

Prepared for:

National Fenestration Rating Council

SIMPLIFICATION OF DOOR LABELING

Draft Progress Report

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1. INTRODUCTION

1.1 Overview

The current NFRC labeling procedure for doors is too cumbersome to implement. The industry needs a simplified procedure that can be more broadly applied. Although there is a wide variation in door types, NFRC has streamlined the rating process by establishing a rating size and glazing sizes for entry doors as well as default frames. The purpose of this research is to further streamline the process without inhibiting potential improvements in the energy efficiency of doors.

Simulation of doors is fairly simple as compared to that for windows because of the fixed glass sizes. A simulator models all opaque elements one time and then models all glazing options in their glazing gasket. So, the total product U-Factor and SHGC for all glazing options is based on the same component U-Factors for the opaque elements. The only component U-Factors that change are the edge-of-glass and center-of-glass U-Factors.

To simplify the rating and labeling of doors, Enermodal first analyzed existing NFRC door data to identify trends specific to door types. The data did not reveal any trends specific to the slab type and frame type.

We also requested component data from door manufacturers who have had their doors rated. We received a small subset of data. Again, because of the variations in the total product values in the database, it was difficult to back out opaque-area trends that would allow us to simplify the ratings.

For SHGC and VT, the task is simpler in that NFRC 100 has already established one option for simplifying determination of SHGC and VT. The calculation of total product SHGC is a simple area-weighted calculation of opaque and glazing system SHGC's. The total product VT can be calculated directly from the glazing system VT since the glass areas are fixed.

We are proposing that simulators determine coefficients for a linear curve-fit of the U-Factor data, along with the individual center-of-glass values. Industry can use these to calculate total product values specific to products going out the door. It would be a simple calculation that utilizes product-specific data generated in accordance with NFRC procedures. A spreadsheet application could be developed for distribution to door fabricators that would calculate the total U-Factor, SHGC and VT for the product being built and generate an NFRC label.

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We are further recommending that NFRC revisit the current door height for swing doors and revise it to 2100 mm (83 in). This is more representative of products with a 6'8" in tall slab. More importantly, we recommend simulations for only no-glass, ½-glass and full-glass doors to simplify the rating and labeling procedures. This would also reduce the confusion and potential for errors in labeling doors. The ½-glass height should also be reduced to 940 mm (37"), so that realistic panel doors can be simulated and that default panel sizes can be established. This will result in ratings that are comparable; this is not currently the case for panel doors.

2. TASKS

The objective of this research project is to simplify door labeling. We reviewed existing NFRC door ratings to identify trends in the data and opportunities for simplifying the rating procedure. The following tasks describe the work that was completed in accordance with our contract.

2.1 Task 1 Examine NFRC Door Data

Task 1 Examine NFRC Door Data

Enermodal extracted all swinging door data from the NFRC database. This data includes product U-Factor, and SHGC and VT if it is to current procedures. Also included is a description of the product and glazing system. Note that the NFRC data from the database does not include detailed information on component U-Factors.

Enermodal used Excel to sort this data according to product type. Our original proposal stated that the data would be separated into the following categories:

Slab	Panels	Sill
Wood	Flush	Default Wood
Steel	6-Panels	Default Steel
Composite		Wood
		Steel
		ADA

The distinctions between the products were not discernible from the database. We attempted to separate the data by frame type, either wood or steel, and glazing type. The glazing types included clear insulating glazing, clear insulating glazing with argon, low-E insulating glazing and low-E insulating glazing with argon. Within each of these glazing types, we were able to sort by glass-size (where identified), gap width, and any of the other variables included in the database. We screened out the units with grids in order isolate the door slab and door frame trends.

Table 1 below shows the general results for each glazing category. We did not include the clear insulating glazing units with argon because there are only a few such products. As expected, as

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the insulating glazing unit improves, the U-factor decreases. As well, the doors with a steel frame have higher U-factors than those with a wood frame.

Table 1 Range of Door U-Factors in NFRC Database

	CLR IG	Low-E IG	Low-E, Arg IG
Steel Frame	0.20-0.49	0.27-0.43	0.20-0.43
Wood Frame	0.12-0.49	0.14-0.45	0.12-0.43

*Doors with grids not included.

Enermodal tried to categorize the doors by glass size. We found that wood frame, full-glass doors with clear insulating glazing vary from 0.33 to 0.42. There is one product with a U of 0.22; however, this product appears to be an outlier and the manufacturer's 1/4-glass listing has the same U-factor. The full-glass doors, both wood and steel framed products, with low-E insulating glazing have a U-factor variation of 0.28-0.44. Wood frame, 1/4-glass doors with clear IG vary from 0.0.19 to 0.46. This information does not distinguish the products by door slab which explains the large variation in results.

