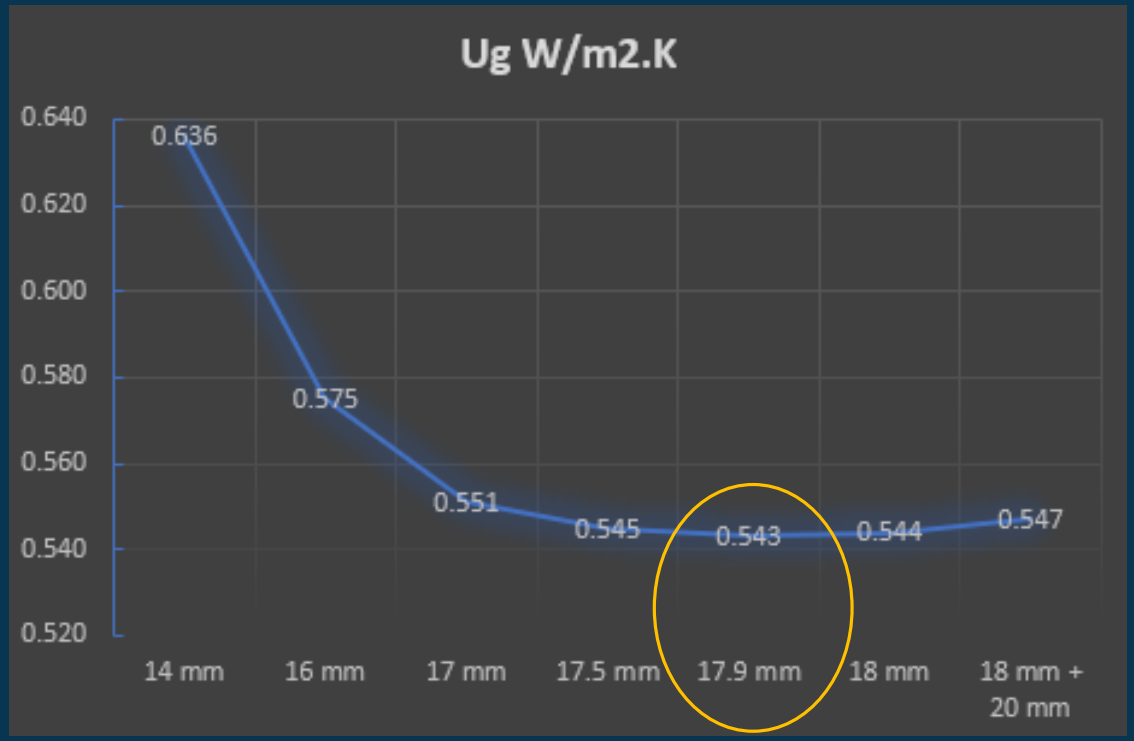
OPTIMAL ARGON GAP WIDTHS:

- NFRC: 12.7 mm (1/2”)
  - EN 673 Ug- 0.123
  - NFRC **Ug- 0.121**
- EN 673: 18 mm (11/16”)
  - EN 673 **Ug- 0.096**
  - NFRC Ug- 0.125



RDH Building Engineering (2014) “International Window Standards, Final Report 2014”

Myth of Ug- 0.088



IF AS LITTLE AS +/- 0.1 mm (0.003”) **CAN AFFECT Ug …**

- How is **Ug- 0.088** so common?
  - Varying overall IG widths
  - Varying glass thicknesses
  - Varying argon gap sizes

“Myth” of Ug- 0.088

GUARDIAN GLASS CONFIGURATOR

GUARDIAN SUNGUARD Advanced Architectural Glass

PERFORMANCE CALCULATOR

September 19, 2018
By Ray, Alison
aray@thinkalpen.com

KIWA confirms to have verified the calculation engine of the software **Guardian Performance Calculator 4.1** to be compliant to EN 410 and EN 673.

