

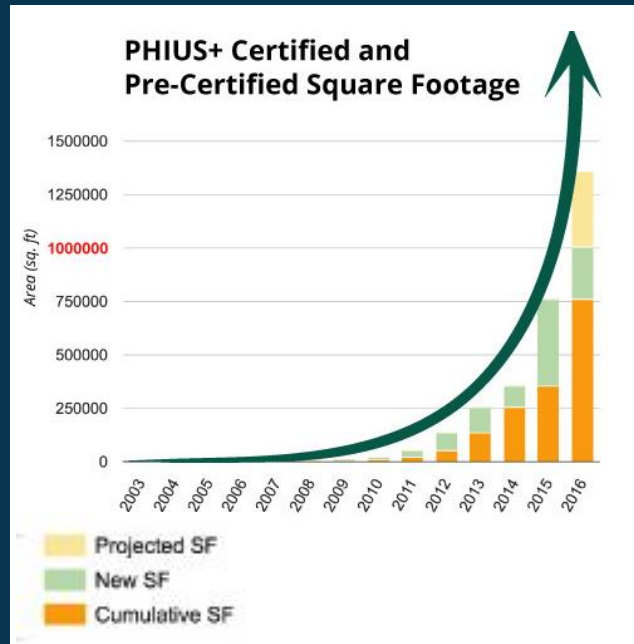
PHIUS and PHI Certifications:

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)

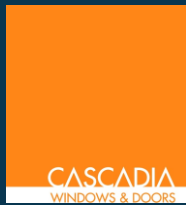
12 states in 2015



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

ASHRAE/IECC /DOE North American Climate Zone: North, East, South-facing; West-facing

PHIUS Passive House Institute US

Alpen Balanced-9 PH+ No Grids

Whole-window installed U-value

Climate specific recommendations:	W/m2K		BTU/hr.ft2.F		SHGC		Ucoog-Value	
	W/m2K	BTU/hr.ft2.F	SHGC	W/m2K	BTU/hr.ft2.F	SHGC	W/m2K	BTU/hr.ft2.F
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 Turn 55-D	FRAME		U-frame		Psi-spacer		Psi-opaque	
	Frame height mm	in	W/m2K	BTU/hr.ft2.F	W/mK	BTU/hr.ft.F	W/mK	BTU/hr.ft.F
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	0.157	
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

ASHRAE/IECC /DOE North American Climate Zone: North, East, South-facing; West-facing

PHIUS Passive House Institute US

Cardinal 4mm med gain LowE,Arg90 No Grids

Whole-window installed U-value

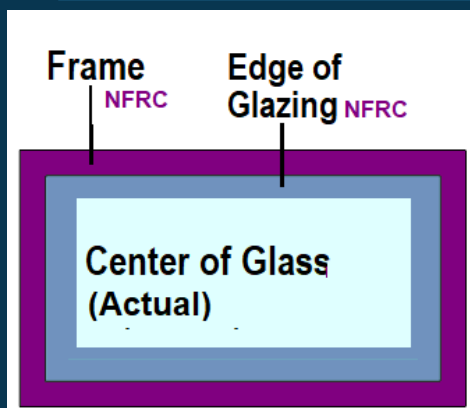
Climate specific recommendations:	W/m2K		BTU/hr.ft2.F		SHGC		Ucoog-Value	
	W/m2K	BTU/hr.ft2.F	SHGC	W/m2K	BTU/hr.ft2.F	SHGC	W/m2K	BTU/hr.ft2.F
8	1.65	0.29	0.360	1.437	0.253			
7	1.59	0.28	0.360	1.365	0.240			
6	1.51	0.27	0.360	1.258	0.221			
5	1.48	0.26	0.360	1.226	0.216			
4	1.44	0.25	0.360	1.176	0.207			
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		U-frame		Psi-spacer		Psi-opaque	
	Frame height mm	in	W/m2K	BTU/hr.ft2.F	W/mK	BTU/hr.ft.F	W/mK	BTU/hr.ft.F
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	0.177	
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

