# Phius Window and Door Certification Program

## Full Certification Protocol Summary

*V1.1 – Updated 13 December 2023*

**Contents**



### Section 1: Program Overview

The Phius Window and Door Certification Program ("Program") is a voluntary program that primarily rates the performance of fenestration products at the individual component level (glass, spacer, and frame) via LBNL THERM/WINDOW software. For best accuracy in building energy modeling, window performance data (e.g., U-values) are needed at the component-level (i.e., for the frame and glass separately) so that windows' performance can be calculated for the exact sizes and configurations planned for the project. This component-level data is generally not otherwise readily available in the marketplace. The program also encompasses some other properties relevant to high-performance building, such as condensation resistance, airtightness, and frame material.

Manufacturers who pursue Phius product certification can better position their products in the passive and high-performance building markets. In turn, practitioners can more easily obtain the data they need to specify products for their projects. The plug-and-play, Phius-verified performance data on Phius product certificates saves time spent on modeling and documentation. Manufacturers who seek Phius product certification simply submit the requested product details to Phius after which performance values are calculated and published.

Phius Certified Products are listed publicly in the Phius Certified Window & Door Database. Manufacturers also receive digital certificates that can be printed and distributed to customers or posted to their respective websites. The subsequent sections outline the paths to certification, general certification process, and certification criteria by climate zone.

## Section 2: Calculated Values and Paths to Certification

The program offers two paths to certification, each with their own protocol: the **Blue Path**, and the **Orange Path.** Regardless of which path protocol is selected, the resulting Phius Certified performance data sheets have the same format and include the following information:

- Frame U-value **(U-Frame)**
- Linear bridge coefficient for the spacer/edge-of-glass effect **(Psi-Spacer)**
- Center-of-glass U-value **(U-COG)** – climate zone dependent[1]
- Center-of-glass solar heat gain coefficient **(SHGC-COG)**
- Whole-window or whole-door ("whole-product") U-value for a standard size unit
- Whole-product SHGC for a standard size unit
- Condensation resistance
- Availability of airtightness test data (ASTM E283 and EN 1026 are acceptable test methods)

The table below outlines the core differences between the two paths:

| **Blue Path** (NFRC Method) | **Orange Path** (EN Method) |
|---|---|
| Based on NFRC standards, this protocol generates calculations per **ISO 15099**.<br>· Full NFRC certification for each product combination and current NFRC Certified Product Directory Numbers (CPD Numbers) are required to utilize this path. | Based on EN standards, this protocol generates calculations based on:<br>· Center-of-Glass U-value per **EN673**<br>· Center-of-Glass Solar Heat Gain Coefficient per **EN 410**<br>· Frame/Spacer performance per **EN 10077-2** |

The differences between the two calculation protocols are as follows:

- For the Blue Path, the data are taken from the Lawrence Berkley National Laboratory (LBNL) THERM and WINDOW simulation files that are minimally modified from NFRC standards instead of completely recalculated per CEN standards as with the Orange Path.
    - This slight modification entails converting the extra heat loss from NFRC's 2.5-inch-wide edge-of-glass area into an equivalent linear coefficient.[2]
- By selecting the Orange Path, Manufacturers receive compatible/comparable ratings to the values typically assigned to imported European windows.
- For the Orange Path, the thermophysical properties of materials are obtained from appendices A, B, and C in NFRC 101. Supporting documentation may be provided to override these default values, subject to Phius approval.
- Both protocols support passive building practitioners with the component-level window data they need to perform building energy modeling, and Phius considers the certifications from each path to be functionally equivalent for Phius project (building) certification.

Embellishments to the standard methods that bring the two paths closer to alignment:

- The same standard sizes are used.
- The same outside temperatures are used for the climate-dependent center of glass U-value calculation.
    - In the Phius Certified Window and Door Database hosted on Phius.org, the Zone 4 U-COG value is used for the Whole-Window U-value calculation for both paths.

[1] Instructions for using LBNL WINDOW software to calculate the climate-dependent center-of-glass properties are available upon request.

[2] See Appendix III for a whitepaper with further details on this conversion.

## Section 3: General Certification Process by Path

The following section outlines the core steps to certification for each path.

