Specifying Windows Using Performance Standards

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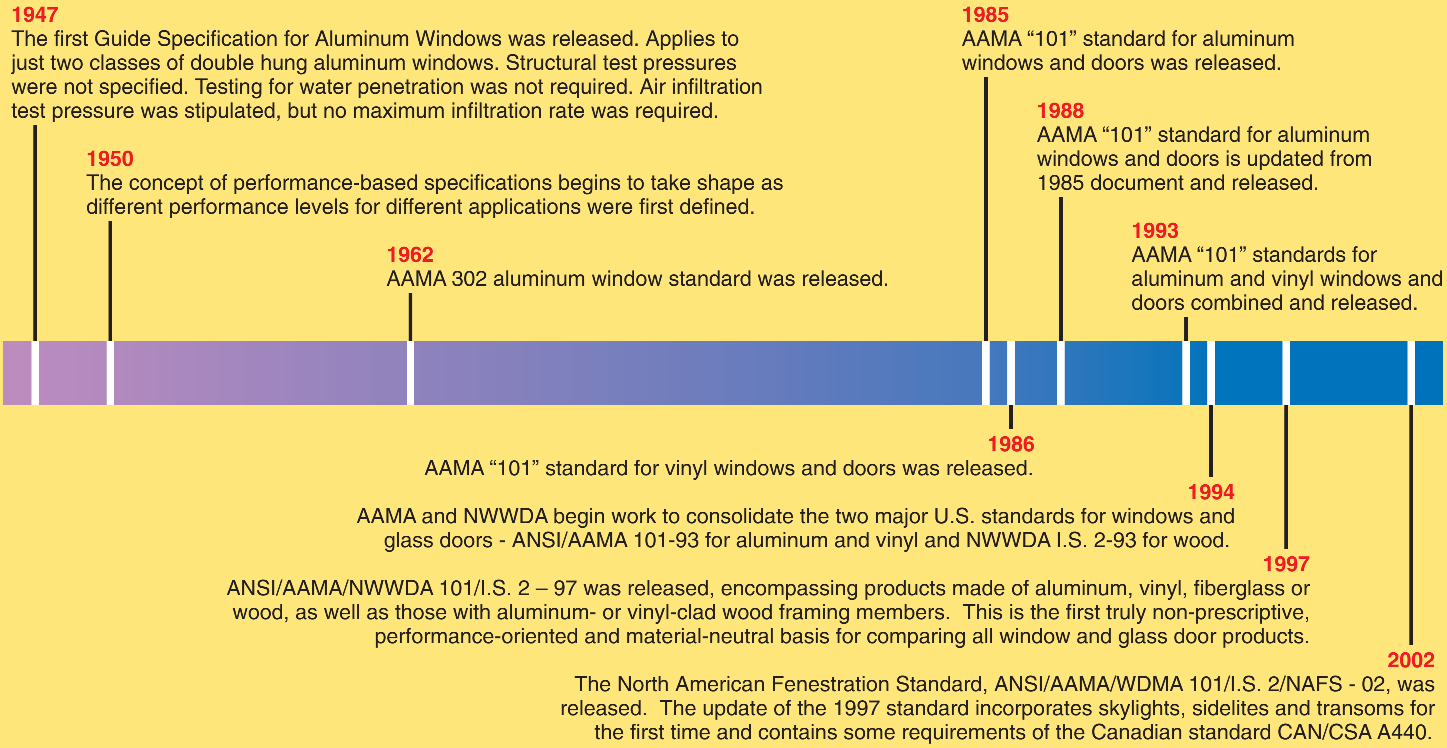
Performance-based standards for windows and doors, rather than attempting to prescribe detailed physical attributes such as framing member thickness, assembly details, etc., rate completely fabricated products according to how they perform under actual job site conditions. They thereby provide a uniform basis for comparing key performance attributes of different manufacturers' windows of the same type and grade for a given application, thereby taking into account the unique properties and comparative strengths and weaknesses of all profile materials. For windows and doors, these essential performance characteristics are structural performance under wind loading and the level of resistance to air leakage, water penetration and forced entry. From this platform, other performance requirements for specific window types (casement, horizontal sliding, etc.), as well as for optional energy efficiency attributes (thermal performance and condensation resistance), can be referenced to meet specific markets or job criteria.

The specifier or product designer determines the level of performance desired under defined conditions. Then, factoring the well-understood characteristics of the material and components into the equation, the manufacturer builds a window that meets the specified performance level. In general, the required performance drives the product's design.

How Window Standards Have Evolved

The evolution of window standards traces an increasingly sophisticated approach to window design and an evolving understanding of the factors influencing window performance, as well as increasingly more stringent performance requirements in response to the demands of architects and specifiers. These efforts have culminated in combined, material-neutral, performance-oriented guidelines for excellence in the design and fabrication of window and door products that recognizes their important role in today's complex building systems.



It is the buyer's task to first determine the tradeoff between performance level and cost that is acceptable for the job at hand. Given equal performance requirements, the choice of framing material (aluminum, vinyl, fiberglass, wood, etc.) basically reduces to one of preference with regard to operating features, appearance, economics, etc., rather than determining which material is "better" than another at some absolute level. Because performance-based standards effectively eliminate the basis for competitive argument as to which fenestration framing material performs the "best," they are said to be "material-neutral."

ANSI/AAMA/NWWDA 101/I.S. 2-97, the first performance-based standard encompassing all framing materials, offers a basis for comparing the key characteristics and quality attributes of all window and door materials and products for the same market applications from a material-neutral point of view. It also serves as the cornerstone for an interlocking system of third-party product performance certification and component-level quality control to establish a uniquely credible total quality management system for manufacturers as well as a reliable specifying mechanism for architects. As noted in the timeline, the International Residential Code (IRC) and International Building Code (IBC) both currently recognize ANSI/AAMA/NWWDA 101/I.S. 2-97 (a.k.a. "101/I.S. 2-97") and ANSI/AAMA/NWWDA 101/I.S. 2/NAFS-02 (a.k.a "101/I.S. 2/NAFS-02").

Because it is the foundation of today's performance standards, 101/I.S. 2-97 and its requirements serve as the basis for this article. Footnotes indicate requirements that were modified in the 2002 revision. Revisions that were made in 101/I.S. 2/NAFS-02 will be specifically addressed later in the article.

What Kind of Window Do You Want?

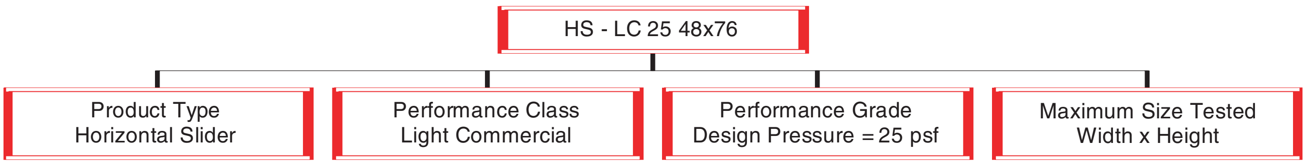
The first step is to select a product operator type, indicated by a letter code. There are 21 distinct product types identified in the 1997 standard, as shown in the following table:

ANSI/AAMA/NWWDA 101/I.S. 2-97 Product Designation System			
TYPE CODE	WINDOW OR GLASS DOOR TYPE	TYPE CODE	WINDOW OR GLASS DOOR TYPE
Sliding Seal Window Products		**Dual Action Window Products**	
H	Single/Double/Triple Hung	DA	Dual Action
HS	Horizontal Sliding	**Specialty Window Products**	
DW	Dual Window	BW	Basement Window
VS	Vertical Sliding	HE	Hinged Egress
Compression Seal Window Products		GH	Greenhouse
AP	Awning, Hopper or Projected	J	Jalousie
C	Casement	JA	Jal-Awning
VP	Vertically Pivoted	TA	Tropical Awning
HP	Horizontally Pivoted	**Door Products**	
SHW	Side-Hinged Inswinging	HGD	Hinged Glass Door
TH	Top-Hinged	DA-HGD	Dual Action Hinged Glass Doors
Fixed Window Products		SGD	Sliding Glass Door
F	Fixed		

What Kind of Building?

Once the type of window is decided upon (double hung, casement, slider, etc.), the next step is to define the kind of structural environment in which the window is to be installed, i.e., residential, light commercial, commercial, heavy commercial or architectural (which includes high-rise applications). 101/I.S. 2-97 helps by defining a product nomenclature and Performance Class designation system. These designations can be quickly and easily used to specify windows.