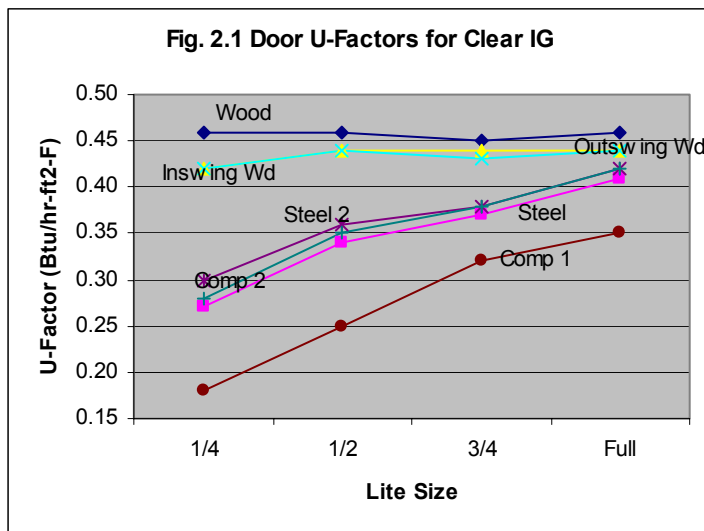


Figure 2.1 compares the total U-factor for three wood doors, two steel-skin doors and two composite doors (i.e. fiberglass skins). The inswing and outswing doors are made by the same manufacturer. For most of the products, it is unclear as to whether it is an outswing or inswing door. In general, we found the outswing doors have equal performance or are better by 0.01 than inswing doors.

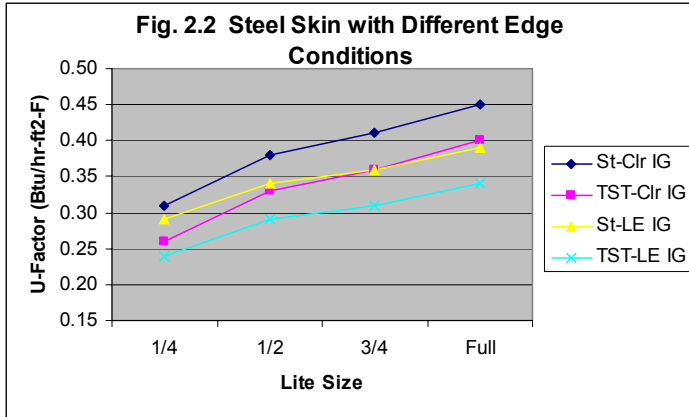
Wood doors generally have higher U-factors than steel-skin and composite

doors because of the rigid insulation in the core of the steel-skin and composite doors.

The difference in the steel doors is unclear from the database. These results are for doors from different manufacturers. The "Steel" door has a steel frame, whereas the "Steel 2" door has a wood frame. We anticipated that the results would be flipped with the "Steel 2" door outperforming the "Steel" door.

"Comp 1" and "Comp 2" represents two doors with composite material slabs and wood frames. They appear to have the same glazing and spacer. There is a significant difference in U-factors, although there is no clear explanation from the available information in the database.

Slab Edge



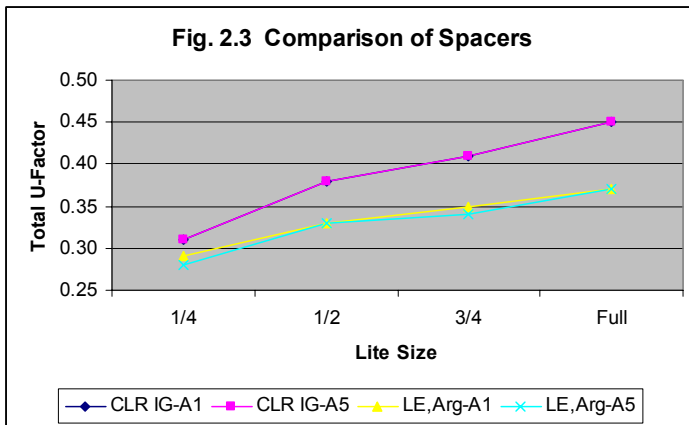
The slab edge is identified for a number of products. The edge condition appears to have a much greater influence on the product performance than whether the product is outswing or inswing and what type of spacer it is. Figure 2.2 compares two products from one manufacturer that just differ in the slab edge. There is a 0.05 difference in the U-factors for the same glass size and glazing

option.

Frames

The database does not include data for doors with identical slab and slab edge conditions for which we could compare frame types.

Spacers



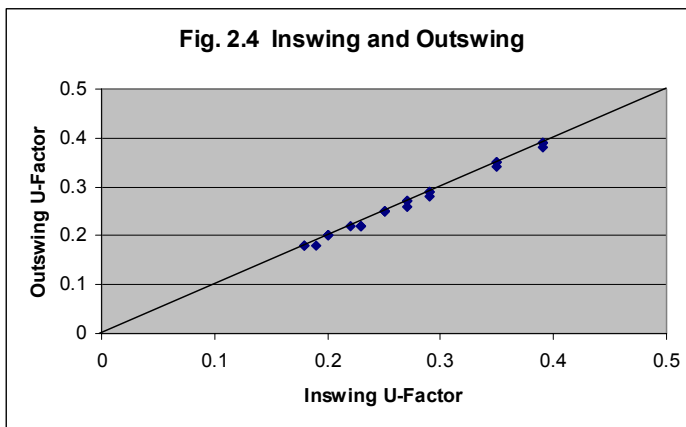
The database shows that different spacers make as much as a 0.01 difference in total U-factor. One manufacturer included aluminum spacer bar, Swiggle and silicone foam in clear insulating units. The units with the foam spacer were consistently 0.01 better than the metal spacers. In a door with low-E glass and argon fill, this difference may be as large as 0.02, but we could not confirm this.

Grids and Dividers

Many of the product lines include internal grids with a 0.75" width. The products with grids have the same U-Factor as those without grids. The SHGC and VT values are lower than those for the units without grids. One product line lists true-divided glasses with a 1.5" width; however, we were unable to determine the make-up of the individual units in order to compare them with units without dividers.