New Project 10

Make-up Name	Transmittance		U-Value (U_g in W/m²·K)	Solar Factor (g)
	Visible (τ_v %)	Solar (τ_e %)		
CG Prem4 x 18ARG x Clear4 x 18ARG x CGPrem4	74.1	46.5	0.5	52.8

Calculation Standard: EN 410:2011 / EN 673:2011

CG Prem4 x 18ARG x Clear4 x 18ARG x CGPrem4

= Ug- 0.088 Btu/h.ft2.F

YOUR TAKE-HOME MESSAGE #2

ALPEN CLEAR PERFORMANCE + CASCADIA WINDOWS & DOORS

Verify your values

NFRC
www.nfrc.org

Passive House Institute US
http://www.phius.org

Passive House Institute
passivehouse.com

Ask the Manufacturer to provide reports

YOUR TAKE-HOME MESSAGE #3

Choose the right product for your project

- Select key thermal performance metrics that reflect your project design
- Think beyond thermal data
  - Is your frame *material* suitable for North American climates?
  - Is your color foil tested and warranted for North America?
  - Does the manufacturer's warranty meet your needs?

Choose the right product for your project

CLIMATE HAS A BIG IMPACT ON FILM SELECTION

30,000’ View Conclusion

- Can be intimidating
- IS time intensive
- Hire a great consultant/modeler
  - *Someone willing to support frequent “model- results- re-model” feedback loop*
- Results WILL change your product line-up
- Be prepared to invest in your team – educate, train, equip

CASCADIA'S EXPERIENCE

A MANUFACTURER'S DESIGN JOURNEY LEARNING EUROPEAN NORMS ON-THE-GO

Balancing Design Choices for One Product but Multiple Certification Targets

IGU THICKNESS

NFRC optimal spacer

vs

PHI optimal spacer

vs

Long-term durability recommendations from IG supplier

FRAME-ONLY FOCUS

Full window modelling

vs

Frame-only

=

More detailed look at optimizing frame performance

IGU Thickness – Multiple Glass Stops is *only one* Consideration

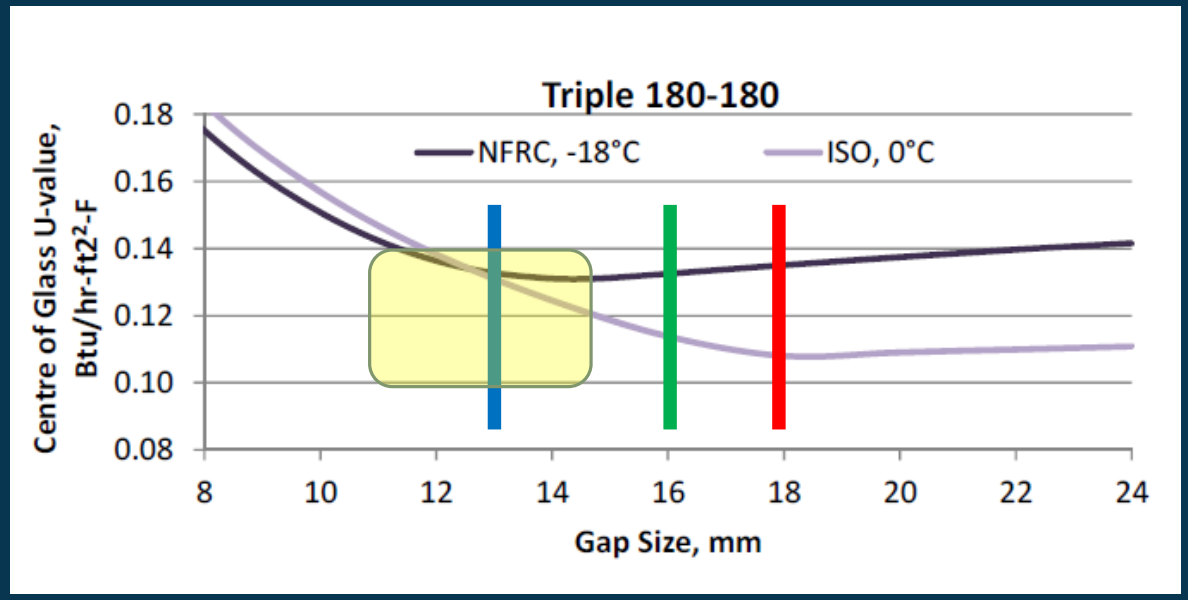
Optimal for NFRC

Optimal for PHI

IG manufacturer's guidance:

Avoid a bigger "balloon" to maintain long term durability

Ultimately, a balanced choice was a slight compromise for all

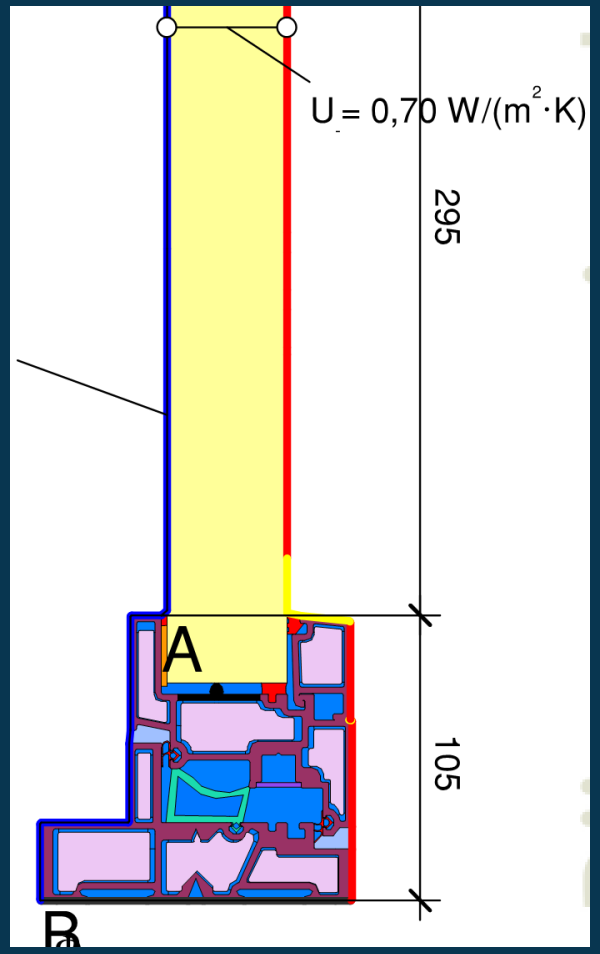


RDH Building Engineering (2014) "International Window Standards, Final Report 2014"

Frame-Only Focus In PHI

PHI CERTIFICATION FOR A WINDOW USES A "**CALIBRATION PANEL**" INSTEAD OF AN IGU IN THE FRAME MODEL

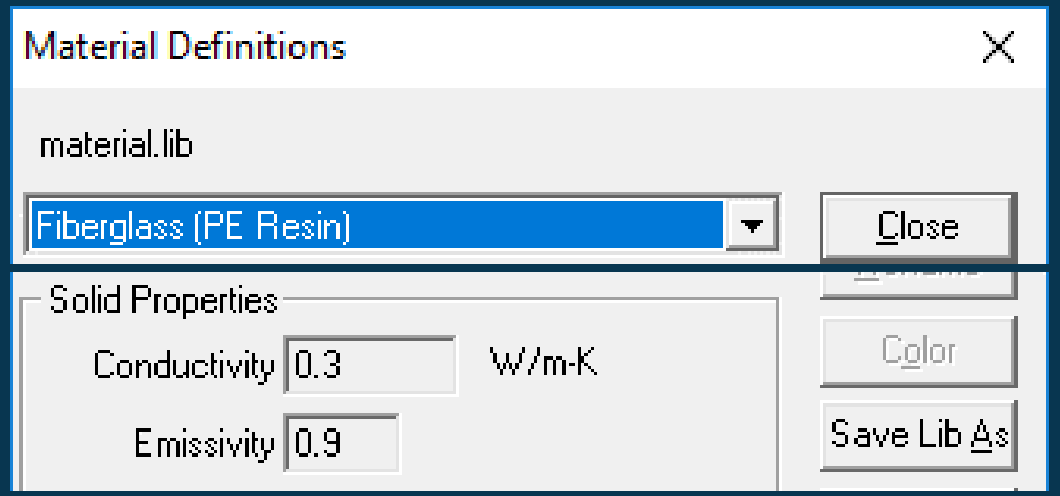
- Panel's U-value set to "worst-allowed" U-glass 0.70 W/m²/K
- Forces manufacturer to optimize frame design at detailed level
- No help from rounding; your U-window must be Usi-0.80 (U-0.1409), and not U-0.1449 rounded to U-0.14