An example of a complete four-part product designator for a Light Commercial horizontal sliding window would thus look like:



Let's take closer look at the elements of this designator and how it provides essential information on its performance. The four parts include:

- Product operator type (per the above table)
- Performance Class
- Performance Grade
- Maximum size tested

Performance Class

The product operator type is designated per the preceding table. The second part of the product designator is the Performance Class. 101I.S. 2-97 recognizes five Performance Classes, each of which addresses the needs of a particular market segment by requiring increasingly stringent basic performance requirements:

Performance Class		
R	=	Residential
LC	=	Light Commercial
C	=	Commercial
HC	=	Heavy Commercial
AW	=	Architectural

Performance Grade

The third element of the product designator is the Performance Grade, the key to Class designation. Entry into each Performance Class is keyed to a minimum (or "gateway") Performance Grade, which is equal to the Design Pressure (wind load) at which the products have been tested, expressed in pounds per square foot (psf) or Pascals (Pa) in the metric system:

Performance Grade		
R	=	15 psf (720 Pa)
LC	=	25 psf (1200 Pa)
C	=	30 psf (1440 Pa)
HC	=	40 psf (1920 Pa)
AW	=	40 psf (1920 Pa)

Wind Speed Associated with Each Classification		
R	=	78 mph
LC	=	100 mph
C	=	110 mph
HC	=	127 mph
AW	=	127 mph

Size Matters...

The maximum size tested (MST) is the last part of the four-part product code and is dependent on the window or door operator type and the typical production size of the product. Although often omitted when writing a specification, MST is included in performance test results and is also called out on AAMA Certification labels. MST is often confused with minimum test size.

Test size is a critical factor in determining compliance with the standard. Each product type has a defined "gateway" or "passport" set of primary requirements before entry into a given product Performance Class is permitted. To provide a uniform basis for comparing the performance of different manufacturers' windows of the same grade and type, product specimens must be tested at the same minimum (or larger) test size. This is because, the smaller the test sample, the easier it is for a window to pass a given set of test parameters due to the smaller area exposed to wind loading and shorter frame spans between corners. Specifying a minimum test size is thus a valuable equalizer when evaluating various suppliers.

The charts below show how the minimum frame size tested varies by Performance Class for casement (C) and horizontal sliding (HS) windows. Note that while the test specimen size for some of the classes are the same, the design load and therefore the structural test pressure increases from Residential to Architectural classes. The required test size is expressed as width by (x) height, rounded to the nearest inch or 10 mm. Also note that while the design load is the same for HC and AW classes, the AW test size is larger for casement (C) windows.

Window Designation	Minimum Frame Size
C – R15	1′5″ (430 mm) x 4′0″ (1220 mm)
C – LC25	2′0″ (610 mm) x 4′0″ (1220 mm)
C – C30	2′0″ (610 mm) x 4′0″ (1220 mm)
C – HC40	2′0″ (610 mm) x 4′0″ (1220 mm)
C – AW40	3′0″ (910 mm) x 5′0″ (1520 mm)

Window Designation	Minimum Frame Size
HS – R15	5′9″ (1753 mm) x 4′0″ (1220 mm)
HS – LC25	5′9″ (1753 mm) x 4′6″ (1372 mm)
HS – C30	5′11″ (1803 mm) x 4′11″ (1499 mm)
HS – HC40	8′0″ (2440 mm) x 6′6″ (1980 mm)
HS – AW40	8′0″ (2440 mm) x 6′6″ (1980 mm)

The Maximum Size Tested comes into play when a manufacturer wants to qualify an entire product line of a given product type, in which units of varying size are offered, at a given performance class (design pressure). The largest size offered (often larger than or at least equal to the minimum test size gateway requirement for the performance class) is tested and its size recorded, thus qualifying all (smaller) products in the line at the indicated performance class rating.

Simply put, a product should indicate an MST equal to or larger than the building opening in which the product is to be installed in order to deliver full benefits of the advertised performance class.

What Performance Level Do I Need?

101/I.S. 2-97 defines four mandatory performance requirements within each Performance Class for a completely fabricated window:

- Structural adequacy to withstand wind loads
- Resistance to water penetration
- Resistance to air leakage
- Forced entry resistance

The first two of these – arguably the most important for a window's functioning as a structural element – are keyed to the Design Pressure (Performance Grade) for the building site. The Design Pressure is a result of wind loading – that is, the force of wind blowing against the installed window. Water penetration is dependent upon the wind pressure behind rain that strikes the window. So, the first order of business must be to determine the wind conditions to which the window will be exposed.

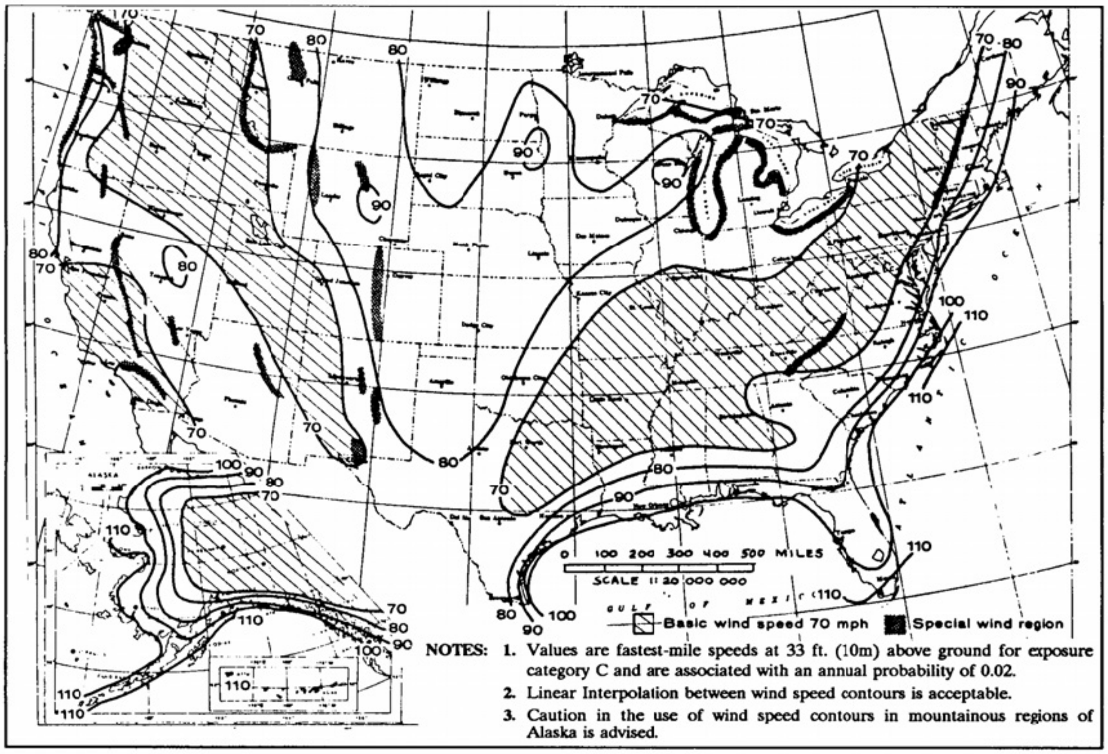
The classic 101I.S. 2-97 reference for determining design wind load is ASCE 7-93**, "Minimum Design Loads for Buildings and Other Structures."

The design wind speed for the building's location (typically a maximum likely to be experienced at that site) is easily determined by reference to the following wind speed map from ASCE -7-93*.

Once the height of the building is known, the Design Pressure can be determined from the second column of ASCE 7-93* "Table 1," a portion of which is excerpted for illustrative purposes from ASCE -7-93* and AAMA TIR A10, "Wind Loads on Components and Cladding for Buildings less than 90 Feet Tall," which also includes more complete information on all four versions of ASCE- 7-93*. As implied in the document title, the table applies only to windows in buildings less than 90 feet tall, and with a sloped roof (pitch greater than 10°).

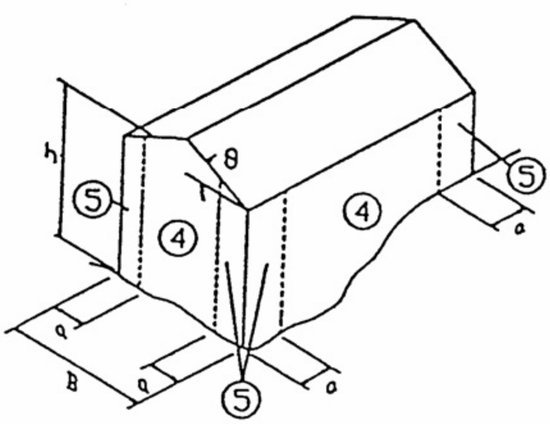
Note that the ASCE 7-93* table shows both positive and negative pressures. This is because windows experience winds that blow against them from the windward side, tending to push the window in (positive loads), as well as "suction" winds tending to pull the window outward (negative loads) due to the aerodynamic characteristics of the building on its leeward side. These negative loads are further broken down according to whether or not the window is located near the corner of the building ("Area 5"), where aerodynamics cause the suction load to

FIGURE 1: BASIC WIND SPEED (mph)



*Map reprinted with permission of ASCE.***

increase in comparison to that experienced away from the corners ("Area 4"). As a rule of thumb, the width of the corner area in which "Area 4" conditions apply is considered to be 0.4 times the roof height (h) at the eaves or 10% of the building's least width, whichever is smaller.



While there are other factors to consider for a given project, such as building use category and coastal locations, the design pressure is the largest absolute value of the positive and negative pressures.