Inswing and Outswing

For a few products it was possible to compare the inswing and outswing operators. It appears that the outswing performs as much as 0.01 better in U-Factor. Figure 2.3 compares the U-Factor results for one manufacturer's product line for which the inswing and outswing could be



identified. For some of the units, the inswing and outswing units had equal U-Factors. For others, the outswing is 0.01 better.

2.2 Task 2 Collect Component Data

To verify trends in the data, component U-Factors were obtained from a couple manufacturers.

2.3 Task 3 Calculate U-Factors for Generic Systems

Enermodal used the data collected in Tasks 1 and 2 to calculate total product U-Factors, SHGC and VT. These results are included in the Excel workbook containing the raw data. Originally,

we intended to take the component U-Factors for similar products to arrive at generic component U-Factors for all opaque components. However, the data analysis in Task 1 demonstrated the wide variation in results and the unknowns in the database. So, we decided to attempt to curve-fit the data.

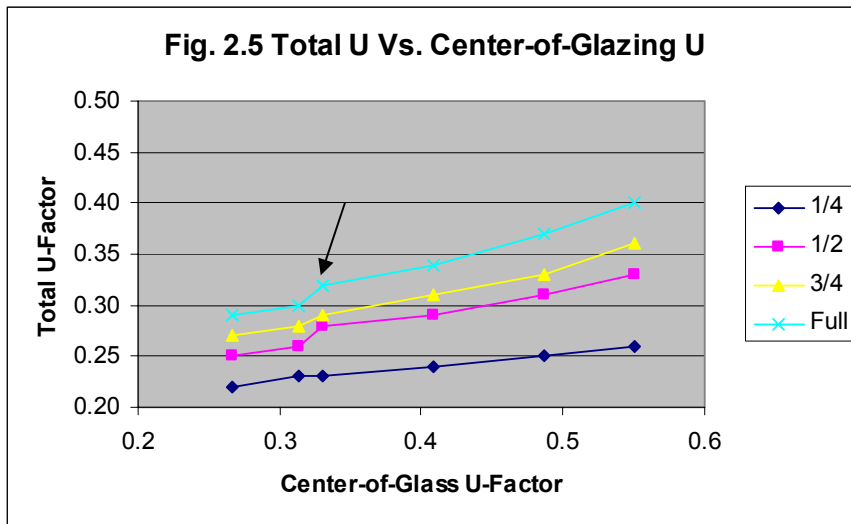


Figure 2.5 charts the total U-factor for different glass sizes versus the center-of-glazing U-factors for a steel door with a wood frame. This particular product includes a wide range of glazing options from a clear insulating unit with a 0.25 inch gap to a low-E insulating unit filled with argon and a gap of 0.75 inches. We took this

data and fit the data for each glass size to an equation of a line. We used a simple interpolation approach between the data for the best and worst case glazing options. We then calculated the total U-Factor and compared it to the reported U-Factor. For 24 different glazing options, the results matched for 19 of the units and there is a 0.01 difference in the results for remaining 6 units. The data point with the arrow pointing to it in Figure 2.5 represents either a misrepresentation of the center-of-glazing U-Factor on our part, inaccurate data in the database or questionable ratings. Because this method of fitting data worked so well, we did not spend a significant amount of time trying to resolve the questions surrounding this one glazing option.

This same approach was used on a wide sampling of the products. The results were consistent with above. Very good agreement was seen, including the results for a product line with triple-glazed units.

2.4 Task 4 Trends in Data

On the positive side, the fact that NFRC has fixed a number of door variables should allow us to identify trends in the data for U-Factor, SHGC and VT. The constants are listed below.

Constants

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- Door Size: 1000mm x 2000 mm (39 in. x 79 in.)
- Door-glass size (none, 1/4, 1/2, 3/4, full)
 - 1/4 glazing: 560 mm x 480 mm (22 in. x 19 in.)
 - 1/2 glazing: 560 mm x 10400 mm (22 in. x 41 in.)
 - 3/4 glazing: 560 mm x 1270 mm (22 in. x 50 in.)
 - Full glazing: 560 mm x 1625 mm (22 in. x 64 in.)
- Frame Height: 63.5 mm (2.5 in.)
- Glass Frame Height: 63.5 mm (2.5 in.)
- Edge-of-glass Height: 63.5 mm (2.5 in.)
- Edge-of-Panel Height: Glass Frame Height: 25 mm (1 in.)

Based on the fixed sizes for the door and the door glasses, we assembled the following table. The table shows the corresponding dimensions, areas and fraction of total area for the individual components.