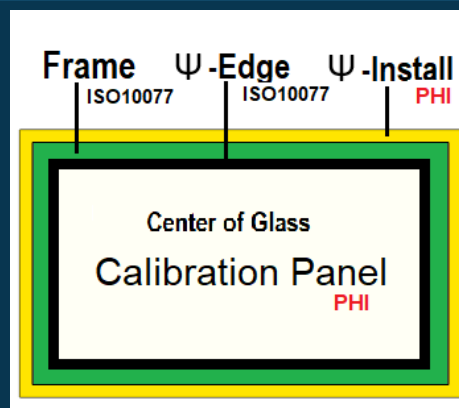
PHIUS
Blue Path

Methods



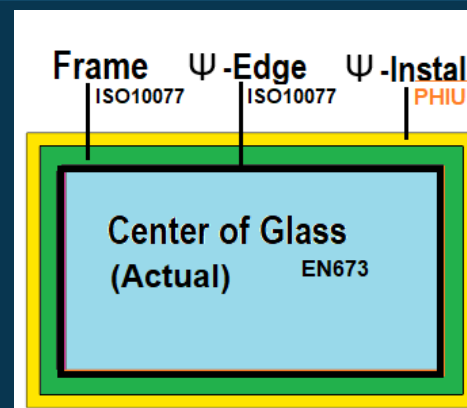
NFRC

1. ISO 15099/ NFRC 100
2. $\Delta 70^\circ \text{ F}$ ($\Delta 38^\circ \text{ C}$)
Outside: 0° F
Inside: 70° F
3. $U_{w \text{ NFRC}} = \text{area weighted average}$



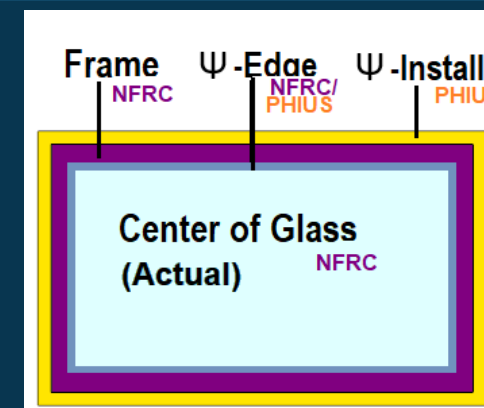
PHI

1. ISO 10077/EN673
2. $\Delta 54^\circ \text{ F}$
Outside: 14° F
Inside: 68° F
3. U_w with **calibration panel** ($U = 0.13$)



PHIUS ORANGE

1. ISO 10077/EN673
2. Component: $\Delta 70^\circ \text{ F}$
Published U_w : Δ varies
3. U_w per ISO 10077 w/ actual glass and PHIUS climate zones



PHIUS BLUE

1. ISO 15099 + Ψ conversion
2. Component: $\Delta 70^\circ \text{ F}$
Published U_w : 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

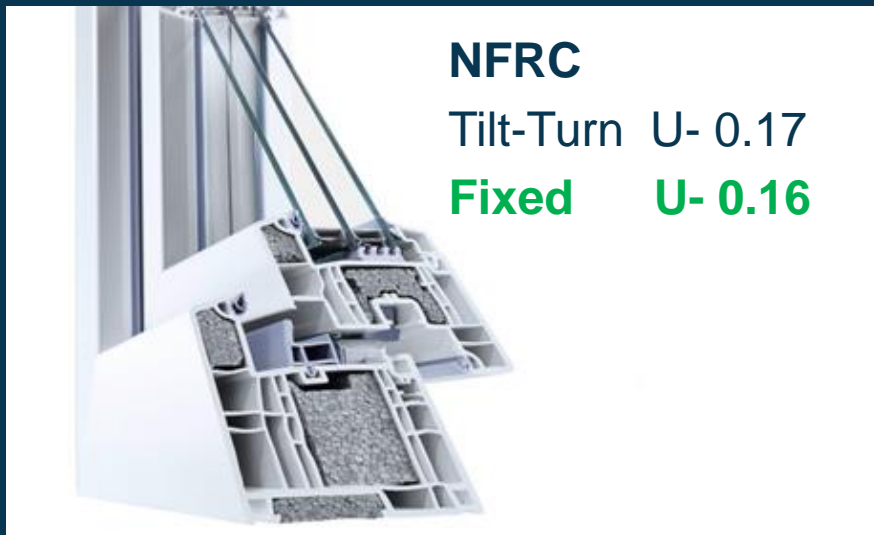
Know that different standards exist

- Is your project outside of “European” ISO climate conditions ($\Delta 54^\circ \text{F}$)?
- Do you need NFRC Certification for Building Code or Tax Credits?
- What performance criteria are most important for your project?



Be prepared to train and market effectively

Tyrol PH+



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



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 been 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...

Build Energy-Efficient Multifamily High Rise Buildings

Join the ENERGY STAR Multifamily High Rise Program for New Construction

[EXPLORE THE PROGRAM →](#)