As a simplified example, consider a 25′ tall (typically three-story) building located in an area with a basic design wind speed of 70 mph. All of the windows will experience a positive design pressure of 19.2 psf. Windows located nearer the center of a wall will experience a negative load of 20.4 psf. As the largest number rules, and since win-

TABLE 1: DESIGN WIND LOAD TABLES (psf)

Mean Roof Height (ft.)	Positive Pressure All Areas	Negative Pressure	
		Area 4	Area 5
BASIC WIND SPEED - 70 MPH			
15	16.6	-17.6	-22.6
20	18.0	-19.1	-24.6
25	19.2	-20.4	-26.2
30	20.3	-21.5	-27.7
40	21.9	-23.3	-29.9
50	23.4	-24.8	-31.9
60	24.6	-26.1	-33.6
70	25.7	-27.2	-35.0
80	26.7	-28.3	-36.4
90	27.7	-29.4	-37.8
BASIC WIND SPEED - 80 MPH			
15	21.6	-22.9	-29.5
20	23.5	-24.9	-32.1
25	25.1	-26.7	-34.3
30	26.5	-28.1	-36.1
40	28.7	-30.4	-39.1
50	30.5	-32.4	-41.7
60	32.2	-34.1	-43.9
70	33.5	-35.6	-45.7
80	34.9	-37.0	-47.6
90	36.2	-38.4	-49.4

QUESTION: *Are these test conditions representative of the worst climate conditions experienced by buildings?*

ANSWER: The rate of water application in the tests is approximately 8″ per hour, which exceeds the greatest rainfall ever recorded in the U.S. since Thomas Jefferson created what is now known as the National Weather Bureau. At a test pressure of approximately 10 psf and above, the equivalent wind velocity represented in these tests exceeds those of a Category 5 hurricane and approaches those of a tornado.

dows are rated for design pressure in increments of 5, this translates to a rounded-up Performance Grade of 25 psf for the application of 101/I.S2-97. Windows to be located in the corner areas of the building (Area 4), however, will experience a negative load of 26.2 psf and should be rated for a minimum design pressure of 30 psf.

Note that as the design pressure increases, the required product class for the application would seem to move upward from Residential to Architectural Class, although the more stringent requirements can also be met within the same class by specifying a higher optional grade. All are keyed to the design pressure (Performance Grade) for the particular Class. Many Commercial Heavy Commercial and Architectural Classes require deflection requirements at design loads. This must be checked for compliance prior to specifying.

***Note: The 101/NAFS-02 discussed later in this article references ASCE 7-95.*

**Note: The 101/I.S 2-97 discussed above references ASCE 7-93.*

Source: ACSE 7-93, Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers (ASCE), copyright 1994, www.pubs.asce.org.

ASCE 7-93 has been updated, and the most current edition at this writing is ASCE 7-02. For further information, the complete text of the manual should be referenced (http://www.pubs.asce.org/ASCE7.html?9991330).

What Kinds of Performance Do the Different Class Designations Indicate?

The Design Pressure (a.k.a. Design Wind Load, or Performance Grade) anchors the major performance considerations of structural loading and resistance to water penetration, and the performance requirements for these aspects get progressively more stringent as the design pressure increases.

Structural Loading

As indicated in the table below, the design pressure indicates the pressure levels applied in testing for structural integrity.

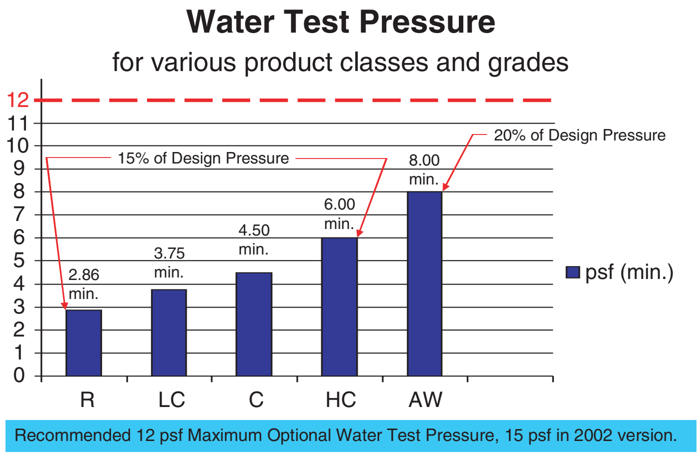
Water Penetration

As the table also shows, testing for water penetration resistance is generally conducted at a pressure equal to 15% of the design pressure – subject to a minimum pressure of 2.86 psf and a recommended maximum of 12 psf. An exception is that, while the minimum design pressure for the Architectural (AW) class is the same as that for the Heavy Commercial (HC) class, the water penetration resistance test pressure for the AW class is increased from 15% to 20% of the design pressure. In addition, the test methods employed to determine water penetration resistance are dependent upon performance class. R, LC and C products are tested to ASTM E 547, HC products to E 547 and E 331 and AW products to E 331 (at the higher test

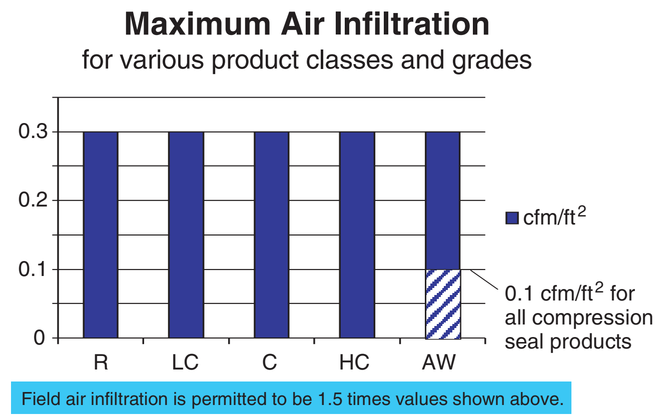
Window/Door Classes	Design Pressure (psf)	Structural Test Pressure (psf)	Water Resistance Test Pressure (psf)	Required Percentage for Water Testing
Residential	15	22.5	2.86	15%
Light Commercial	25	37.5	3.75	15%
Commercial	30	45.0	4.50	15%
Heavy Commercial	40	60.0	6.00	15%
Architectural	40	60.0	8.00	20%

Note: Design pressure requirements should be obtained from the local building code. AAMA TIR A10 is also a useful source if ASCE 702 is referenced in the building code.

pressure of 20% of design load). To pass this test, no water is permitted to pass the interior plane of the framing in any of the water penetration resistance test procedures. In addition, no water is permitted to penetrate the corner seals of the tested assembly and enter the building wall cavity.

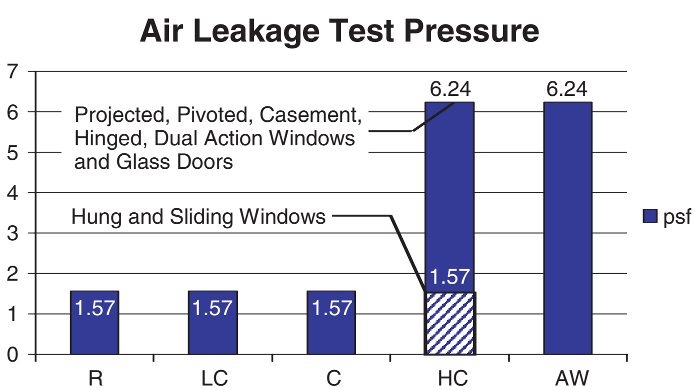


The maximum allowable air leakage rate, determined at these test pressures, is 0.3 cubic feet per minute per square foot of frame area (cfm/ft²) for all Performance Classes. The sole exceptions to this are 1) 1.2 cfm/ft² for jalousie windows, and 2) a much tighter requirement of 0.1 cfm/ft² for AW compression seal, fixed and dual-action products.



Then There's Air Leakage…

The 101/I.S. 2-97 standard also addresses air leakage, once merely a drafty nuisance but today a key element of important energy-efficiency criteria. Minimum air leakage test pressures for each Performance Class are not keyed directly to the design pressure, but vary by operator type. All window types in the R, LC and C Classes are tested at 1.57 psf. For HC class windows, all types except hung and sliding windows are tested at 6.24 psf. Hung and sliding HC windows are tested at 1.57 psf. All AW windows are tested for air leakage at 6.24 psf.



Maximum Air Leakage

Note that while the AW air leakage test pressure is the same as that used for the HC Class, the allowable air leakage rate for AW class products is greatly reduced from the HC class. Both are tougher than the other classes.

The table on the following page, excerpted from the 101/I.S. 2-97 standard, summarizes the test pressures and performance requirements for all Classes of two different product types.

What if I Want to Specify a Higher Performance Level than the Minimum?

101/I.S. 2-97 and 101/I.S. 2/NAFS-02 make it possible to specify higher uniform load structural and water penetration resistance test pressures than the required performance class gateway minimums, such as in cases where the installed product will be subject to severe weather conditions or excessive wind loadings.