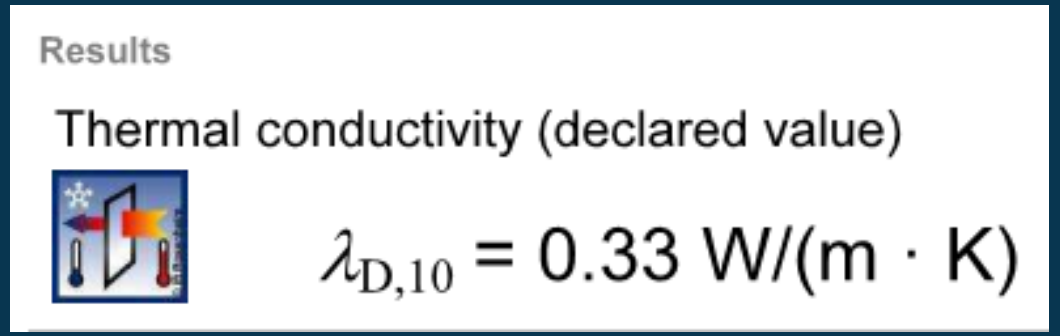
Thermal model with calibration panel in lieu of IGU

What About Material Standards? European Norm vs ASTM

- PHI is not used to some materials used more commonly in North America – *eg. pultruded fiberglass*
- PHI did not recognize commonly accepted k-value (thermal conductivity) of fiberglass frame material
- k-value testing yielded different results under EN standard
- 0.30 (ASTM) vs. 0.33 (EN)



THERM k-value for fiberglass (NFRC value, with ASTM testing)



EN tested k-value for fiberglass (round up according to standard)