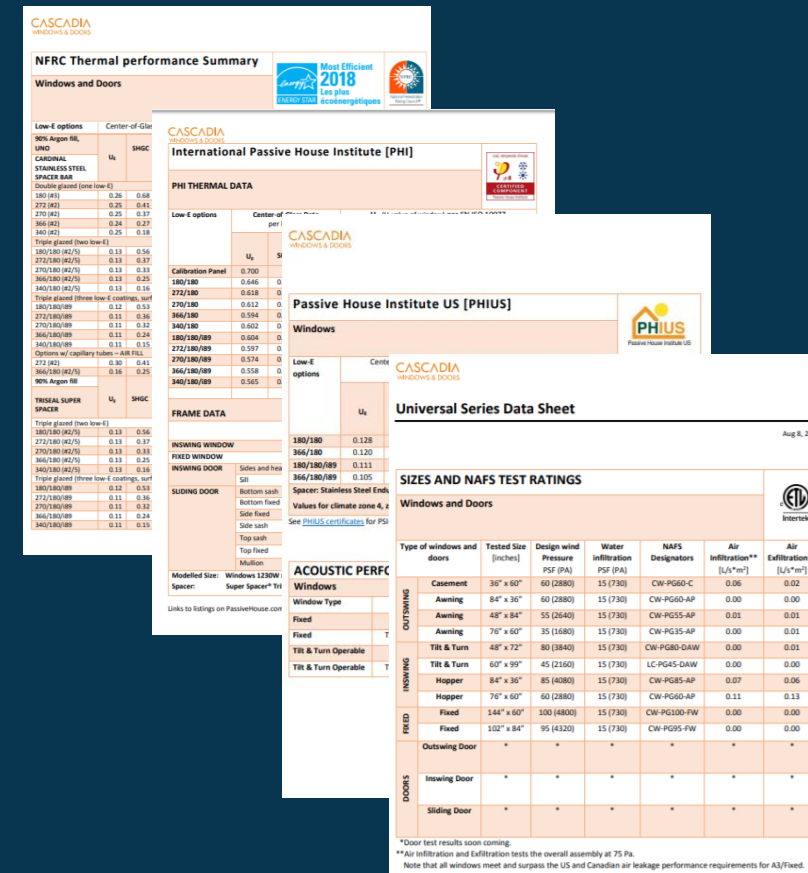


CODE & COMMENTARY TO THE ENERGY CONSERVATION CONSTRUCTION CODE OF NEW YORK STATE – 2016
GENERAL REQUIREMENTS

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?



NFRC Thermal Performance Summary

Windows and Doors

Low-E options | Center-of-Glass

Model	U _f	SHGC
180 (A3)	0.26	0.68
272 (A1)	0.26	0.41
270 (A2)	0.26	0.37
366 (A2)	0.24	0.27
340 (A2)	0.25	0.18

Double glazed (one low-E)

Model	U _f	SHGC
180/180 (A2/7)	0.13	0.56
272/180 (A2/7)	0.13	0.37
270/180 (A2/7)	0.13	0.33
366/180 (A2/7)	0.13	0.25
340/180 (A2/7)	0.13	0.16

Triples glazed (two low-E)

Model	U _f	SHGC
180/180/180 (A2/7)	0.12	0.53
272/180/180 (A2/7)	0.11	0.36
270/180/180 (A2/7)	0.11	0.32
366/180/180 (A2/7)	0.11	0.24
340/180/180 (A2/7)	0.11	0.15

Options w/ capillary tubes - AAR File

Model	U _f	SHGC
272 (A2)	0.20	0.41
366/180 (A2/7)	0.16	0.25

90% Argon Fill

TRIGLASS SUPER SPACER

U_f SHGC

Triple glazed (two low-E)

Model	U _f	SHGC
180/180 (A2/7)	0.13	0.56
272/180 (A2/7)	0.13	0.37
270/180 (A2/7)	0.13	0.33
366/180 (A2/7)	0.13	0.25
340/180 (A2/7)	0.13	0.16

Triples glazed (two low-E coatings, soft)

Model	U _f	SHGC
180/180/180 (A2/7)	0.12	0.53
272/180/180 (A2/7)	0.11	0.36
270/180/180 (A2/7)	0.11	0.32
366/180/180 (A2/7)	0.11	0.24
340/180/180 (A2/7)	0.11	0.15

Options w/ capillary tubes - AAR File

Model	U _f	SHGC
272 (A2)	0.20	0.41
366/180 (A2/7)	0.16	0.25

90% Argon Fill

FRAME DATA

U_f SHGC

INSLWING WINDOW

Model	U _f	SHGC
180/180	0.128	
366/180	0.120	

INSLWING WINDOW

Model	U _f	SHGC
180/180/180	0.111	
366/180/180	0.105	

Spacer: Stainless Steel Ends

Values for climate zone 4, 5

See PHUS certificates for PSI

ACOUSITC PERF

Modelled Size: Windows 2330M
Spacer: Super Spacer™ Tri

Links to listings on Passivhouse.com

International Passive House Institute (PHI)

PHI THERMAL DATA

Low-E options | Center-of-glass

U_f SHGC

Calibration Panel

Model	U _f	SHGC
180/180	0.546	0
272/180	0.618	0
270/180	0.612	0
366/180	0.594	0
340/180	0.602	0
180/180/180	0.604	0
272/180/180	0.597	0
270/180/180	0.574	0
366/180/180	0.558	0
340/180/180	0.565	0