All products tested under optional performance grades are required to conform to all of the minimum require-

QUESTION: *Can you guess why these pressures of 1.57 and 6.24 psf were chosen?*
ANSWER: They are the equivalent static air pressures generated by a 25 or 50 mph wind velocity. They, therefore, loosely correspond to a light storm and a heavy storm exposure of the wall.

Window/Door Designation (Minimum Test Size)		Design Pressure psf	Design Pressure Pa	Structural Test Pressure psf	Structural Test Pressure Pa	Water Resistance Test Pressure psf	Water Resistance Test Pressure Pa	Air Infiltration Test Pressure psf	Air Infiltration Test Pressure Pa	Air Infiltration Maximum Rate ft³/min /ft²	Air Infiltration Maximum Rate m³/hr /m²
GROUP I		**Sliding Seal Window Products**									
Single/Double/Triple Hung Windows											
H-R15	(3′8″ x 5′0″)	15	720	22.5	1080	2.86	140	1.57	75	.03	5
H-LC25	(3′8″ x 6′5″)	25	1200	37.5	1800	3.75	180	1.57	75	.03	5
H-C30	(4′6″ x 7′6″)	30	1440	45.0	2160	4.50	220	1.57	75	.03	5
H-HC40	(5′8″ x 8′0″)	40	1920	60.0	2880	6.00	290	1.57	75	.03	5
H-AW40	(5′8″ x 8′0″)	40	1920	60.0	2880	8.00	390	6.24	300	.03	5
GROUP II		**Compression Seal Window Products**									
Casement Windows											
C-R15	(1′5″ x 4′0″)	15	720	22.5	1080	2.86	140	1.57	75	.03	5
C-LC25	(2′0″ x 4′0″)	25	1200	37.5	1800	3.75	180	1.57	75	.03	5
C-C30	(2′0″ x 4′0″)	30	1440	45.0	2160	4.50	220	1.57	75	.03	5
C-HC40	(2′0″ x 4′0″)	40	1920	60.0	2880	6.00	290	6.24	300	.03	5
C-AW40	(3′0″ x 5′0″)	40	1920	60.0	2880	8.00	390	6.24	300	0.1	2

Optional Performance Grades (from 101 I.S. 2-97)

Optional Performance Grade	Applicable Product Designation	Design Pressure psf	Design Pressure (Pa)	Structural Test Pressure psf	Structural Test Pressure (Pa)	Water Resistance Test Pressure R,LC,C and HC psf	Water Resistance Test Pressure R,LC,C and HC (Pa)	Water Resistance Test Pressure AW psf	Water Resistance Test Pressure AW (Pa)
20	R	20.0	(960)	30.0	(1400)	3.00	(150)	—	—
25	R	25.0	(1200)	37.5	(1800)	3.75	(180)	—	—
30	R,LC	30.0	(1440)	45.0	(2160)	4.50	(220)	—	—
35	R,LC,C	35.0	(1680)	52.5	(2520)	5.25	(260)	—	—
40	R,LC,C	40.0	(1920)	60.0	(2880)	6.00	(290)	8.00	(390)
45	R,LC,C,HC,AW	45.0	(2160)	67.5	(3240)	6.75	(330)	9.00	(440)
50	R,LC,C,HC,AW	50.0	(2400)	75.0	(3600)	7.50	(360)	10.00	(480)
55	R,LC,C,HC,AW	55.0	(2640)	82.5	(3960)	8.25	(400)	11.00	(530)
60	R,LC,C,HC,AW	60.0	(2880)	90.0	(4320)	9.00	(440)	12.00	(580)
65	R,LC,C,HC,AW	65.0	(3120)	97.5	(4680)	9.75	(470)	12.00	(580)
70	R,LC,C,HC,AW	70.0	(3360)	105.0	(5040)	10.50	(510)	12.00	(580)
75	R,LC,C,HC,AW	75.0	(3600)	112.5	(5400)	11.25	(540)	12.00	(580)
80	R,LC,C,HC,AW	80.0	(3830)	120.0	(5750)	12.00	(580)	12.00	(580)
85	R,LC,C,HC,AW	85.0	(4080)	127.5	(6110)	12.00	(580)	12.00	(580)
90	R,LC,C,HC,AW	90.0	(4320)	135.0	(6470)	12.00	(580)	12.00	(580)
95	R,LC,C,HC,AW	95.0	(4560)	142.5	(6840)	12.00	(580)	12.00	(580)
100	R,LC,C,HC,AW	100.0	(4800)	150.0	(7200)	12.00	(580)	12.00	(580)
105	R,LC,C,HC,AW	105.0	(5040)	157.5	(7560)	12.00	(580)	12.00	(580)

These product designations are not included as optional performance grades in the 2002 version.
These values differ in the 2002 version. Please see the updated standard for the revised values.

ments of the standard for the product designation under consideration. Only after successful entry into the Performance Class at the minimum Performance Grade, when tested at the minimum test specimen size, can a product be tested for an optional Performance Grade.

Products can be tested to meet design loads up to an infinite number beyond the minimum value for a given Performance Class in increments of five psf. Note that in such cases, the structural test load and the water penetration resistance test pressure increase correspondingly, since they are keyed to the design pressure (150% of the design pressure for uniform load structural test and 15% for water penetration testing [20% for AW products]), up to a maximum of 12 psf.

The requirements of the simple example cited earlier – a window with a design pressure of 20 – can be met by a Residential Class product tested to a 20 psf design pressure (rather than the minimum of 15 psf for that Class). Products with higher design pressures (e.g., 25, such as a Residential Class product tested at 25 psf or an entry level Light Commercial grade product) will of course meet the requirement, but may be more expensive than necessary for the application.

Note that all conditions for a given class must be met, not just the design pressure. This is an important distinction. For example, a manufacturer cannot stipulate that a product deserves an AW80 designation if it meets an 80 psf design pressure but only the minimum AW water pressure of 8 psf. In this case the highest permitted rating would be AW40.

Consider the following additional examples of higher performance ratings:

Example #1 — A window tested at a design pressure of 80 psf and for water resistance at 8 psf. This window is actually only an AW 40 since it only meets the 8 psf water test (20% of 40 = 8 psf). It could also be rated as an HC 50 based on the 8 psf water test (15% of 50 = 7.5 psf).

Example #2 — A window tested at a design pressure of 50 psf and for water resistance at 12 psf. This window is either an AW 50 or an HC 50 since it exceeds the water test pressure at both the 15% and 20% level (15% of 50 = 7.5 psf and 20% of 50 = 10 psf) as long as the minimum AW size was tested.

Example #3 — A window tested at a design pressure of 75 psf and for water resistance at 12 psf. According to 101/I.S. 2-97, this window is either an AW75 or an HC75 since it meets the maximum 12 psf water test for both classes as long as the minimum AW size was tested.

Does the Type of Window I Chose Have Its Own Requirements?

The primary Class gateway requirements for structural performance, air infiltration and water penetration are specified for all operating types, but each type has additional unique requirements, such as operating force for hung windows or racking tests for projected windows. Products where the sash is operated by pulling on the edge of the sash must be tested for the ability to resist deglazing during operation. All AW products are required to undergo life cycle testing according to the test specification AAMA 910.

Maximum Operating Force

Operating force necessary to maintain motion is measured in the 1997 version of the standard, as shown in the following example table for hung windows. As discussed later, the 2002 version adds a requirement for maximum breakaway force as necessary to initiate sash motion.

Window Designation	Force To Maintain Motion
R	30 lbf (140 N)
LC	35 lbf (155 N)
C, HC, AW	45 lbf (200 N)

Deglazing Test (Primary window sash only for vertical and horizontal sliding units)

When tested in accordance with ASTM E 987, operating sash members must not move from their original position, in relation to the glazing materials, by more than the original glazing bite. As an example, the load for horizontal rails of a hung window must be 70 lbf (320 N), and 50 lbf (230 N) for all other sash members.

Life Cycle Testing (AW products only)

Life cycle testing is of particular interest to those specifying AW Class products, but may be optionally applied to any class of product. Described separately in AAMA 910, "Voluntary 'Life Cycle' Specifications and Test Methods for Architectural Grade Windows and Sliding Glass Doors," these tests employ accelerated testing and usage simulation methods to model the normal wear that can be expected due to the typical number of vent operating and locking hardware opening/closing cycles experienced during the life of a typical architectural class product. Loading conditions are also applied to simulate real-world operating and maintenance conditions and predictable misuse such as:

- Carelessness by the occupants or by building maintenance personnel
- Ignorance of proper operating or maintenance procedure
- Application of excessive operating force to the limits of normal physical ability
- Attempted operation without proper keys or devices

Note that damage due to vandalism, improper erection or handling practices, intentional abuse and detention or psychiatric applications are not addressed by these tests. Environmental conditions, such as temperature cycling, UV exposure, etc., are also not addressed.

Air leakage and water penetration test results must not exceed the gateway Performance Requirements for the desired product class and performance grade, both before and after accelerated cycling. In addition, there must be no damage to fasteners, hardware, sash balances and other components that would render the window inoperable.