Table 2 Dimensions, Areas, and Fraction of Areas for Door Components

	Width (mm)	Height (mm)	Area (mm ²)		Fraction	Area (mm ²)		Fraction
Door	1000	2000	2000000					
None (slab)								
1/4-Lite	560	480	152849	excl edge of lite	0.0764	268800	incl edge	0.1344
1/2-Lite	560	1040	395329	excl edge of lite	0.1977	582400	incl edge	0.2912
3/4-Lite	560	1270	494919	excl edge of lite	0.2475	711200	incl edge	0.3556
Full Lite	560	1625	648634	excl edge of lite	0.3243	910000	incl edge	0.4550
Frame Ht		63.5						
Lite Frame Ht		63.5						
Edge-of-Lite Ht		63.5						
1/4-Lite			115951		0.0580			
1/2-Lite			187071		0.0935			
3/4-Lite			216281		0.1081			
Full Lite			261366		0.1307			
Edge-of-Panel Ht		25						

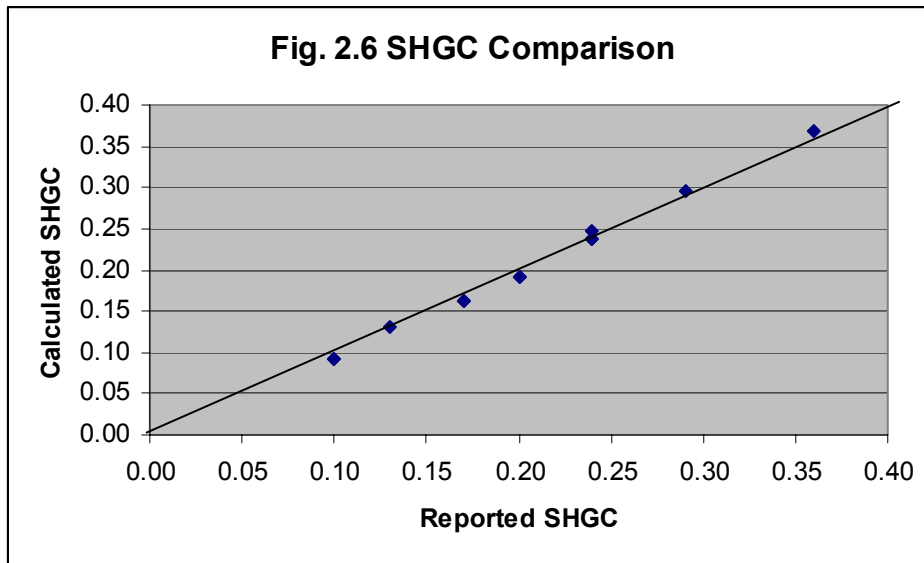
We attempted to identify

trends in the U-Factor data. The large variation in the door constructions, particularly the slab edge, limited this effort. However, we were able to use the fraction of areas that include the edge-of-glass area with the center-of-glass area to arrive at trends in the SHGC and VT data.

Most notably, we found that by assuming a SHGC of 0.03 for the opaque elements of doors, that a total SHGC could be calculated from the center-of-glass SHGC and area fractions. Figure 2.6 compares the reported SHGC values with the calculated SHGC values for a door with a steel skin slab, steel edge and a wood frame. The calculated values agree with the

reported values to within 0.0 to 0.01 for the range of glass sizes and glazing options in the product line. As for visible light transmittance, VT, the area fractions are sufficient for determine the total VT.

The equations resulting from this approach are given in section 3. This is the same approach as is used for SHGC and VT in NFRC 100. Doors are further simplified because the area of the door and the area of the door glass are fixed.



3. CONCLUSIONS

After reviewing the NFRC database and performance data for door components, we recognized that the best approach to simplifying door rating and labeling is to provide manufacturers with a set of equations from which they can calculate the door U-Factor, solar heat gain coefficient and visible light transmittance. This approach is similar to that used by window manufacturers for SHGC and VT. A set of coefficients are determined by a simulator for each product line. These coefficients are based on the best and worst performing products in a product line. This approach would reduce the modeling considerably, because each glazing option does not need to be modeled in Therm. Each glazing option in a product line would be modeled in WINDOW 5 to determine the center-of-glass U-Factor, SHGC and VT.

A manufacturer must determine door ratings for both flush and panel doors, with and without door glass. To further simplify the door rating procedure, we are also proposing to change the default door height to be more consistent with products sold today; only provide ratings for flush, ½-glass and full-glass doors; and establish panel sizes that are consistent with door glass sizes. Currently, simulators appear to be using different approaches to determining the panel areas; establishing default panel sizes will allow consumers to better compare products.

The conclusions are based on use of the proposed changes to the default door size, glass sizes and panel sizes. If the size changes are rejected, the simplified calculations can still be performed using the existing default sizes.

3.1 NFRC Swinging Door Size

The current swinging door size is 1000 mm by 2000 mm (39 in by 79 in) for a single door and 2000 mm by 2000 mm (79 in by 79 in) for a double door. This refers to the unit size and includes the door slab plus door frame. The history behind the swing door size is traced back to the U.S. and Canadian harmonization effort. The NFRC size was a 36x80 slab. When the standard moved to metric the size was fixed at 2000 mm.

While the overall width of 1000 mm is reasonable for a door slab that is 914 mm (36 in) wide, the height is too short. One of the most commonly produced door slabs is 914 mm by 2032 mm (36 in by 80 in). The addition of the head and sill height to the slab height results in a total height of approximately 2100 mm (83 in).

We are proposing that the NFRC 100 swinging door size be changed to 1000 mm by 2100 mm (39 in by 83 in). This modification will result in ratings that better represent products that are installed and simplify the rating process for door manufacturers.

3.2 Glass Sizes

Currently, glazed doors are rated at four different glass sizes: 1/4, 1/2, 3/4 and full. The width of the glass is the same for each size, 560 mm (22 in). The heights are 480 mm (19 in), 1040 mm (41 in), 1270 mm (50 in), and 1625 mm (64 in) respectively; although, a 1/4-glass is not one-fourth the height of a full-glass, etc. The confusion comes from there being too many sizes even though the variation in U-Factors is relatively small. Table 3.1 compares the range of U-Factors for different doors. The variation in door U-factors for wood products is 0.05 Btu/hr-ft²-F or less because the frame U-factor and glazing U-factor are close in value. The variation in U-Factor for the better insulating products is greater because the slab and frame have a lower U-Factor than the glazing.