Passive House Institute US (PHIUS)

Universal Series Data Sheet

Aug 8, 2018

SIZES AND NAFS TEST RATINGS

Windows and Doors

Type of windows and doors	Tested Size [inches]	Design wind Pressure PSF (PA)	Water Infiltration PSF (PA)	NAFS Designators	Air Infiltration** [L/s*m ²]	Air Exfiltration** [L/s*m ²]	
OUTSLWING	Casement	36" x 60"	60 (2880)	15 (730)	CW-PG60-C	0.06	0.02
	Awning	84" x 36"	60 (2880)	15 (730)	CW-PG60-AP	0.00	0.00
	Awning	48" x 84"	55 (2640)	15 (730)	CW-PG55-AP	0.01	0.01
	Awning	76" x 60"	35 (1680)	15 (730)	CW-PG35-AP	0.00	0.01
	Tilt & Turn	48" x 72"	80 (3840)	15 (730)	CW-PG80-DAW	0.00	0.01
	Tilt & Turn	60" x 99"	45 (2160)	15 (730)	LC-PG45-DAW	0.00	0.00
INSLWING	Hopper	84" x 36"	85 (4080)	15 (730)	CW-PG85-AP	0.07	0.06
	Hopper	76" x 60"	60 (2880)	15 (730)	CW-PG60-AP	0.11	0.13
	Fixed	144" x 60"	100 (4800)	15 (730)	CW-PG100-FW	0.00	0.00
FIXED	Fixed	102" x 84"	95 (4520)	15 (730)	CW-PG95-FW	0.00	0.00
DOORS	Outswing Door	*	*	*	*	*	*
	Inswing Door	*	*	*	*	*	*
	Sliding Door	*	*	*	*	*	*

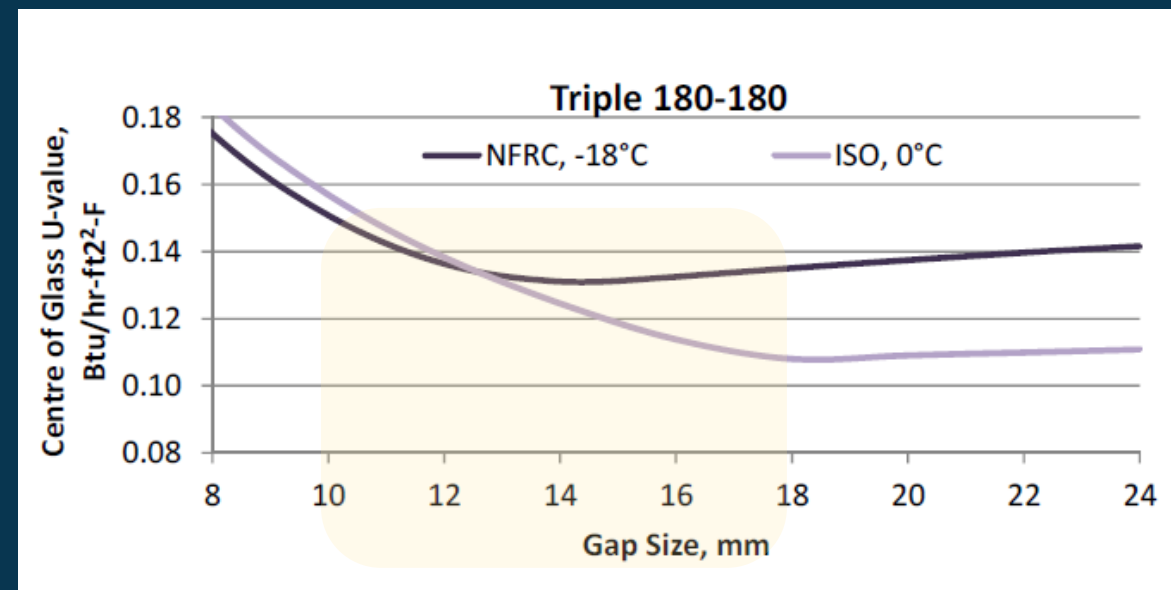
*Door test results soon coming.
**Air Infiltration and Exfiltration tests the overall assembly at 75 Pa.
Note that all windows meet and surpass the US and Canadian air leakage performance requirements for A3/Fixed.