**Blue Path**

- The Manufacturer contacts an NFRC-accredited Simulation Laboratory with a Phius Blue Path Simulator on staff who has been trained to do the Phius conversion and is licensed to use the Phius Window Calculator to produce Blue Path certificates. A list of qualified simulators can be found on the Phius website.
- The Manufacturer must authorize the original lab to release the NFRC-authored simulation models to the Blue Path Simulator's laboratory (the original lab and Blue Path lab may be the same institution).
- The Manufacturer works with the Blue Path Simulator to determine the scope of work after which the Blue Path Simulator quotes the cost for the conversion job. Phius works with the NFRC Simulator to determine the total number of products to be certified and then calculates the Phius Certified Product Database listing fee. The calculation and inspection work proceeds per NFRC standard practice.
- The NFRC-accredited Simulation Laboratory sends converted THERM and WINDOW files and certificate calculation files to Phius for a quality inspection.
- Phius contacts the manufacturer to identify which products are to be listed on the Phius website and bills the appropriate database listing fee.
- Upon payment of the database listing fee, the Phius Certified Product mark is awarded, and the values are published to the Phius Certified Window & Door Database.

**Orange Path**

- The Manufacturer works with the Phius Product Certification Manager to determine the scope of work, after which Phius quotes the job cost (not-to-exceed estimate). Current pricing information is available upon request. The Agreement is then executed and Phius invoices the Manufacturer for a down payment.
- The Product Certification Manager selects a Phius-trained simulator (either in-house or licensed third party).
- A Phius-trained Reviewer (either the Product Certification Manager or a Phius-trained third party) performs a quality check on the calculations and informs the Simulator of any required corrections.
- Once confirmed by the Reviewer, the results are sent to Phius for final review. Once approved, the results are shared with the Manufacturer and Phius invoices the Manufacturer for final payment.
- The Phius Certified Product mark is awarded, and the values are published to the Phius database.

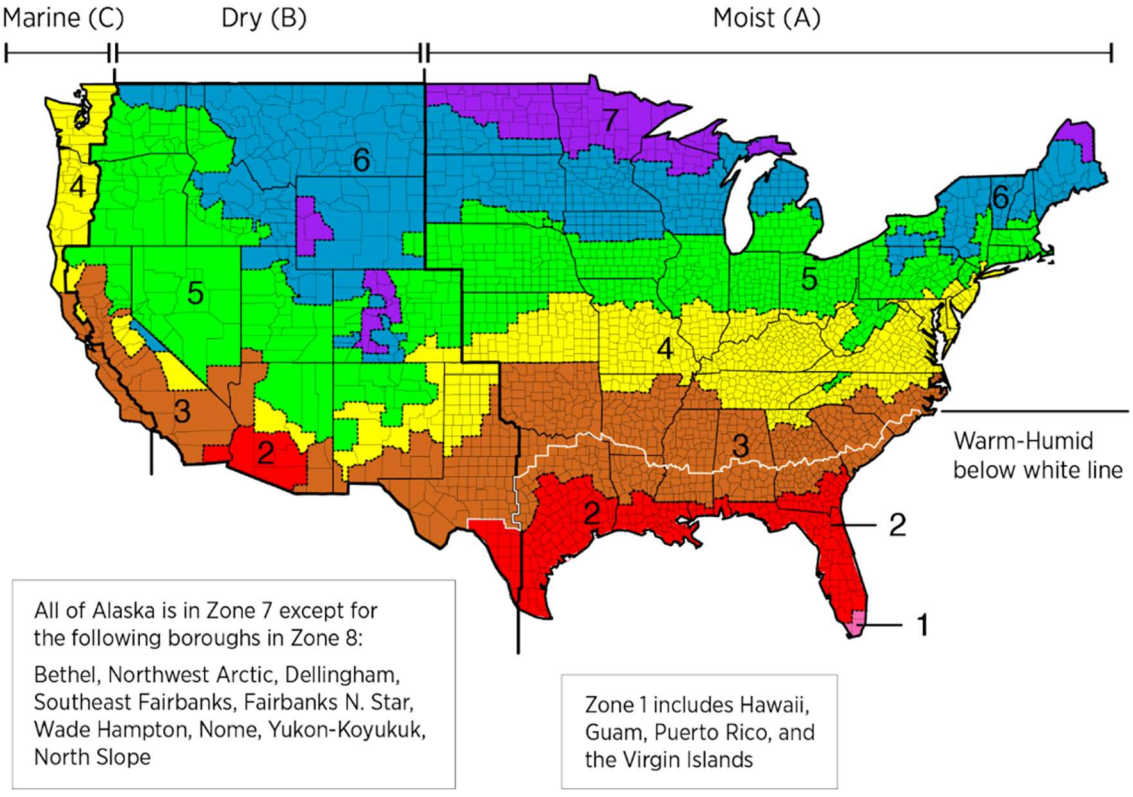
## Appendix I: Certification Criteria by Climate Zone