AAMA 910 outlines the life cycle testing procedures and stipulates the order in which testing is to be done, as follows:

Before Cycling

- Operating Force (Hung and Sliding Windows and Sliding Glass Doors only)
- Air Leakage Test
- Water Penetration Resistance Test

Product Testing

- Vent Cycle Testing (1st half)
- Locking Hardware Testing (1st half)
- Access Panel Cycling (if applicable)
- Misuse Testing (Racking, deglazing, torsion, etc.)
- Vent Cycle Testing (2nd half)
- Locking Hardware Testing (2nd half)

After Cycling

- Operating Force (Hung and Sliding Windows and Sliding Glass Doors only)
- Air Leakage Test
- Water Penetration Test

AAMA 910 carefully stipulates that in order to pass the life cycle tests, no window shall be partially tested or shall have any limitations or restrictions. No adjustments are permitted during the testing sequence. In other words, this is a pass/fail specification and the fenestration product either meets all of the requirements for its class and performance grade or it fails to pass.

What if the Window has Mullions?

The standard imposes additional requirements on intermediate framing members such as mullions. Note that in window lingo, a mullion is defined as an intermediate connecting member used to "join" two or more fenestration products together in a single rough opening. It should not be confused with a "muntin," which is often a decorative profile that divides a lite of glass or panel into smaller sections.

The most important of the requirements for mullions is that structural members must be designed to withstand the full wind load for the project site and that all AW products and HC hung products must not exceed a deflection limit of one 175th of the span (typically expressed as L/175 where L is the span length). AAMA 450, "Voluntary Performance Rating Method for Mulled Fenestration Assemblies," describes the method for determining the structural capabilities of mulled units including multiple window or door assemblies combined into a composite unit.

The definition of a combination unit is very important. Basically, combination units are formed by a combination of two or more separate windows or glass door units whose frames are mulled together utilizing a combination mullion. Composite units are a window or glass door unit consisting of two or more sash or panels within a single frame utilizing an integral mullion.

Products which are designed to be stacked or combined in the field are tested as individual units according to the requirements of their operator type. By contrast, composite units are normally shipped as separate window units to be joined in the field using combination mullions. A field-mulled "combination assembly" is shipped as separate window units; a "composite unit" is shipped as a single unit. The structural framing provided to join these individual units in the field is not covered in the performance standard. Evidence of compliance for these joining members is normally provided by calculation or compliance with AAMA 450.

Are the Materials Good Enough?

While the product performance requirements of the standard are material neutral, Section 3.0 of AAMA/NWWDA 101/I.S. 2 - 97 (and section 6.0 of AAMA/WDMA 101/I.S. 2/NAFS – 02) collect all of the minimum materials specifications which were previously scattered throughout the predecessor documents. They provide guidance for materials issues which may affect the performance of window and door products. Key material-specific requirements are:

- Aluminum extrusion properties should reference chapter 7 of the American Society of Metals aluminum properties and physical metallurgy.). Commercial alloy 6063-T5 is one of the several alloys that will meet these requirements.
- Rigid PVC extrusions where used as a sash, frame or other structural or glass-retaining member, must comply with AAMA 303. Other polymeric materials are covered by similar 300-series specifications.
- Wood parts, where used, must be wood or wood composites that have been kiln-dried to a moisture content no greater than 12% at the time of fabrication. All exposed wood surfaces must be sound. Defects and discolorations are permitted, provided the surface is suitable for an opaque finish.

Specifications for other materials are added as standards are developed. For example, Cellular PVC, Fiberglass, Steel, Cellulosic Composites, Fiber Reinforced PVC and ABS Plastic were added to the 2002 "international" version of the standard.

What About the Glass?

The performance requirements for glass and glazing are often very specifically outlined in applicable building codes. Governing standards typically cited for annealed glass (ASTM C 1036), safety glazing (ANSI Z97.1 or CPSC 16 CFR 1201), tempered glazing (ASTM C 1048 [Kind FT]) and insulating glazing (ASTM E 774 level C or higher [Level A for AW products]) are incorporated into both standards.

Requirements for glass strength are addressed by reference to ASTM E 1300, "Standard Practice for Determining the Minimum Thickness and Type of Glass Required to Resist a Specified Load." Performance testing per 101/I.S. 2-97 or 101/I.S. 2/NAFS-02 must be performed on units glazed with the minimum strength glazing as called for by ASTM E 1300 for the design load of the product. This is required so that the glazing cannot artificially increase the performance of the product being tested. The latest version of E 1300 allows the user to determine glass strength based on 1, 2, 3 or 4 sided support of the edge of the glazing.

Note that products tested with plastic glazing materials do not qualify glass glazing materials, nor do products tested with glass qualify plastic glazing materials. Products tested with sealed insulating glass do not qualify single glazed products.

Going International: The 2002 Version

Now that you understand the 1997 version, let's look at the differences between ANSI/AAMA/NWWDA 101/I.S. 2-97 and the newer ANSI/AAMA/WDMA 101/I.S. 2/NAFS – 02. The latter represents a combination of 101/I.S. 2 - 97 and Canada's CSA A440, and is intended to meet the requirements of markets throughout North America. It includes more performance requirements, more materials options and encompasses skylights.

In October 2002, it was accepted by the International Code Commission (ICC) for the International Residential Code (IRC) and International Building Code (IBC). The IBC and IRC thus currently recognize both 101/I.S. 2/NAFS-02 and 101/I.S. 2-97.

While the basics remain the same, there are differences between these two versions of the standard. It is therefore important for the user to understand the requirements and match them to the project requirements. The table below summarizes the most important differences:

Requirement	1997 Version	2002 Version
Measurements	IP Primary	Metric Primary
Product Types	21 Products	26 Products
Performance Grade	No limits on ratings	Grade capped at entry + 60 psf except AW
Water Penetration	12 psf max test pressure	15 psf max test pressure
Air Leakage	Leakage allowance: 0.3 and 0.1 cfm/ft^2	6.24 psf test pressure for HC leakage allowance: 0.3 cfm/ft^2 except jalousie @ 1.2 cfm/ft^2
Operating Force	Force to maintain motion ONLY	Force to initiate and maintain motion per E 2068
Deflection Limit	AW and HC Hung ONLY	All HC and AW products
Permanent Deformation	0.4% (0.2% for AW)	0.4%, 0.3% or 0.2%
Forced Entry	ASTM, CAWM, AAMA	ASTM ONLY
Minimum Test Size	—	Increased for most products
Glass Strength	ASTM E 1300-94	ASTM E 1300-00
Materials	Aluminum, Wood, Vinyl	Added 6 materials

Let's take a closer look at the most significant of these changes.

Metric Units

Design and test pressures are internationalized, being expressed first in metric units (e.g., Pascals [Pa] for pressure, Newton's [N] for force, etc.), then in IP (inch-pounds) units, the latter shown in parentheses. This reverses the convention used in 101-I.S. 2-97.

When expressed in IP units, the product designator code appears the same as under 101/I.S. 2-97 (example: H-LC25 for a hung window of light commercial class qualified at a design pressure of 25 psf). If the rating is desired in metric units, design pressure (in Pascals) is preceded by an "M" (example: H-LCM1200, where 1200 Pa = 25 psf). Air leakage rates are expressed in liters per second per square meter (L/s/m2)as well as cubic feet per minute per square foot (cfm/ft2).

New Product Types

101/I.S. 2/NAFS-02 makes some important additions to the list of products covered by the standard, notably:

- Skylights and Roof Windows. A major change in 101/I.S. 2/NAFS-02 is the inclusion of skylights and roof windows. The intent is to absorb and supersede the previous AAMA/WDMA 1600/I.S. 7 standards governing these products. Separate product designations are defined for glass-glazed skylights ("SKG"), plastic-glazed skylights ("SKP") and roof windows ("RW"). The minimum (also termed "gateway") Performance Grade requirements for each Class, which are the same as those in 101/I.S. 2-97, apply to skylights and roof windows as well as window types (except that skylights are typically not offered in LC or AW classifications).
- Side Lights ("SLT") and Transoms ("TR"). Under 101/I.S. 2-97, these were treated as varieties of fixed ("F") window products. 101/I.S. 2/NAFS-02 recognizes that the framing of these products usually differs from that of typical "picture" windows and defines appropriate performance requirements for them.
- Specialty Products ("SP"). This category was established to clarify how performance is to be measured for size and shape variations of other product types (e.g., half-rounds, trapezoids and other configurations) and is congruent with current NFRC terminology. Note that this does not replace the "specialty products" grouping defined in 101/I.S. 2-97, so the existing categories for Basement, Greenhouse, Jalousie, etc. windows still stand.

New Maximum Optional Performance Grade

Like 101/I.S. 2-97, 101/I.S. 2/NAFS-02 makes it possible to specify higher uniform load structural test and water resistance test pressures. What's new is that 101/I.S. 2/NAFS-02 sets maximum performance levels at which a product (except skylights) may qualify within each performance class (except for the Architectural [AW] grade), by capping the maximum performance grade (design pressure) at 2880 Pa (60 psf) above the minimum (gateway) level for each class (except AW, for which there is no maximum). This was done to discourage artificially high performance grade ratings in a given class. For example, qualifying an LC product at a performance grade of 100 makes less sense than qualifying it as an HC or AW product.