Reacting to Material Differences

K-VALUE TESTING NOT UNEXPECTED

- lengthy process
- resulted in design changes

INSULATION TYPE

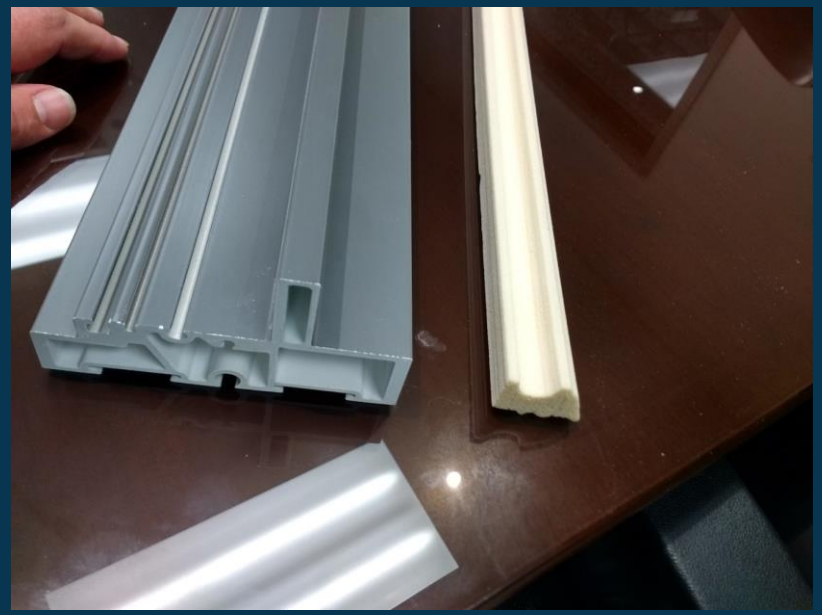
NOVEL MILLING PATTERN IN SASH

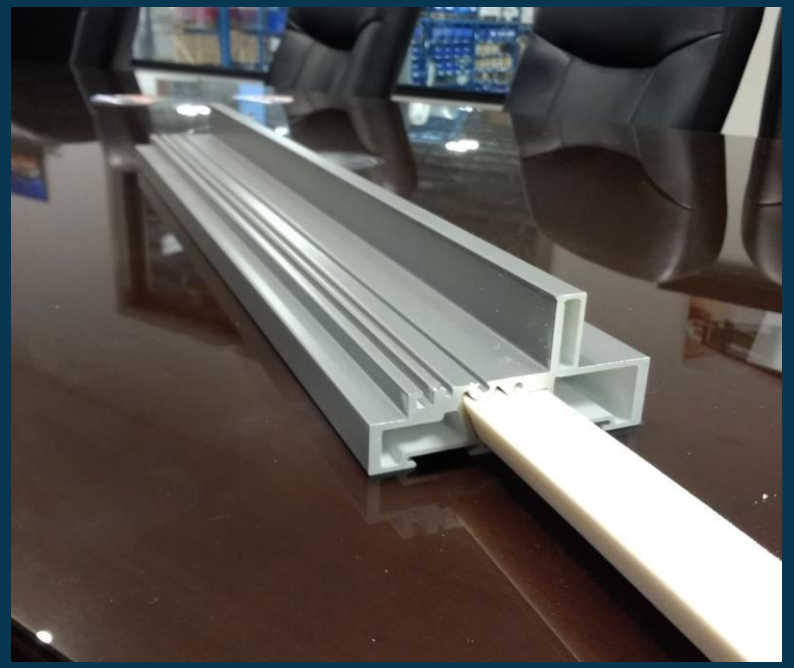
Image property of Calvin & Hobbes by Bill Watterson

Reacting to Material Differences

1. Insulation type

- EPS to PU
- How do you cut thermoset insulation?