“Myth” of Ug-0.088

OPTIMAL ARGON GAP WIDTHS:

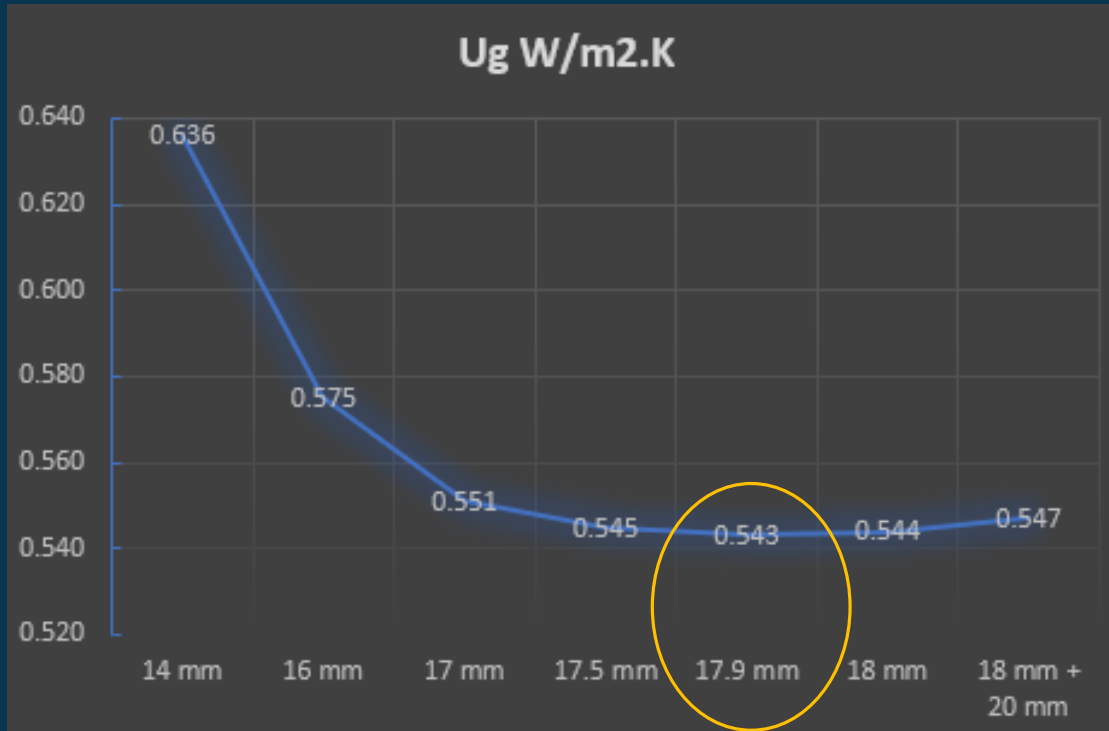
- NFRC: 12.7 mm (1/2")
 - EN 673 Ug- 0.123
 - NFRC **Ug- 0.121**

- 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



PERFORMANCE CALCULATOR

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



New Project 10

Make-up Name	Transmittance		U-Value (U_g in $W/m^2 \cdot K$)	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



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

ENERGY PERFORMANCE RATINGS

U-Factor (U.S./I-P)	Solar Heat Gain Coefficient
0.10	---

ADDITIONAL PERF

Visible Transmittance
0.30

Climate specific recommendations:

Climate Zone	W/m2K	BTU/hr.ft2.F	SHGC
8	0.67	0.12	0.33
7	0.66	0.12	0.33
6	0.64	0.11	0.33
5	0.64	0.11	0.33
4	0.64	0.11	0.33
Marine North	0.64	0.11	0.33
Marine South	0.65	0.11	0.33
3	0.64	0.11	0.33
2, West	0.65	0.11	0.33
2, East	0.65	0.11	0.33

CERTIFICATE
Certified Passive House Component
Component ID: 1152w03 valid until 31st December 2018

Category: Window Frame
Manufacturer: Alpen High-Performance Products, Newell, CO, USA
Product name: Alpen Tyrol Tilt-Turn

This certificate was awarded based on the following criteria for the cool, temperate climate zone:

Comfort: $U_{w,0.78} \leq 0.80 \text{ W/(m}^2\text{K)}$
 $U_{w,0.90} \leq 0.85 \text{ W/(m}^2\text{K)}$
with $U_{f,0.78} = 0.70 \text{ W/(m}^2\text{K)}$

Hygiene: $f_{w,0.78} \geq 0.70$

Passive House efficiency class: p1E, p1D, p1C, p1B, p1A

CERTIFIED COMPONENT
Passive House Institute



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?