The table below outlines the requirements to secure a climate zone recommendation at standard model size. They are to be interpreted as a starting point for evaluating a window or door's suitability for use in a certain zone. (For Phius Project Certification, more nuanced standards dictate products' suitability and supersede the product-level zone recommendations – product-level climate zone recommendations are not required in order to use a given product in a Phius building project.)

**Table 1: Phius Window & Door Certification Criteria by Climate Zone**

| Climate Zone | Max Whole-Window U-Value (*Btu/h·ft²·°F*) | *Max Whole-Window U-Value (W/mK)* | Max Whole-Window SHGC |
|---|---|---|---|
| 8 | 0.11 | *0.62* | - |
| 7 | 0.12 | *0.68* | - |
| 6 | 0.13 | *0.74* | - |
| 5A, 5B | 0.16 | *0.91* | - |
| 4A, 4B | 0.19 | *1.08* | 0.4 |
| 4C, 5C | 0.24 | *1.36* | - |
| 3A | 0.23 | *1.31* | 0.25 |
| 3B | 0.29 | *1.65* | 0.25 |
| 3C | 0.29 | *1.65* | 0.3 |
| 0, 1, 2 | 0.29 | *1.65* | 0.25 |

**Companion Graphic to Table 1: Corresponding IECC Climate Zones[3]**




[3] Graphic source: https://basc.pnnl.gov/images/iecc-climate-zone-map

## Appendix II: Standard Model Sizes

Tables 2 and 3 below outline the standard model sizes used for whole-product U-values and whole-product SHGC values. Standard model sizes mirror those used by the NFRC. Nomenclature differs slightly, but there are no deviations in assigned standard model sizes for product categories. Product types that are "grayed-out" in each table are not available in that table's scope (e.g., curtain wall products are only modeled as two-lite products, therefore there is no one-lite standard size available for a curtain wall).

**Table 2: Phius Window and Door Certification Standard Model Sizes, One-Lite Products**

| ONE LITE PRODUCTS, STANDARD MODEL SIZES | | | |
|---|---|---|---|
| **Phius Classifications** | **NFRC Equivalent** | **One-Lite Standard Model Size (mm)** | |
| **WINDOWS** | | **Width** | **Height** |
| **Awning** | **Projecting (Awning - Single)** | 1500 | 600 |
| **Casement** | **Casement - Single** | 600 | 1500 |
| **Single Hung** | n/a | - | - |
| **Double Hung** | n/a | - | - |
| **Dual Action Tilt Turn** | **Dual-Action** | 1200 | 1500 |
| **Fixed** | Fixed | 1200 | 1500 |
| **Horizontal Sliding** | n/a | - | - |
| **DOORS AND DOOR RELATED** | | **Width** | **Height** |
| **Single Swinging Door** | **Side-Hinged Exterior Door** | 960 | 2090 |
| **Double Swinging Door** | n/a | - | - |
| **Sliding Door** | n/a | - | - |
| **Sidelite** | Sidelite | 960 | 2090 |
| **Transom** | Transom | 2000 | 600 |
| **Residential Roll Up Garage Door** | **Garage (Vehicular Access)/Rolling Door** | 2134 | 2134 |
| **Residential Swinging Garage Door** | **n/a** | 2134 | 2134 |
| **SKYLIGHTS** | | **Width** | **Height** |
| **Skylight** | **Skylight/Roof Window** | 1200 | 1200 |
| **GLAZED WALL SYSTEMS** | | **Width** | **Height** |
| **Curtain Wall** | n/a | - | - |
| **Window Wall** | n/a | - | - |
| **Sloped Glazing** | n/a | - | - |
| **Spandrel Panel System** | n/a | - | - |
| **Storefront** | n/a | - | - |