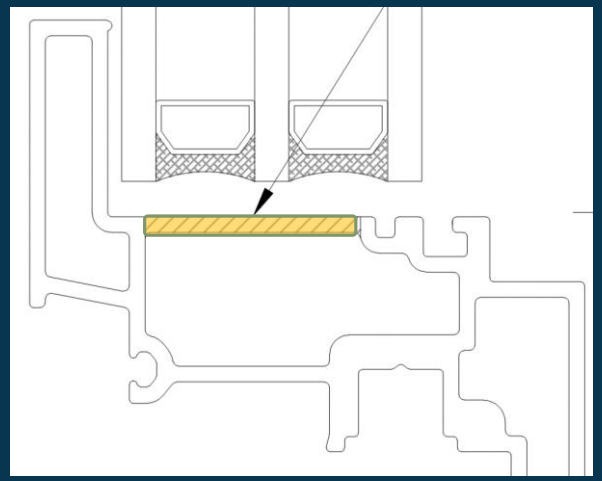


Polyurethane (PU) insulation cut to fit frame cavities

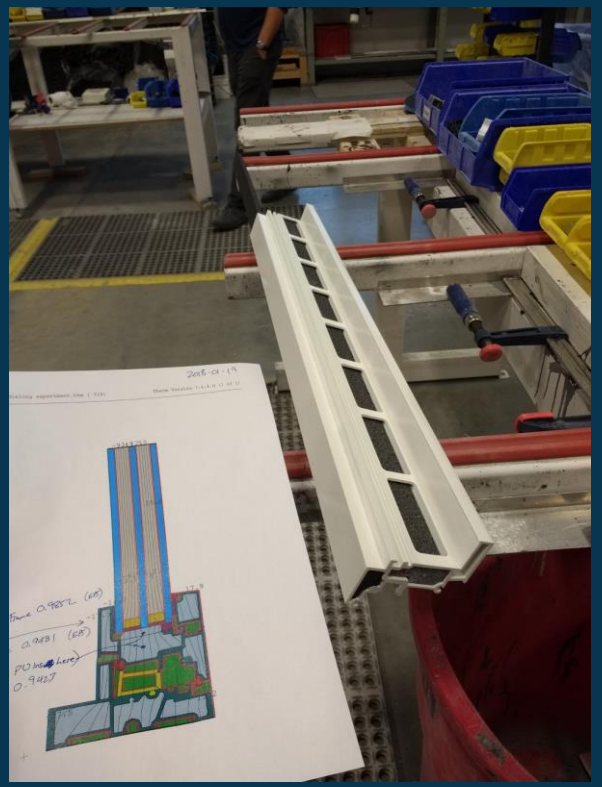
Reacting to Material Differences

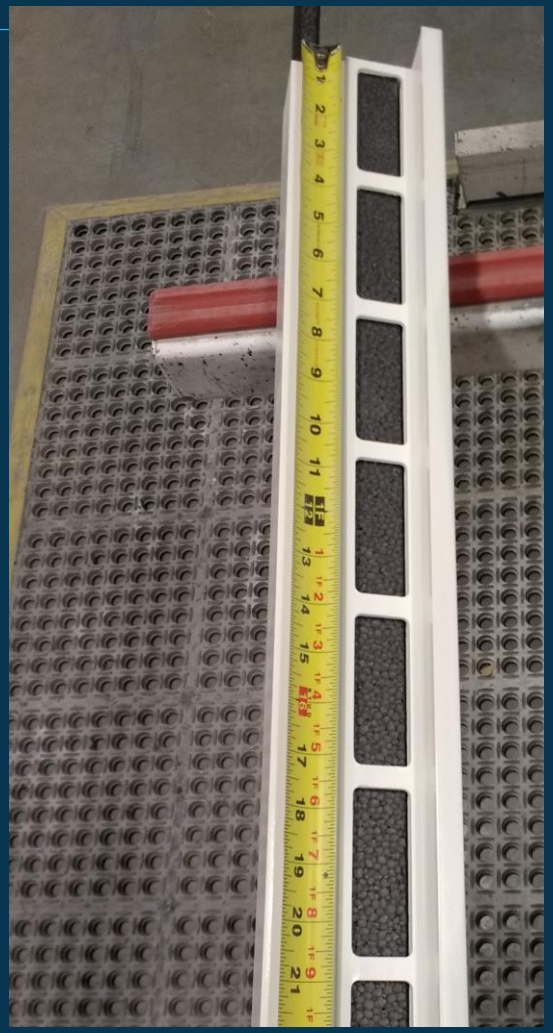
Novel milling pattern

- Thankfully, we over-design the sash profile (structurally)
- Cut out some material that crosses the isotherms



Milling pattern in over-designed material reduces thermal bridging from frame wall that crosses isotherms





30,000’ View Conclusions

FOR MANUFACTURERS

Learn what your certification body will want early on

- including proofs and testing
- especially PHI (for material conductivity)

Be careful when designing PHI-optimized IGUs

- Consult with IG supplier
- Careful about too big a balloon

FOR SPECIFIERS

Many manufacturers that offer NFRC and PHI certified products will have two or more variants

- Specify the right one
- Can have different price tags
- Consider NFRC version’s price vs performance
  - sometimes PHI data is available for these versions too

Questions?

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