Table 3.1 Comparison of Door U-Factors by Glass Size

Glass Size	Inswing Wood			Wood Entry		Fiberglass Entry		6-Panel Skin	Steel
	U=0.60	U=0.50	U=0.32	U=0.50	U=0.37	U=0.50	U=0.26	U=0.50	U=0.26
1/4	0.42	0.42	0.42	0.45	0.45	0.12	0.12	0.21	0.21
1/2	0.44	0.42	0.40	0.46	0.45	0.19	0.16	0.27	0.24
3/4	0.47	0.44	0.39	0.46	0.42	0.26	0.19	0.34	0.28
Full	0.47	0.43	0.37	0.45	0.41	0.29	0.21	0.37	0.29
Full	0.49	0.44	0.36	0.46	0.40	0.33	0.23	0.41	0.32

The variation in SHGC and VT is much greater because of the wide variation in glazing SHGC and VT. Table 3.2 compares the SHGC of the doors shown in Table 3.1. The center-of-glazing SHGC have been estimated and the results appear to be consistent for similar glazing options. The exception is the Inswing Wood door with a center-of-glazing U of 0.50. This must be a tinted insulating unit, but it is not identifiable from the NFRC database listing. If the glass areas actually corresponded to their names, e.g. a 1/4-glass is one-fourth as tall as the full glass, etc., the change in SHGC between glass sizes would be the same. For instance, for clear insulating glazing, the difference in SHGC would be 0.06-0.07.

Table 3.2 Comparison of Door SHGC by Glass Size

Glass Size	Inswing Wood			Wood Entry		Fiberglass Entry		6-Panel Steel Skin	
	SHGC=0	SHGC=?	SHGC=0	SHGC=0	SHGC=0	SHGC=0	SHGC=0	SHGC=0	SHGC=0
	.78	=?	.42	0.78	.42	.78	.42	.78	.42
1/4	0.04	0.04	0.04	0.08	0.08	0.01	0.01	*	*
1/2	0.12	0.08	0.08	0.12	0.11	0.11	0.06	0.11	0.06
3/4	0.22	0.13	0.13	0.26	0.24	0.23	0.12	0.23	0.12
Full	0.26	0.15	0.15	0.32	0.29	0.27	0.14	0.28	0.14
	0.32	0.18	0.18	0.39	0.35	0.35	0.15	0.35	0.18

Rating doors at three glass conditions: 1) No Glass; 2) 1/2-Glass; and 3) Full-Glass, would demonstrate the same range as the existing ratings but would simplify the rating and labeling procedures and reduce the potential for errors in identifying the pertinent numbers. In addition, the proposed 1/2-glass size has been chosen to allow for panel sizes to be established (refer to section 3.3). Table 3.3 gives the proposed glass sizes and represents a revision to the existing Table 5-1 in NFRC 100-2004.

Table 3.3 Proposed Revision to Table 5-1 Glazing and Divider Patterns for Doors

Individual Product	For Doors with	Simulated or Test as	Glass inserts for a 6-panel door	Optional Caming Pattern for Flush and Panel Doors
1/2 glazing	Up to 0.526 m ² (815 in. ²)	560 mm by 920 mm (22 in. by 36 in.)	Area of upper four panels, and intermediate stiles and rail should equal 1/2-glass size, not including 25 mm of edge of panel around outside perimeter	5 vertical 8 horizontal
Full glazing	0.710 m ² (1100 in. ²) or more	560 mm by 1630 mm (22 in. by 64 in.)	Area of all six panels, and intermediate stiles and rails should equal full-glass size, not including 25 mm of edge of panel around outside perimeter	5 vertical 13 horizontal

The result of the increase in height of the doors and the reduction in the $\frac{1}{2}$ -glass height will depend on the door slab material and glazing performance.

- For wood doors, product U-factors will go down slightly for units with clear insulating glazing. For units with low-E glazing, the U-factors may increase slightly. We anticipate small to negligible changes because the U-factors for the glass and door slabs separately are close in value.
- For composite doors, product U-factors will go down for units with clear insulating glazing and low-E glazing because there will be more door slab area and the slab has a lower U-factor than the glass.
- SHGC and VT values should decrease slightly for both door types because there will be more opaque area.