**Table 3: Phius Window and Door Certification Standard Model Sizes, Two-Lite Products**

| TWO LITE | | | |
|---|---|---|---|
| **Phius Classifications** | **NFRC Equivalent** | **Two-Lite Standard Model Size (mm)** | |
| **WINDOWS** | | **Width** | **Height** |
| **Awning** | n/a | 1500 | 1200 |
| **Casement** | **Casement - Double** | 1200 | 1500 |
| **Single Hung** | **Vertical Slider** | 1200 | 1500 |
| **Double Hung** | **Vertical Slider** | 1200 | 1500 |
| **Dual Action Tilt Turn** | n/a | 2400 | 1500 |
| **Fixed** | n/a | 2400 | 1500 |
| **Horizontal Sliding** | **Horizontal Slider** | 1500 | 1200 |
| **DOORS AND DOOR RELATED** | | **Width** | **Height** |
| Single Swinging Door | n/a | - | - |
| **Double Swinging Door** | **Side-Hinged Exterior Door (Double)** | 1920 | 2090 |
| **Sliding Door** | **Sliding Glass Door** | 2000 | 2000 |
| Sidelite | n/a | - | - |
| Transom | n/a | - | - |
| Residential Roll Up Garage Door | n/a | - | - |
| Residential Swinging Garage Door | n/a | - | - |
| **SKYLIGHTS** | | **Width** | **Height** |
| **Skylight** | **n/a** | 2400 | 1200 |
| **GLAZED WALL SYSTEMS** | | **Width** | **Height** |
| **Curtain Wall** | Curtain Wall | 2000 | 2000 |
| **Window Wall** | Window Wall | 2000 | 2000 |
| **Sloped Glazing** | Sloped Glazing | 2000 | 2000 |
| **Spandrel Panel System** | Spandrel Panel System | 2000 | 2000 |
| **Storefront** | **n/a** | 2000 | 2000 |

**Combination units** (e.g. two products mulled together) will receive a "Combination Unit" designation (rather than "One-Lite" or "Two-Lite"), and a model size that is a composite of the standard NFRC sizes in the table above according to the subsequent conditions:

**Table 4: Two-Lite Combination Unit Standard Size Parameters**

| Two-Lite Combination Unit Orientation | Width | Height |
|---|---|---|
| Horizontal | **Sum** of applicable NFRC model sizes | **Average** of applicable NFRC model sizes |
| Vertical | **Average** of applicable NFRC model sizes | **Sum** of applicable NFRC model sizes |

Below are two examples of this composite logic for combination units in practice:

**Example, horizontal:**

Fixed **Casement** (600 W x 1500 H)

*beside an*

Operable **Dual Action Tilt Turn** (1200 W x 1500 H)

**Width**: 600 + 1200 = 1800 mm
**Height:** (1500 + 1500) / 2 = 1500 mm

**Combination unit model size:** 1800 mm Wide x 1500 mm High.

**Example, vertical:**

Operable **Awning** (1500 W x 600 H)

*above a*

Fixed **Picture Window** (1200 W x 1500 H)

**Width**: (1500 + 1200) / 2 = 1350 mm
**Height:** 600 + 1500 = 2100 mm

**Combination unit model size:** 1350 mm Wide x 2100 mm High.

***Note:*** Combination units are not present in the existing NFRC protocol. Therefore, any Blue Path products that aim to use their NFRC simulations as the basis for a Phius-certified Combination Unit must provide separate performance data and CPD numbers for each product that will comprise the Combination Unit. Phius Blue Path protocol allows for the creation of Combination Units from the data and simulations of each individual product that will be mulled together. Orange Path products that seek the Combination Unit designation will follow the same existing submission requirements as One-Lite and Two-Lite products.

## Appendix III: NFRC and PHIUS U-Factor Calculation Comparison, Jeff Baker, WESTLab, 06.26.2014

**NFRC and PHIUS U-Factor Calculation Comparison**

Prepared by Jeff Baker, WESTLab

June 26, 2014

There has been considerable interest in a method of extracting the input data for the Passive House Planning Package (PHPP) whole building energy modeling tool from the National Fenestration Rating Council (NFRC) window performance data. In order to determine if this input data can be exacted, the differences between the NFRC and Passive House Institute US (PHIUS) programs need to be understood.