Comparison of Foil Durability Test in Arizona

	Original	5 Years	7.5 Years	10 Years
Approved for North American Exteriors				
NOT Approved for North American Exteriors				

Choose the right product for your project

CLIMATE HAS A BIG IMPACT ON FILM SELECTION



30,000' View Conclusion

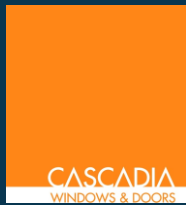
- Can be intimidating
- IS time intensive
- Hire a great consultant/modeler
 - *Someone willing to support frequent “model- results- re-model” feedback loop*
- Results WILL change your product line-up
- Be prepared to invest in your team – educate, train, equip



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

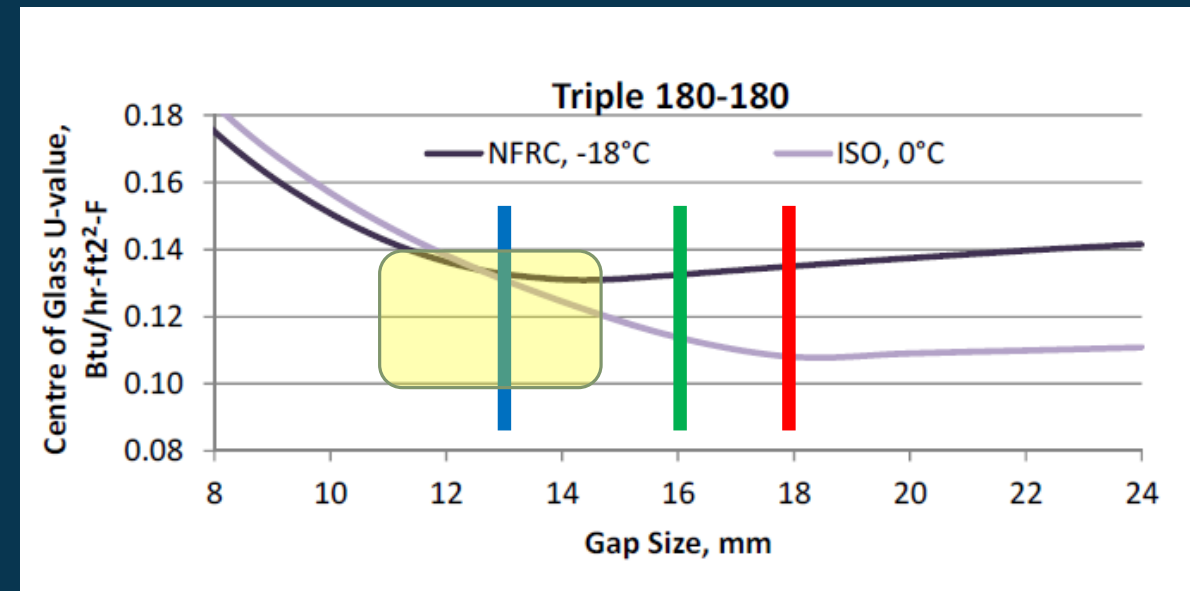
Optimal for NFRC

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

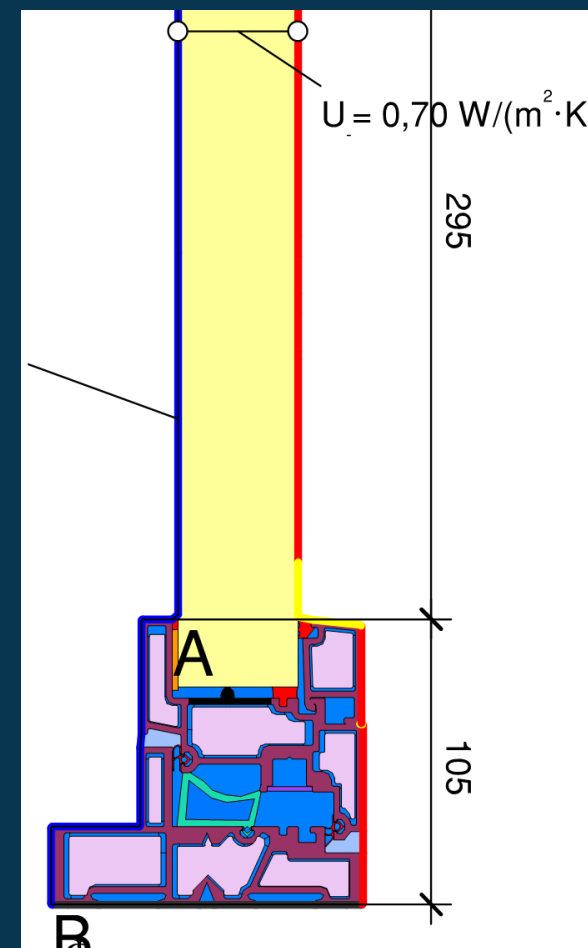


RDH Building Engineering (2014) "International Window Standards, Final Report 2014"