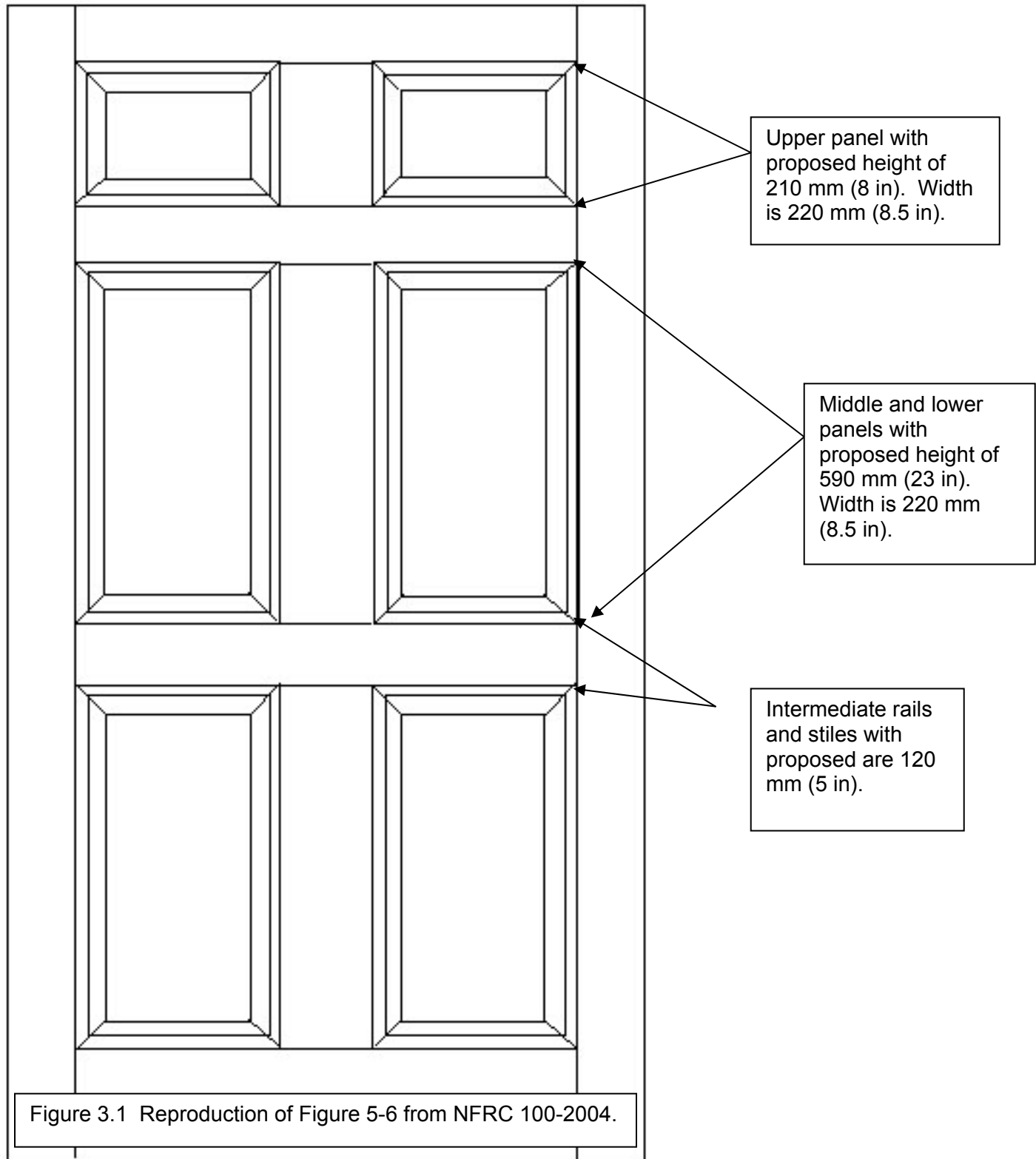
Another important question is how a product will be labeled that has $\frac{3}{4}$ glass. Wood doors manufacturers would prefer to apply the full-glass values to the $\frac{3}{4}$ -glass unit and composite door manufacturers would prefer to apply the $\frac{1}{2}$ -glass values to the $\frac{3}{4}$ -glass unit. This is an issue the door manufacturers will need to resolve.

3.3 Default Panel Sizes

Manufacturers must rate their flush and panel doors. In NFRC 100-2004, ratings for 6-panel doors are used to represent all panel door options. There are also a set of rules for rating panel doors with glass. Currently, glazed panel doors may have different glazing areas depending on the assumed panel sizes. This makes it difficult for consumers to compare like products.

We attempted to fix the panel sizes in accordance with the glass sizes to minimize the potential differences in simulations and to further simplify the door rating procedure. If the $\frac{1}{2}$ -glass height is set equal to the half of the full glass height, it is impossible to establish the panel heights with constant heights for the intermediate rails as is depicted in the Figure 3.1, which is Figure 5-6 of the Typical 6-Panel Layout in NFRC 100-2004. The reason is that the sum of the heights of the smaller upper panel plus the upper intermediate rail plus the center panel needs to equal the sum of the heights of the lower panel plus the lower intermediate rail. This is impossible if the rail heights are equal and the center and lower panel heights are equal.

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Assuming the existing ½-glass height of 1040 mm (41 in), the upper, middle and lower panel heights would have to be nearly equal to add up to the ½-glass and full-glass heights. So, we looked at a number of alternatives for the ½-glass size and the panel size. Tables 3.4a and 3.4b show what we are recommending for the ½-glass height of 920 mm (36 inches) that is closer to half the full-glass height than the current default and is more representative of ½- lite products sold. Note that the heights we are proposing for the panels do not include the 25 mm (1 in) panel edges. The heights do include the approximate 12 mm (0.5 in) where the panel profile sits in the frame (Figure 3.2).

Table 3.4a Proposed ½-Glass Size and Panel Heights (SI)

Options	Height (mm)
Full Glass	1630
Half Glass	920
Upper Panel	210
Rail	120
Middle Panel	590
Rail	120
Lower Panel	590

Table 3.4b Proposed ½-Glass Size and Panel Heights (I-P)

Options	Height (mm)
Full Glass	64
Half Glass	36
Upper Panel	8
Rail	5
Middle Panel	23
Rail	5
Lower Panel	23

We are also proposing to fix the panel width. Based on a glass width of 560 mm (22 in), and a stile width of 120 mm (5 in), the panel width would be 220 mm (8.5 in).