The PHIUS window certification program follows the ISO 10077 procedure that determines a glass U-factor, frame U-factor, and lineal Psi (Ψ) value and total product U-factor. This program calculates the glass U-factor at ten different sets of temperature conditions (20°C interior and -18°C, -12°C, -10°C, -4°C, -2°C, 2°C, 5°C, 7°C, 10°C, 21°C exterior) with fixed surface heat transfer coefficients. The frame U-factor and Ψ value are determined at one set of temperatures (20°C interior and -10°C exterior) with fixed surface heat transfer coefficients. The ten total product U-factors are determined using the ten different center-of-glass U-factors with the frame and Ψ values for the single set of temperatures.

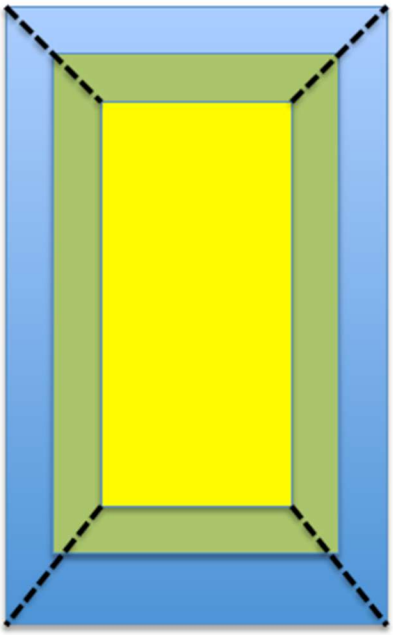
The NFRC certification program follows the ISO 15099 procedure that determines a center-of-glass, edge-of-glass, frame, and total product U-factor. This program calculated the U-factors at a single set of temperatures (21°C interior and -18°C exterior) with variable surface heat transfer coefficients.

The two different ISO procedures, the temperature conditions, and surface heat transfer coefficient, will result in different total product U-factors. The procedures also area weight the component data differently. If the differences between the NFRC and PHIUS window programs can be ignored and that the NFRC results are acceptable for input into

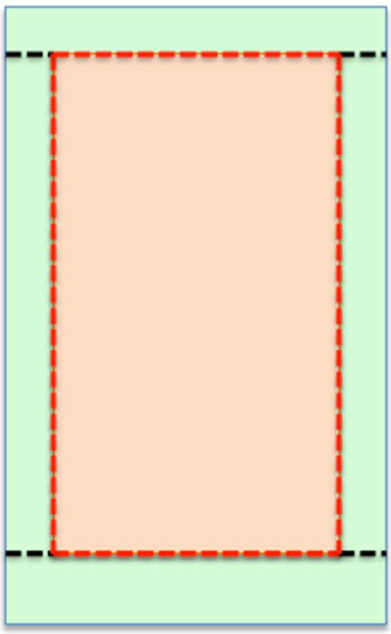
the PHPP program several assumptions have to be made in order to derive the PHPP window input data. First, assume the NFRC center-of-glass U-factor is equal to the PHIUS glass U-factor. Second, that the NFRC frame U-factors are equal to the PHIUS frame U-factors. Third, the difference in the frame area weighting can be ignored. Finally, that the NFRC and PHIUS total product U-factors are equal at the NFRC rated product sizes. With these assumptions the PHIUS glass and frame U-factors are known, but the Ψ values still need to be determined from the available NFRC data.

**Derivation of the PHIUS Ψ value from NFRC data**

NFRC Area Weighted Method



PHIUS Area and Lineal Method



NFRC Center-of-Glass Area - $A_{cg}$

NFRC Edge-of-Glass Area - $A_{eg}$

NFRC Frame Area - $A_{fr}$

PHIUS Glass Area - $A_g$

PHIUS Lineal Length - L

PHIUS Frame Area - $A_f$

$$U_{NFRC} = \frac{U_{cg} * A_{cg} + \sum_1^n U_{eg}{}^i * A_{eg}{}^i + \sum_1^n U_{fr}{}^i * A_{fr}{}^i}{A_{total}}$$

$$U_{PHIUS} = \frac{U_g * A_g + \sum_1^n U_f{}^i * A_f{}^i + \sum_1^n \Psi^i * L^i}{A_{total}}$$

Where:

- $U_{cg}$ = NFRC Center-of-Glass U-factor
- $U_{eg}$ = NFRC Edge-of-Glass U-factor
- $U_{fr}$ = NFRC Frame U-factor
- $U_{NFRC}$ = NFRC Total Product U-factor
- $U_g$ = PHIUS Glass U-factor, will assume equal to NFRC $U_{cg}$
- $U_f$ = PHIUS Frame U-factor, will assume equal to NFRC $U_{fr}$
- $\Psi$ = PHIUS Lineal Conductance, to be determined
- $U_{PHIUS}$ = PHIUS Total Product U-factor, will assume equal to $U_{NFRC}$
- $A_{total}$ = Total area of the product and assumed the same for NFRC and PHIUS