Frame-Only Focus In PHI

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

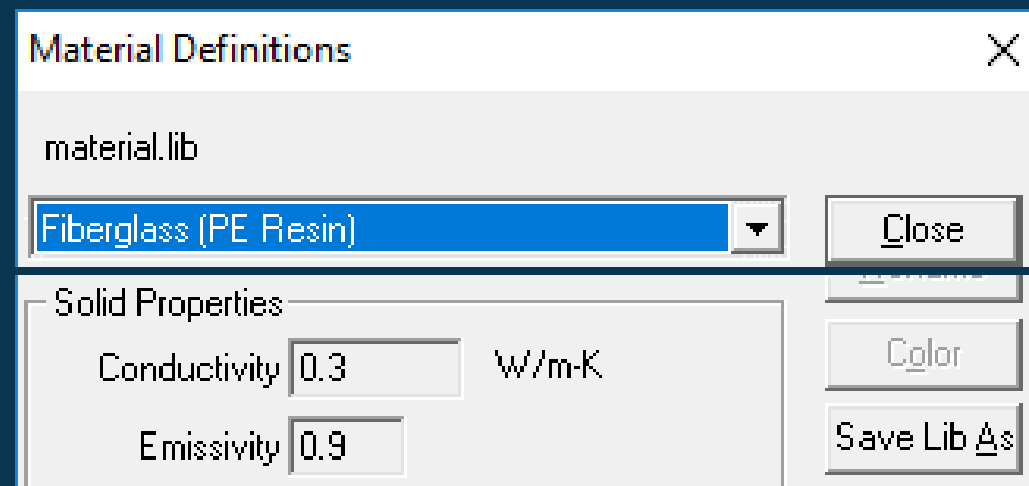
- Panel’s U-value set to “worst-allowed” U-glass $0.70 \text{ W/m}^2/\text{K}$
- Forces manufacturer to optimize frame design at detailed level
- No help from rounding; your U-window must be $U_{si}-0.80$ ($U-0.1409$), and not $U-0.1449$ rounded to $U-0.14$



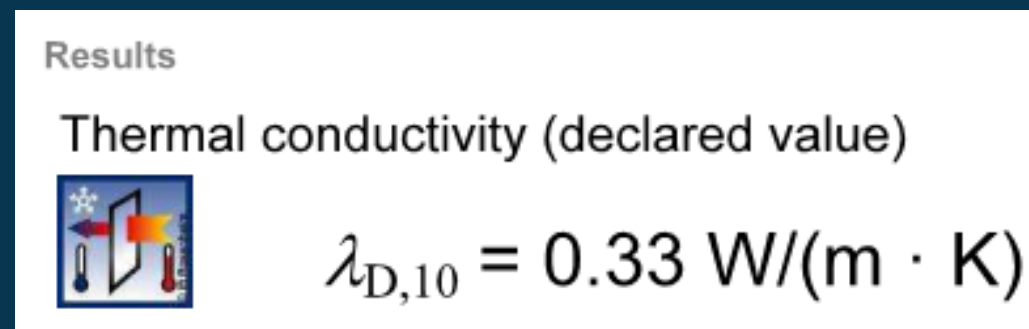
Thermal model with calibration panel in lieu of IGU

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)