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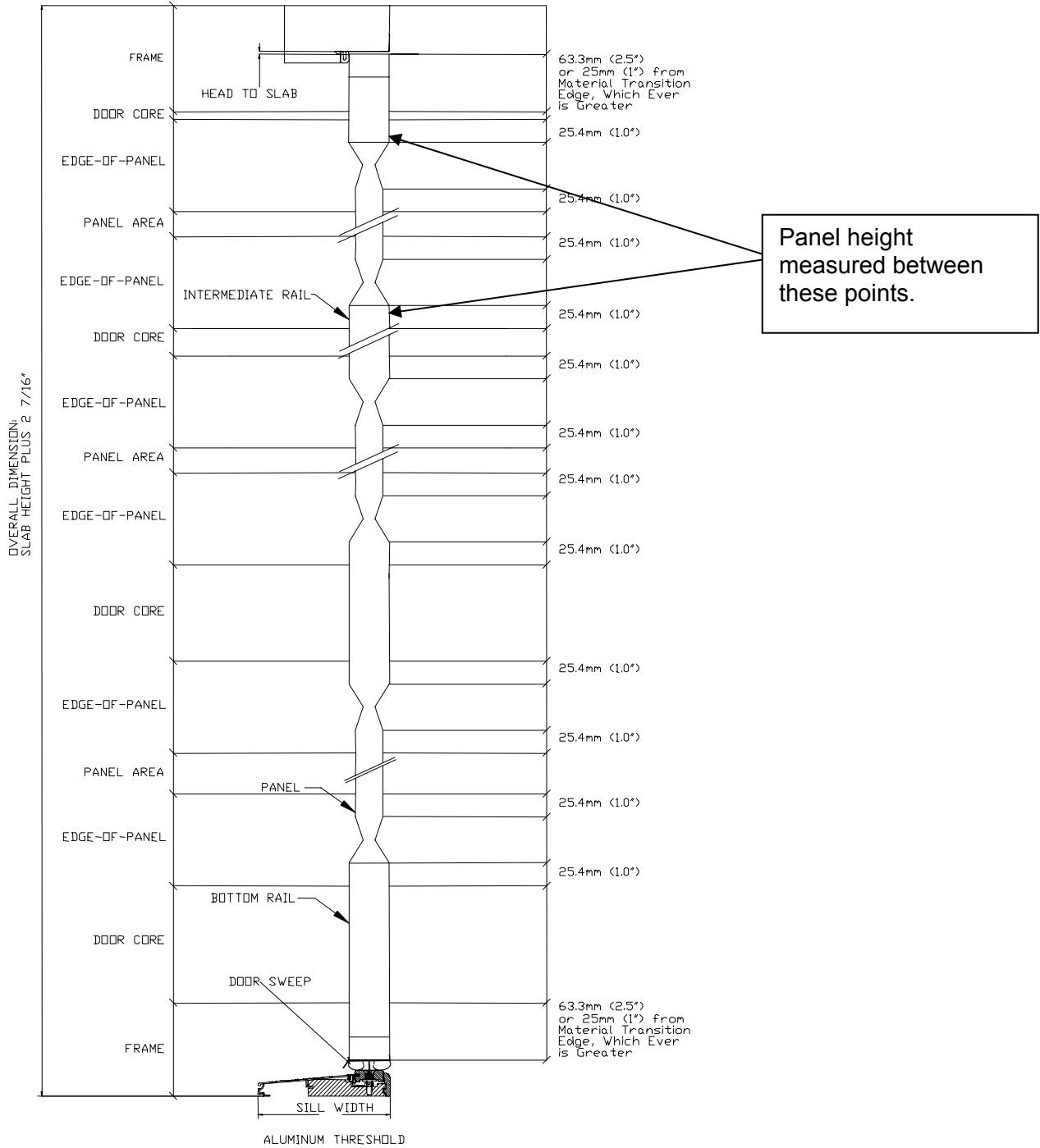


Figure 3.2 Example of proposed panel height reference points.

3.4 U-Factor

An NFRC simulator would perform the following simulations:

- Total door U-Factor for flush door
- Total door U-Factor for worst performing glazing option (not including single-glazed options that would be modeled separately) for each glass size
- Total door U-Factor for best performing glazing option for each glass size
- Center-of-glazing U-Factor, SHGC and VT for all glazing options

For each glass size, the following equation could be used to calculate the total product U-factor:

$$U = \text{Coeff_Ua} * U_{\text{cog}} + \text{Coeff_Ub}$$

The simulator determines the coefficients in the equation for each glass size from the U-Factor for the best performing and worst performing glazing options in a door product line. The worst performing glazing option should be a double-glazed unit. Single glazing should be modeled separately. The coefficients for each glass size is determined as follows:

$$\text{Coeff_Ua} = (U_{\text{worst}} - U_{\text{best}}) / (U_{\text{cog-worst}} - U_{\text{cog-best}})$$

$$\text{Coeff_Ub} = U_{\text{best}} - U_{\text{cog-best}} * \text{Coeff-Ua}$$

Where

- U_{best} is the door U-factor for the best-performing glazing option at a specific glass size
- U_{worst} is the door U-factor for the worst-performing glazing option at a specific glass size. This should be a double-glazed unit. Single glazing should be modeled separately.
- U_{cogbest} is the center-of-glazing U-factor for the best performing glazing option.
- $U_{\text{cog-worst}}$ is the center-of-glazing U-factor for the worst performing glazing option. This should be a double-glazed unit. Single glazing should be modeled separately*.