With $U_{NFRC} = U_{PHIUS}$ and the assumptions listed above $\Psi$ can be solved:

$$U_{cg} * A_{cg} + \sum_{1}^{n} {U_{eg}}^{i} * {A_{eg}}^{i} = U_{cg} * A_g + \sum_{1}^{n} \Psi^i * L^i$$

$$A_g = A_{cg} + \sum_{1}^{n} {A_{eg}}^{i}$$

$$\sum_{1}^{n} {U_{eg}}^{i} * {A_{eg}}^{i} = \sum_{1}^{n} U_{cg} * {A_{eg}}^{i} + \sum_{1}^{n} \Psi^i * L^i$$

For each component i

$${U_{eg}}^{i} * {A_{eg}}^{i} = U_{cg} * {A_{eg}}^{i} + \Psi^i * L^i$$

$${A_{eg}}^{i} = \left(L^i - 0.0635/2\right) * 0.0635 \quad \text{(L in meters)}$$

$$\Psi^i = \frac{({U_{eg}}^{i} - U_{cg}) * (L^i - 0.0635/2) * 0.0635}{L^i}$$

Where $L^i$ is the component length at the product sightline using the NFRC model product size.

Now the input data for the PHPP program can be generated from the available NFRC product data calculations. The final question is how close do the PHIUS U-factors calculated from the NFRC data compare with actual PHIUS calculations.

This comparison has been done for a four-sided product. NFRC and PHIUS handle vertical and horizontal sliding products differently. NFRC treats these products as a single unit with two sashes, where PHIUS breaks them up into two separate units. If the NFRC results are used and the NFRC product is separated along the center of the meeting rail of the sliding product and half the meeting rail is used in each of the PHIUS equivalent products, the analysis presented above works as is and the input data for the PHPP program can be generated for the two products used to represent a sliding product.

A comparison of two products was done between U-factors generated using the PHIUS method and following the PHIUS method with NFRC input data. The results for all of the PHIUS temperatures and the NFRC inputs are included on the next page. The results indicate that the NFRC data is very comparable with the PHIUS data for -18°C. The NFRC results give U-factors lower than the PHIUS as a result of the differences in the ISO 10077 and 15099 procedures. For glass options with higher center-of-glass U-factors the NFRC results would be slightly higher than the PHIUS results.

The conclusion from this comparison is that the NFRC input data for the PHPP program provide results very comparable to the PHIUS data. Therefore, using NFRC input data for the PHPP program would be an accurate representation of the fenestration performance data.

**Aluminum Clad Casement Window**

| PHIUS | Glass option 1 | | | Glass option 2 | | | Glass option 3 | | | Glass option 4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Exterior Temperature** | **Ucg** | **Utotal** | **SHGCcg** | **Ucg** | **Utotal** | **SHGCcg** | **Ucg** | **Utotal** | **SHGCcg** | **Ucg** | **Utotal** | **SHGCcg** |
| **21** | 0.18 | 0.23 | 0.70 | 0.12 | 0.18 | 0.55 | 0.12 | 0.20 | 0.44 | 0.14 | 0.21 | 0.51 |
| **10** | 0.17 | 0.22 | 0.70 | 0.14 | 0.20 | 0.55 | 0.12 | 0.19 | 0.44 | 0.13 | 0.20 | 0.51 |
| **7** | 0.17 | 0.22 | 0.70 | 0.14 | 0.19 | 0.55 | 0.12 | 0.19 | 0.44 | 0.13 | 0.20 | 0.51 |
| **5** | 0.17 | 0.22 | 0.70 | 0.14 | 0.19 | 0.55 | 0.12 | 0.19 | 0.44 | 0.13 | 0.20 | 0.51 |
| **2** | 0.17 | 0.22 | 0.70 | 0.14 | 0.19 | 0.55 | 0.12 | 0.19 | 0.44 | 0.13 | 0.20 | 0.51 |
| **-2** | 0.16 | 0.22 | 0.70 | 0.14 | 0.19 | 0.55 | 0.11 | 0.19 | 0.44 | 0.13 | 0.20 | 0.51 |
| **-4** | 0.16 | 0.22 | 0.70 | 0.14 | 0.19 | 0.55 | 0.11 | 0.19 | 0.44 | 0.13 | 0.20 | 0.51 |
| **-10** | 0.16 | 0.22 | 0.70 | 0.14 | 0.19 | 0.55 | 0.11 | 0.19 | 0.44 | 0.13 | 0.20 | 0.51 |
| **-12** | 0.16 | 0.22 | 0.70 | 0.14 | 0.19 | 0.55 | 0.11 | 0.19 | 0.44 | 0.13 | 0.20 | 0.51 |
| **-18** | 0.159 | 0.218 | 0.697 | 0.136 | 0.190 | 0.548 | 0.111 | 0.185 | 0.445 | 0.126 | 0.200 | 0.507 |
| **NFRC (-18)** | 0.151 | 0.209 | 0.687 | 0.137 | 0.195 | 0.542 | 0.100 | 0.174 | 0.426 | 0.116 | 0.188 | 0.487 |