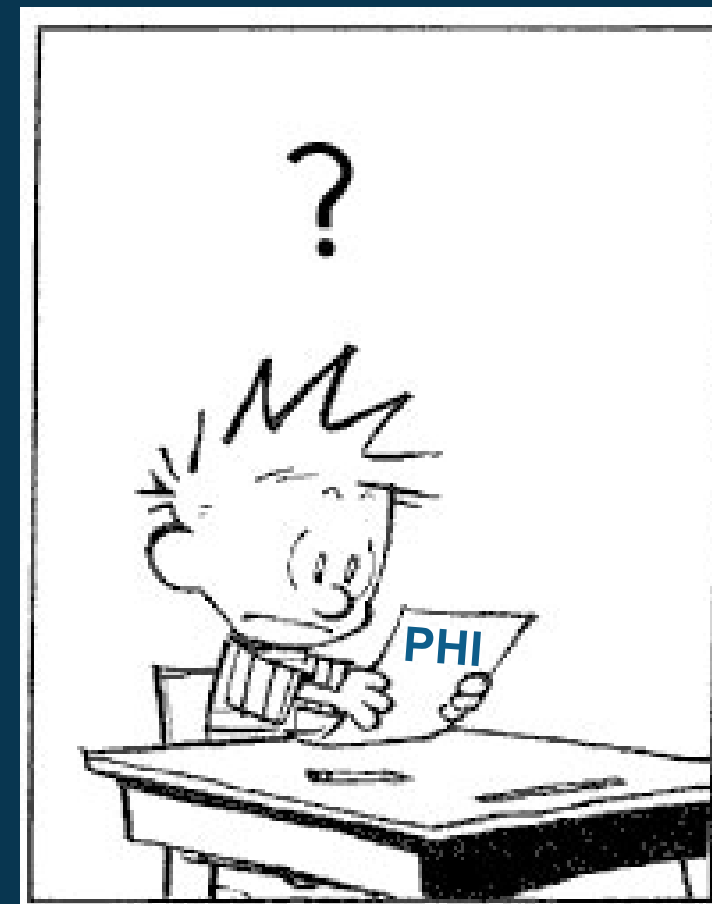
Reacting to Material Differences

K-VALUE TESTING NOT UNEXPECTED

- lengthy process
- resulted in design changes

INSULATION TYPE

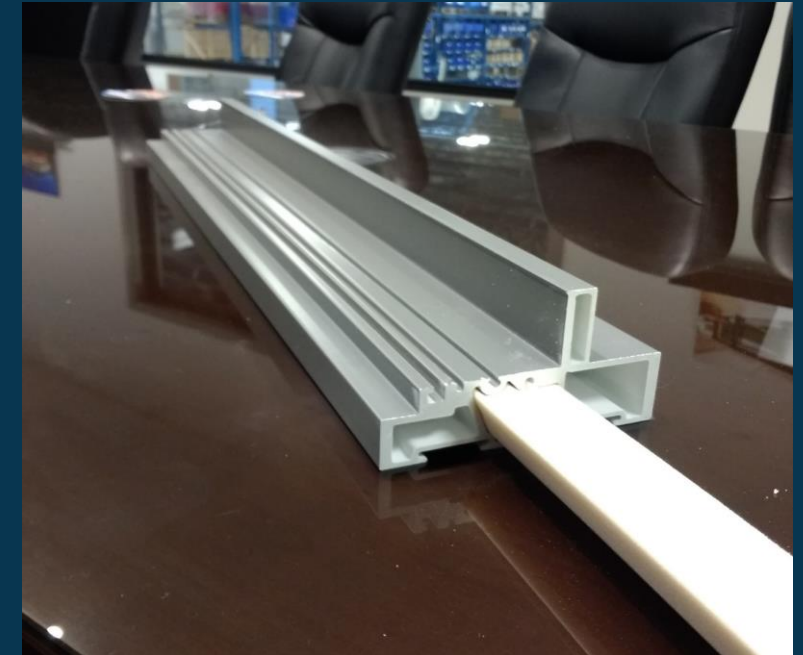
NOVEL MILLING PATTERN IN SASH



Reacting to Material Differences

1. Insulation type

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

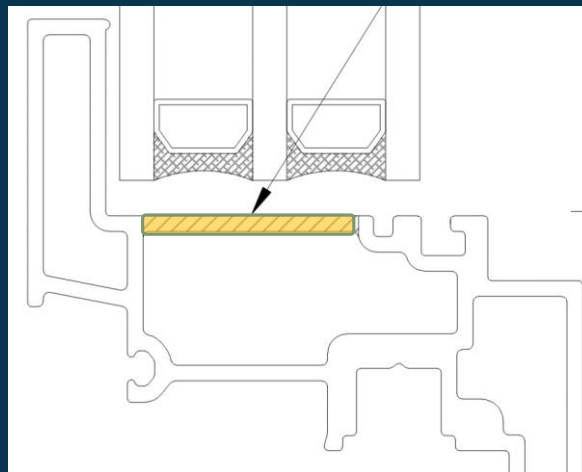


Polyurethane (PU) insulation cut to fit frame cavities

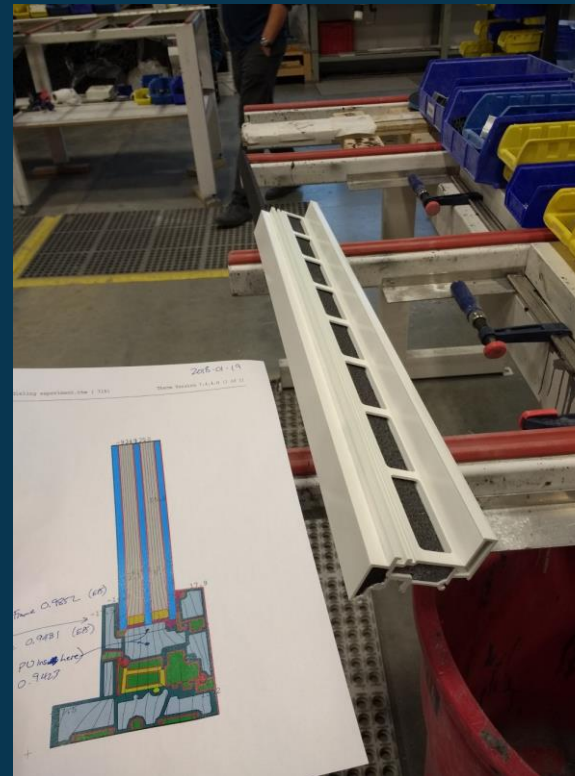
Reacting to Material Differences

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

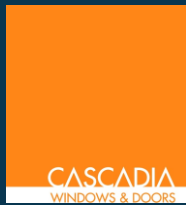
- Consult with IG supplier
- Careful about too big a balloon

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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