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*There is a very limited number of doors with single glazing in the database. In one product line, it was unclear what the difference between the single-glazed units was so that we could not evaluate the accuracy of the curve fit.

The following table lists the coefficients that must be determined for use by the manufacturer.

Door U-Factor Coefficients

	Coeff_Ua	Coeff_Ub
1/2-Glass		
Full Glass		

Because products may be sold with different spacers, door glass frames and installed in different frames, a manufacturer has the option of grouping these options as follows:

- Spacers may be grouped, but a manufacturer could also ask for a set of coefficients for each spacer type in the product line.
- The NFRC default door glass frame may be used to represent all door glass frame options
- The NFRC default steel door frame may be used to represent all door frames.
- Assume an inswing door and label outswing and inswing doors with outswing results.

These groupings ensure that a product will be labeled with U-Factors that are equal to or higher than the U-Factor simulated for a specific product.

As proof of this concept, the following tables demonstrate the application of this approach to existing products lines. The existing glass sizes were used for the calculations. At the top of each page on the right side, the calculated coefficients are shown. Directly below this table, the calculated U-factor is compared to the certified U-Factor. When the difference is more than 0.01, we deduce that there are errors in the input to the database or in the simulations.

3.5 SHGC

SHGC is simpler in that the manufacturer only needs the center-of-glass SHGC. We are proposing that the solar heat gain coefficient through the opaque elements be assumed to be 0.03. The total SHGC is then calculated based on the sum of the solar heat gain through the opaque area plus the solar heat gain through the glass area. Because the door glass sizes are set, it is straight forward to calculate the glazing and opaque area fractions and fix these values in the equations. The following set of equations reflects the current door size and glass sizes in NFRC 100-2004 and would apply only to flush doors:

$$\text{SHGC}_{\text{flush}} = 0.03$$

$$\text{SHGC}_{1/4} = 0.0264 + 0.1215 * \text{SHGC}_{\text{cog}}$$

$$\text{SHGC}_{1/2} = 0.0219 + 0.2712 * \text{SHGC}_{\text{cog}}$$

$$\text{SHGC}_{3/4} = 0.0200 + 0.3327 * \text{SHGC}_{\text{cog}}$$

$$\text{SHGC}_{\text{full}} = 0.0172 + 0.4276 * \text{SHGC}_{\text{cog}}$$

These equations would not apply to panel doors. The current approach to replacing panels with glass does not result in the default glass sizes given for flush doors. A single set of equations that would apply to all panel doors cannot be determined using the current approach for panel doors.

Based on the proposed door height and glass sizes in sections 3.1 and 3.2, the equations would be as follows:

$$\text{SHGC}_{\text{flush}} = 0.03$$

$$\text{SHGC}_{1/2} = 0.0232 + 0.2277 * \text{SHGC}_{\text{cog}}$$

$$\text{SHGC}_{\text{full}} = 0.0178 + 0.4085 * \text{SHGC}_{\text{cog}}$$

These equations would apply to both flush and panel doors.

3.6 Visible Transmittance

Visible light transmittance is the simplest. The manufacturer only needs to plug the center-of-glass VT into the equations. The total VT is then calculated from the visible light transmittance through the fraction of glass area. Again, because the door glass sizes are set, it is straight

forward to calculate the glazing area fractions and fix these values in the equations. The equations for the existing sizes in NFRC 100-2004 are as follows:

$$VT_{\text{flush}} = 0.0$$

$$VT_{\frac{1}{4}} = 0.1215 * VT_{\text{cog}}$$

$$VT_{\frac{1}{2}} = 0.2712 * VT_{\text{cog}}$$

$$VT_{\frac{3}{4}} = 0.3327 * VT_{\text{cog}}$$

$$VT_{\text{full}} = 0.4276 * VT_{\text{cog}}$$

These equations would not apply to both flush and panel doors. The current approach to replacing panels with glass does not result in the default glass sizes given for flush doors. A single set of equations that would apply to all panel doors cannot be determined using the current approach for panel doors.

Those for the proposed sizes are

$$VT_{\text{flush}} = 0.0$$

$$VT_{\frac{1}{2}} = 0.2277 * VT_{\text{cog}}$$

$$VT_{\text{full}} = 0.4085 * VT_{\text{cog}}$$

These equations would apply to flush and panel doors.

3.7 Further Simplifications

Rather than having a set of equations for all options, we propose the following simplifications:

- Group spacers as per NFRC 100
- Group inswing and outswing with inswing the group leader
- Assume an add-on for doors installed in steel frames
- Provide an adjustment to SHGC and VT for grids and dividers

This approach could easily be implemented through a stand-alone spreadsheet that would be customized for each slab manufacturer. The coefficients for the equations for each product

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would be input by the NFRC simulator into the spreadsheet along with the center-of-glass results from WINDOW 5. The manufacturer could provide this spreadsheet to their fabricators, etc. The user would simply identify the product being built and print out the corresponding NFRC label.

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Dividers?

Database Recommendations (to be completed)

Database needs to distinguish frame type and slab, as well as glass size. In the current database, it is very difficult to distinguish the differences between products.