| PHIUS | Glass option 5 | | | Glass option 6 | | | Glass option 7 | | | Glass option 8 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Exterior Temperature** | Ucg | Utotal | SHGCcg | Ucg | Utotal | SHGCcg | Ucg | Utotal | SHGCcg | Ucg | Utotal | SHGCcg |
| **21** | 0.15 | 0.21 | 0.57 | 0.10 | 0.17 | 0.38 | 0.10 | 0.16 | 0.26 | 0.13 | 0.20 | 0.26 |
| **10** | 0.15 | 0.21 | 0.57 | 0.12 | 0.18 | 0.38 | 0.11 | 0.18 | 0.26 | 0.13 | 0.20 | 0.26 |
| **7** | 0.15 | 0.21 | 0.57 | 0.12 | 0.18 | 0.38 | 0.11 | 0.18 | 0.26 | 0.13 | 0.20 | 0.26 |
| **5** | 0.15 | 0.21 | 0.57 | 0.12 | 0.18 | 0.38 | 0.11 | 0.18 | 0.26 | 0.13 | 0.19 | 0.26 |
| **2** | 0.15 | 0.21 | 0.57 | 0.12 | 0.18 | 0.38 | 0.11 | 0.18 | 0.26 | 0.13 | 0.19 | 0.26 |
| **-2** | 0.15 | 0.21 | 0.57 | 0.12 | 0.18 | 0.38 | 0.11 | 0.18 | 0.26 | 0.13 | 0.19 | 0.26 |
| **-4** | 0.15 | 0.21 | 0.57 | 0.12 | 0.18 | 0.38 | 0.11 | 0.18 | 0.26 | 0.13 | 0.19 | 0.26 |
| **-10** | 0.15 | 0.21 | 0.57 | 0.11 | 0.18 | 0.38 | 0.11 | 0.18 | 0.25 | 0.13 | 0.19 | 0.25 |
| **-12** | 0.15 | 0.21 | 0.57 | 0.11 | 0.18 | 0.38 | 0.11 | 0.18 | 0.26 | 0.13 | 0.19 | 0.26 |
| **-18** | 0.146 | 0.208 | 0.565 | 0.114 | 0.178 | 0.380 | 0.111 | 0.176 | 0.256 | 0.127 | 0.191 | 0.256 |
| **NFRC (-18)** | 0.140 | 0.200 | 0.560 | 0.113 | 0.175 | 0.357 | 0.111 | 0.173 | 0.236 | 0.118 | 0.182 | 0.237 |