New Maximum Water Penetration Resistance Performance Levels

The water test pressure is now capped at 15 psf (720 Pa) instead of the 12 psf referenced in 101/I.S. 2-97. This allows testing for the harsher conditions found in the Maritime Provinces of Canada and also those often specified in the hurricane prone regions of the United States. Returning to a previous example - a window tested at a design pressure of 75 psf and for water resistance at 12 psf: According to 101/I.S. 2-97, this window is either an AW75 or an HC75 since it meets the maximum 12 psf water test for both classes. According to the 2002 version it is either an AW60 or an HC75.

Also, under 101/I.S. 2/NAFS-02, all AW class windows must pass both ASTM E 331 and E 547 water tests. Skylights and roof windows must be tested per ASTM E 331 with the test unit in a sloped orientation (at the lowest slope angle recommended by the manufacturer) in a manner simulating field installation, including flashing.

Air Leakage Requirements Upgraded for Heavy Commercial Products

Under 101/I.S. 2-97, the air leakage test pressure is 1.57 psf for all but compression seal, fixed, and dual action windows in the Heavy Commercial Class; and all of the Architectural Class, which require a test pressure of 6.24 psf. 101/I.S. 2/NAFS-02 now requires the 6.24 psf test pressure for all of the Heavy Commercial (HC) Class as well, representing a significant minimum performance upgrade.

Because of other performance requirements introduced in 101/I.S. 2/NAFS-02, a leakage rate of 0.1 cfm/ft^2 is no longer required for AW class awning, hopper, projected, casement, vertically pivoted, single-hinged inswinging, fixed and dual action products. The 0.3 cfm/ft^2 leakage resistance level is allowed for all classes, with 0.1 cfm/ft^2 posed as an option. (The exception is Jalousie windows ["R" class], which allow a 1.2 cfm/ft^2 (6.0 L/s/m^2) minimum air leakage level at the 1.57 psf test pressure).

Operating Force

101/I.S. 2/NAFS-02 requires testing and performance requirements for maximum operating force required to initiate motion of the window sash as well as maintain motion according to the requirements of ASTM E 2068, while 101/I.S. 2-97 required only the latter ("operating force after the sash is in motion"). The following table shows how these forces differ for hung windows.

Window Designation	Force To Maintain Motion (1997 version)	Force To Initiate Motion (2002 ONLY)
R	30 lbf (140 N)	45 lbf (200 N)
LC	35 lbf (155 N)	50 lbf (230 N)
C, HC, AW	45 lbf (200 N)	50 lbf (230 N)

Note that while specific forces are the same in 101/I.S. 2/NAFS-02 as in the 1997 version for most products and classes, a lower maximum force to maintain motion is specified for Residential Class Vertical Sliding products. Such products meeting 101/I.S. 2/NAFS-02 requirements will now be easier to operate.

Deflection Limit

The 1997 standard applied maximum deflection limits (L/175) to AW and HC class hung window types only. In the 2002 version, this has been expanded to include all HC and AW products.

Permanent Deformation

While the design and test pressures remain the same in the newer standard, the minimum performance bar under the uniform load structural test has been raised for some product classes. Under 101/I.S. 2-97, there can be no permanent deformation of any main frame, sash, panel or sash member in excess of 0.4% of its span for R, LC, C or HC class products or 0.2% of its span for AW class products. 101/I.S. 2/NAFS-02 raises the bar by requiring that there be no permanent deformation of any main frame, sash, panel or sash member in excess of 0.4% of its span for R, LC class products and 0.3% of its span for C and HC class products. AW class products must still meet the heftier requirement of 0.2%.

Note that this relates to permanent deformation, not temporary deflection while the test load is applied.

Minimum Test Sizes Increased

For the vast majority of product types and classes, NAFS-1 increases the minimum size of units submitted for test for initial ("gateway") qualification of a product within a given performance class, effectively ensuring that those products are more robust. While minimum test sizes for the most popular Residential (R) products (hung, fixed and vertically sliding, for example), are left unchanged, most others require larger minimum test sizes at all class levels. The table below shows the example of minimum test sizes for casement-type windows.

Window Designation	Minimum Frame Size	
	1997	2002
C – R15	1′5″ (430 mm) x 4′0″ (1220 mm)	2′0″ (600 mm) x 5′0″ (1500 mm)
C – LC25	2′0″ (610 mm) x 4′0″ (1220 mm)	2′8″ (800 mm) x 5′0″ (1500 mm)
C – C30	2′0″ (610 mm) x 4′0″ (1220 mm)	2′8″ (800 mm) x 5′0″ (1500 mm)
C – HC40	2′0″ (610 mm) x 4′0″ (1220 mm)	3′0″ (900 mm) x 5′0″ (1500 mm)
C – AW40	3′0″ (910 mm) x 5′0″ (1520 mm)	3′0″ (900 mm) x 5′0″ (1500 mm)

Note that while the design load is the same for HC and AW classes, the AW test size is larger in the 1997 version but not the 2002 version

Materials

New and upgraded materials specifications have been added for fiberglass, fiber reinforced PVC, ABS, cellular PVC, steel and cellulosic wood composites. This greatly expands the scope of the standard. The standards referenced include:

- **ALUMINUM:** AAMA 505 for testing of thermal barrier extrusions; AAMA TI A8-04 and AAMA QAG-1 relative to thermal barrier materials
- **ORGANIC COATINGS:** AAMA 613, 614 or 615 for coatings on polymers; AAMA 2603, 2604 or 2605 for coatings on aluminum extrusions or panels
- **GLASS:** ASTM E 1300-00 replaces ASTM E 1300-94
- **STEEL:** Several coating options are listed
- **FIBERGLASS:** AAMA 305
- **CELLULOSIC COMPOSITE MATERIALS:** WDMA I.S.-10
- **PVC:** AAMA 303-01, ASTM D4726 and appendix A.1 "Thermal Plastic Corner Weld Test"
- **FIBER-REINFORCED PVC:** AAMA 310
- **ABS:** Compounds and profiles per AAMA 304

A Specification "Cheat-Sheet"

A specification writer is burdened with the responsibility for a great many building elements. The good news is that once you've figured out the requirements and designation for your windows, there's no need for word-smithing a complicated window specification. 101/I.S. 2 - 97 and 101/I.S. 2/NAFS-02 provide a short, fill-in-the-blank, specification form that includes all of the elements we have just discussed.

Short Form Specification

All aluminum and/or vinyl (PVC) and/or wood windows and glass doors shall conform to the ______________________ (See note below) voluntary specification(s) in ANSI/AAMA/NWWDA 101/I.S. 2-97 or 101/I.S. 2/NAFS-02, be labeled with the "AAMA" or "WDMA Hallmark" label, have the sash arrangement(s) and be of the size(s) shown on the drawings and be as manufactured by ______________________ or ______________________ or approved equal.

All that is necessary is to insert the product designator, derived as described above, in the first blank, and any preferred supplier in the last blanks.

Some Working Examples

The following examples (based on a now-obsolete edition of a state building code) illustrate how the ANSI/AAMA/NWWDA 101/I.S. 2-97 and ANSI/AAMA/WDMA 101/I.S. 2/NAFS standards can be used to specify and select products that meet code requirements. Compliance with other codes can be assured in the same manner.

Example #1

The first example is a low rise hotel building. The information required from the architect to correctly specify the project are location, design wind velocity, building type, building footprint, building height, roof slope and window operator type.

For this example, let's assume the building is located in Morehead City, North Carolina. The design wind velocity is 110 mph. The architect is designing a new hotel which he/she has decided will be rated Commercial. Refer to pages 5 and 6 for a review of how to determine performance classes and grades. The hotel has a rectangular footprint of 300 feet by 150 feet. This will be a low rise (three-story) building with a mean roof height of 35 feet. The roof will be flat and gravel covered. The architect has chosen casement windows for this building in order to take advantage of their maximum opening area and capture the prevailing sea breezes. Impact resistance has not been included in this example because the architect has designed the building as a partially open structure.

The first step in building a window specification based on these criteria is to determine the velocity pressure based on the given wind speed. Looking at the wind load tables in the local code, we find that for 110 mph and 3 stories (25 feet), the velocity pressure is 47 psf. While not indicated in the wind load table, notes and exceptions in the actual table allow a 10% reduction in this design pressure to 42.3 psf for windows located within four feet of the building corners (where wind loads tend to concentrate) due to the effects of the flat roof, while the design pressure for windows located more than four feet from the corners can be further reduced to 36.8 psf.

The product specifications require three pieces of information: the window operator type, the product performance class and the product performance grade. There are two performance grades on this project for the corner window and the non-corner windows. Therefore:

- Window Operator Type = **Casement** (as selected by the architect)
- Window Performance Class = **Commercial** (as selected by the architect)
- Window Performance Grade = **40** (Design Pressure = 40) (As specified in the code)
- Window Performance Grade at corners = **45** (Design Pressure = 45) (As specified in the code)

Note: The values of 40 and 45 psf must be used because windows are rated in the standards in 5 psf intervals.

The window, skylight and door standards provide a short form guide specification as presented earlier. Using this guide specification the project specification becomes:

"All aluminum and/or vinyl (PVC) and/or wood windows and glass doors within 4 ft of building corners shall conform to the C - C45 and all other windows and glass doors shall conform to the C - C40 voluntary specifications found in ANSI/AAMA/NWWDA 101/I.S. 2-97 or ANSI/ AAMA/WDMA 101/I.S. 2/NAFS-02, be certified and labeled with the "AAMA" or "WDMA Hallmark" label, have the sash arrangement(s) and be of the size(s) shown on the drawings and be as manufactured by (Preferred Manufacturer) or approved equal."

If impact resistance were required for this coastal location, we could add it to our specification as an extra criterion.

The last stage in the process is selecting products that comply with the specification we have just developed. AAMA publishes a Certified Products Directory of all products authorized for certification by their programs to both performance specifications. The first first step is to identify the products which meet or exceed the project requirements.

Aluminum Prime Windows

Complies with AAMA/NWWDA 101/I.S. 2-97 and NFRC 100, if applicable

Part

COMPANY	SERIES MODEL & DESCRIPTION	101/I.S. 2-97 DESIGNATION	MAXIMUM SIZE TESTED FRAME W x H	SASH W x H	NFRC RATED
TYPE/CLASS C-C – CASEMENT (COMMERCIAL)					
ALL WEATHER ARCHITECTURAL ALUM.,	3000 (XX)(OG)(CMBSO)	C-C40-62x54	5' 2" x 4' 6"	2' 6" x 4' 5"	
BLOMBURG WINDOW SYSTEMS	1400 (XX)(OG)(CMBSO)	C-C30-66x61	5' 6" x 5' 1"	2' 8" x 5' 0"	YES

The second step is to review the list of manufacturers with compliant products. From this list of manufacturers, a limited list of those who will be permitted to bid on the project can be developed.

COMPANY	SERIES MODEL & DESCRIPTION	101/I.S. 2-97 DESIGNATION	MAXIMUM SIZE TESTED FRAME W x H	SASH W x H	NFRC RATED
GERKIN WINDOWS & DOORS	RHINO 5300 (XOX)(IG)(INS GL)(ASTM)	C-C30 – 111 x 74	9' 3" x 6' 2"	3' 0" x 6' 0"	
	RHINO 5300 (XOX)(IG)(INS GL)(ASTM)	C-C55 – 92 x 62	7' 8" x 5' 2"	2' 6" x 5' 0"	
	RHINO 5300 (XOX)(IG)(INS GL)(ASTM)	C-C90 – 75 x 50	6' 3" x 4' 2"	2' 0" x 4' 0"	
MANNIX/A DIV. OF INTERSTATE WINDOW CORP.	1900 (XOX)(IG)(INS GL)(AAMA)	C-C70 – 96 x 51	8' 0" x 4' 3"	2' 0" x 4' 0"	
MILGARD MFG., INC. (HOLLISTER, CA)	910-C/910-S/911-C (OX)(CG & OG)(INS GL)(CMBSO)	C-C35 – 90 x 60	7' 6" x 5' 0"	2' 5" x 4' 11"	YES

Acceptable products have been highlighted.

After review of the returned bids from qualified suppliers, the best supplier can be selected and awarded a contract for the windows and doors on this hotel. The Certified Products Directory includes contact information for all companies and plants producing rated products.

Example #2

The next example is a single family residence.

For the second example, let's assume the residence is located in Fayetteville, North Carolina. The design wind velocity is 90 mph. The architect is designing a new home which will he/she has decided will be rated Residential. Again, refer to pages 5 and 6 for a review of how to determine performance classes and grades. The house has a rectangular footprint of 90 feet by 50 feet. This will be a low rise (one story) building with a mean roof height of 15 feet. The roof will be sloped at a 6/12 pitch. The architect has chosen horizontal sliding windows for this building because he wants the windows to remain in the plane of the wall and wishes to provide the maximum viewing area. Impact resistance has not been included because it is not considered necessary this far from the coast.

As before, the first step in building a window specification is to determine the velocity pressure based on the given wind speed. Looking at the wind load table in the local code, we find that for 90 mph and one story, the velocity pressure is 25 psf. This time, notes and exceptions do not permit a reduction of the design pressure to 90% of the velocity pressure because the roof is sloped. Therefore, the corner design pressure remains 25 psf. However, the design pressure may be reduced to 21.8 psf for windows or doors that are more than 4 feet from the building corners.

Again, the product specifications require just three pieces of information: the window operator type, the product performance class and the product performance grade. Therefore:

- Window Operator Type = **Horizontal Slider** (as selected by the architect)
- Window Performance Class = **Residential** (as selected by the architect)
- Window Performance Grade = **25** (Design Pressure = 25) (as specified in the code)

Note that there is only one performance grade on this project, higher than the minimum for the Residential Class. So, the Performance Grade is rounded off to the next higher 5 psf increment. This time, because this project involves combination windows with non-integral mating or joining mullions, a requirement must be added to the specification requiring calculations. Again using the guide specification provided, the project specification is easily developed:

> *"All aluminum and/or vinyl (PVC) and/or wood windows and glass doors shall conform to the HS-R25 voluntary specifications found in ANSI/AAMA/NWWDA 101/I.S. 2-97 or ANSI/AAMA/WDMA 101/I.S. 2/NAFS-02, be certified and labeled with the AAMA label, have the sash arrangement(s) and be of the size(s) shown on the drawings and be as manufactured by Preferred Manufacturer or approved equal. All intermediate mullions not tested as part of the window or door qualification shall provide deflection limited to L/175 as proven either by separate test or mathematical calculation."*

Again as previously stated, the AAMA Certified Products Directory provides easy reference to locate products which meet or exceed the project requirements and their manufacturers.

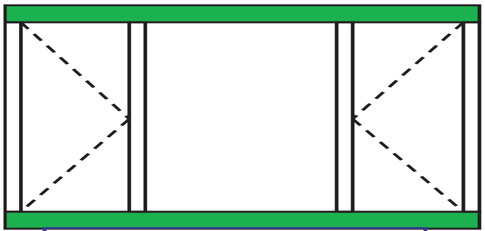
Let's look more closely at the use of mullions as posed in this example, as mullion deflections are of concern on some projects and limits may be imposed by some building codes.

Mullions

The standard addresses two different types of mullioned units: those with integral mullions and combination units joined or mated by mullions. The standard imposes limits on some integral mullions and requires that combination mullions meet project or code requirements.

Integral mullions run between continuous perimeter framing members and are part of window units as they are shipped from the factory. The mullions are tested with the unit and deflection limits applied to the unit also apply to the integral mullions. Products using integral mullions are rated as a single unit and can be identified as meeting the standard with a single label.

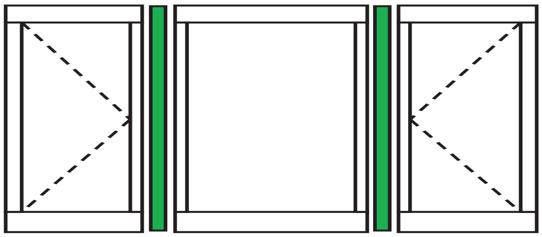
By contrast, composite units are normally shipped as separate window units to be joined in the field using combination mullions. The individual window units are tested but not the combination mullions. They may be evaluated by a separate test or by calculation. Products using combination mullions must be tested as individual units and each unit is rated and labeled separately (the illustrated example would require three such labels). AAMA 450 may be used to rate the combination mullion.



Integral Window Unit

MULLION: INTEGRAL
TESTED: SINGLE UNIT
COMPLIANCE: TEST ENTIRE UNIT

INDICATES CONTINUOUS STRUCTURAL FRAMING MEMBER



Composite Window Unit

MULLION: MATING
TESTED: EACH UNIT
COMPLIANCE: TEST EACH UNIT & CALCULATE MATING MULLION

$$\Delta = \frac{5WL^3}{384EI}$$

(Formula for evaluating loaded single span beams should you choose to perform the calculation.)

A Peek at the Future of Window Standards

In 1996, AAMA, WDMA, NFRC, CWDMA, NRC and CSA began negotiating on full harmonization of the AAMA/NWWDA 101/I.S. 2 and CSA A440 national standards. While 101/I.S. 2/NAFS-02 has made significant strides toward that goal, the next incarnation, dubbed 101/I.S. 2/A440, should accomplish the mission in time for submittal to the ICC for referencing in the 2006 International Building Code (IBC) and International Residential Code (IRC). The next obvious step will be cross-certification of products so that one label can be applied to all products regardless of the certifying agency. AAMA is also exploring this same concept with several foreign agencies and in fact achieved cross certification with Japan in 1998.