**Aluminum Clad Picture Window**

| PHIUS | Glass option 1 | | | Glass option 2 | | | Glass option 3 | | | Glass option 4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Exterior Temperature** | **Ucg** | **Utotal** | **SHGCcg** | **Ucg** | **Utotal** | **SHGCcg** | **Ucg** | **Utotal** | **SHGCcg** | **Ucg** | **Utotal** | **SHGCcg** |
| **21** | 0.16 | 0.20 | 0.68 | 0.12 | 0.16 | 0.54 | 0.12 | 0.17 | 0.43 | 0.13 | 0.19 | 0.50 |
| **10** | 0.15 | 0.19 | 0.68 | 0.14 | 0.18 | 0.54 | 0.11 | 0.17 | 0.43 | 0.12 | 0.18 | 0.50 |
| **7** | 0.15 | 0.19 | 0.68 | 0.14 | 0.18 | 0.54 | 0.11 | 0.16 | 0.43 | 0.12 | 0.18 | 0.50 |
| **5** | 0.15 | 0.19 | 0.68 | 0.14 | 0.18 | 0.54 | 0.11 | 0.16 | 0.43 | 0.12 | 0.18 | 0.50 |
| **2** | 0.15 | 0.19 | 0.68 | 0.14 | 0.18 | 0.54 | 0.11 | 0.16 | 0.43 | 0.12 | 0.18 | 0.50 |
| **-2** | 0.15 | 0.19 | 0.68 | 0.14 | 0.18 | 0.54 | 0.11 | 0.16 | 0.43 | 0.12 | 0.18 | 0.50 |
| **-4** | 0.15 | 0.19 | 0.68 | 0.14 | 0.18 | 0.54 | 0.11 | 0.16 | 0.43 | 0.12 | 0.18 | 0.50 |
| **-10** | 0.15 | 0.19 | 0.68 | 0.14 | 0.18 | 0.54 | 0.10 | 0.16 | 0.43 | 0.12 | 0.18 | 0.50 |
| **-12** | 0.15 | 0.19 | 0.68 | 0.14 | 0.18 | 0.54 | 0.10 | 0.16 | 0.43 | 0.12 | 0.18 | 0.50 |
| **-18** | 0.152 | 0.195 | 0.682 | 0.136 | 0.179 | 0.538 | 0.103 | 0.161 | 0.432 | 0.116 | 0.175 | 0.505 |
| **NFRC (-18)** | 0.143 | 0.184 | 0.670 | 0.137 | 0.176 | 0.532 | 0.100 | 0.156 | 0.426 | 0.116 | 0.172 | 0.487 |

| PHIUS | Glass option 5 | | | Glass option 6 | | | Glass option 7 | | | Glass option 8 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Exterior Temperature** | Ucg | Utotal | SHGCcg | Ucg | Utotal | SHGCcg | Ucg | Utotal | SHGCcg | Ucg | Utotal | SHGCcg |
| **21** | 0.13 | 0.18 | 0.54 | 0.11 | 0.15 | 0.37 | 0.10 | 0.15 | 0.25 | 0.12 | 0.16 | 0.25 |
| **10** | 0.13 | 0.18 | 0.54 | 0.13 | 0.17 | 0.37 | 0.12 | 0.17 | 0.25 | 0.12 | 0.16 | 0.25 |
| **7** | 0.13 | 0.18 | 0.54 | 0.13 | 0.17 | 0.37 | 0.12 | 0.17 | 0.25 | 0.12 | 0.16 | 0.25 |
| **5** | 0.13 | 0.18 | 0.54 | 0.13 | 0.17 | 0.37 | 0.12 | 0.17 | 0.25 | 0.11 | 0.16 | 0.25 |
| **2** | 0.13 | 0.18 | 0.54 | 0.13 | 0.17 | 0.37 | 0.12 | 0.17 | 0.25 | 0.11 | 0.16 | 0.25 |
| **-2** | 0.13 | 0.18 | 0.54 | 0.12 | 0.17 | 0.37 | 0.12 | 0.17 | 0.25 | 0.11 | 0.16 | 0.25 |
| **-4** | 0.13 | 0.18 | 0.54 | 0.12 | 0.17 | 0.37 | 0.12 | 0.17 | 0.25 | 0.11 | 0.16 | 0.25 |
| **-10** | 0.13 | 0.18 | 0.54 | 0.12 | 0.17 | 0.36 | 0.12 | 0.16 | 0.25 | 0.11 | 0.16 | 0.25 |
| **-12** | 0.13 | 0.18 | 0.54 | 0.12 | 0.17 | 0.37 | 0.12 | 0.16 | 0.25 | 0.11 | 0.16 | 0.25 |
| **-18** | 0.128 | 0.175 | 0.539 | 0.122 | 0.165 | 0.367 | 0.118 | 0.163 | 0.251 | 0.112 | 0.160 | 0.251 |
| **NFRC (-18)** | 0.126 | 0.167 | 0.533 | 0.118 | 0.159 | 0.345 | 0.115 | 0.157 | 0.233 | 0.106 | 0.151 | 0.233 |