Current drafts of 101/I.S. 2/A440 include some significant changes:

- A new specification for side-hinged exterior doors has been added. This includes a new "Limited Water" (LW) rating for these products and will incorporate new testing requirements for operating cycles, hardware water penetration resistance, vertical loading and forced entry resistance.
- The product rating system is being expanded to provide a primary designator similar to that in current use and a new secondary designator which allows the reporting of performance criteria such as negative test pressures, optional performance criteria and water test pressures not currently provided.
- Numerous new sash, frame and glazing material requirements have been added.

A Word about Certification

As the basis for AAMA's nationally-recognized, ANSI-accredited Certification Program, 101/I.S. 2-97 and 101/I.S. 2/NAFS-02 offer a truly uniform basis for comparing the key characteristics and quality attributes of window and door products.

After AAMA introduced the first window performance standard in 1947, architects and specifiers soon realized the benefits of including performance standards in their project specifications. While analysis of tested products helped in product selection, the problem of quality assurance still remained to be addressed. AAMA began offering a product quality assurance program in 1962. This program has evolved into the product certification programs offered by several associations today. Seeking national recognition of its program, AAMA achieved accreditation of the program by the American National Standards Institute (ANSI) in 1972, the first such program to obtain this prestigious recognition.

There are three basic formats for certification programs:

- Self-Certification (essentially an enhanced warranty)
- Second-Party Certification (the most common format)
- Third-Party Certification (the most independent format).

The differences basically pertain to the ways in which manufacturing, administration and inspection/certification are interrelated. To select the appropriate level of certification for a particular project, the architect should understand the meaning of each level of certification.

Self-Certification

Many project specifications allow proof of compliance by submission of a test report. Manufacturers who have tested their products to the performance standards indicated in the specification may choose to apply a company label to their own products drawing attention to the performance level achieved. This label generally states something along the lines of "meets or exceeds the requirements of ..." and is usually supported by some sort of testing. The manufacturer administers its own testing and certification program and performs in-house inspections as part of its own Quality Control program.

This is the lowest level of certification, in which the manufacturer is using testing to an industry standard to enhance what is essentially a product warranty. Unless the manufacturer participates as a licensee in the official Certification Program, there is no independent verification of test results and no follow-up inspection to verify that actual production-line units continue to meet the requirements.

Second-Party Certification

Second-party certification is probably the most prevalent format currently specified. The second party is frequently a trade association which developed the program for its members but now offers the service publicly. A published Procedural Guide usually establishes rules for participation in the program and expulsion from it if the requirements are not met. The manufacturer voluntarily submits its product to an independent laboratory for testing and rating, and the trade association staff performs both the administrative and plant inspection functions, and grants the certification.

While this is the most popular form of certification, the potential exists for influencing the staff of the association if the manufacturer is a member. If the program is to have meaning and benefit for the specifier or consumer, it must include barriers to any such interference on the part of the manufacturer.

This may be accomplished by requiring control of the procedures used by the testing laboratory, in-plant inspections and administration of the program by a staff of inspectors and certifiers who are independent of the manufacturer's direct control. Maintenance of this independence is critical to the success of the program.

Third-Party Certification

The highest and most independent level of certification is third-party certification. In this type of program, the certifying or inspection agency is independently under contract to the administering agency, often a trade association to which the manufacturer may belong. There is no direct link between the certifying/inspection agency – those who ultimately grant or deny certification of the product – and the manufacturer. The sponsoring trade association acts as a buffer between the product manufacturer and the certifying agency. Program procedures for testing and laboratory accreditation are normally similar to those for second- party programs.

Testing is performed by an independent laboratory. Inspection and granting of certification is performed by a separate validator organization under contract to the sponsoring trade association. Acting as administrator, the association audits the validator but never sees the test reports and never certifies a product. The key to independence is that the validator is employed by the program administrator, not the manufacturer. This level of certification has been offered by AAMA since 1962.

If the program is ANSI-accredited, ANSI also audits both the administrator and the validator annually to ensure that program independence is being maintained. Laboratory independence is maintained by not permitting them to be directly involved in either the design or manufacture of the products being tested for certification.

Product Certification Scope

Several types of product certification are available.

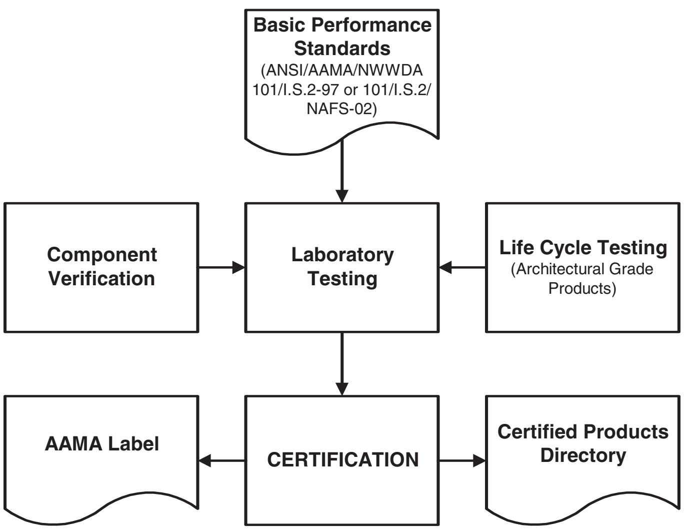
- **Air, Water, Structural** - This is the most common type of certification and was the first program developed. Most specifiers are somewhat familiar with the air, water and structural programs.

■ **Thermal** - Because of recent code activity in America and the acceptance of the Model Energy Code and the IECC by many states. This is the fastest growing type of US product certification primarily as a result the 1993 and 1995 CABO Model Energy Code requirements for thermal certification.

■ **Component** - Verification that components have been tested and meet certain recognizable standards is part of several certification programs, including the AAMA Certification Program and the NFRC Certification Program.

■ **Acoustical** - This most recent certification program was first introduced by AAMA in 1996.

A closer look at the AAMA program reveals several levels and stages that must be successfully navigated before a manufacturer's products can be approved to bear the AAMA label.



First of all, the essential performance requirements are dictated by both ANSI/AAMA/NWWDA 101/I.S. 2 - 97 and ANSI/AAMA/NWWDA 101/I.S. 2/NAFS - 02 standards. Other applicable standards referenced within them include AAMA, ASTM or CAWM Forced Entry, AAMA Components, AAMA 1503, NFRC 100, AAMA 910 Life Cycle Testing, various other ASTM, CGSB, IGMA and SMA standards.

Independent Energy Performance Certification

Manufacturers may also certify product thermal performance to either the AAMA 1503 standard or to National Fenestration Rating Council (NFRC) requirements (NFRC-100), without the prerequisite of certification for basic structural, air and water performance requirements specified in 101/I.S. 2-97 or 101/I.S. 2/NAFS – 02. This allows specifiers to more easily identify products that comply with code requirements and market pressures for substantiated energy performance.

Component Verification Addresses the Total Window System

AAMA certification goes beyond basic quality assurance for completed window units by recognizing that a window is a complex system of components that must perform properly and continuously over a long service life. Accordingly, the AAMA Certification Program includes a system for verification and documentation of components' compliance with the applicable standards referenced within 101/I.S. 2-97 or 101/I.S. 2/NAFS-02.

As noted earlier, these standards reference specific test methods and performance requirements that apply to aluminum extrusions and cladding, vinyl extrusions and cladding and to wood framing members and parts, as well as components such as reinforcing members, glass, aluminum finishes, weatherstrip, gaskets, glazing beads, sealants, hardware and screens.

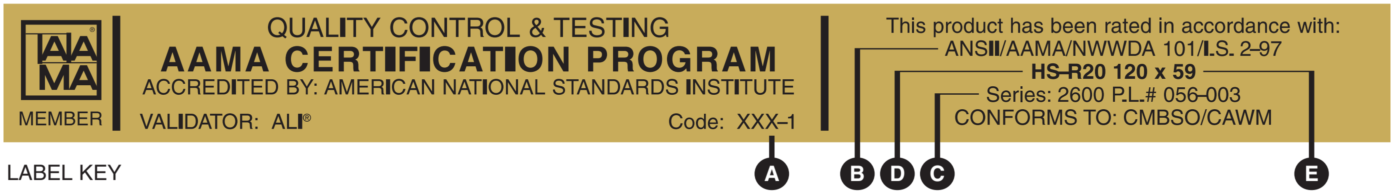
All polymeric framing or sash members (PVC, ABS, Fiberglass, etc.) must be separately certified by AAMA before they can be used in an AAMA certified window, door or skylight.

If a component supplier cannot demonstrate that its product complies with applicable standards via testing at an accredited laboratory, the component may not be used in products approved to bear the AAMA Certification Label.

Laboratory Testing

Actual testing of the complete product may be carried out at an AAMA-accredited independent laboratory of the manufacturer's choosing. The laboratory conducts the requisite tests on prototype samples of the particular window type, class and grade according to methods specified in ANSI/AAMA/NWWDA 101/I.S. 2-97 or 101/I.S. 2/NAFS – 02, and other applicable standards and submits a test report to the administrator/validator, who reviews them to verify that the laboratory followed the proper procedures.

Once all tests and conformance to requirements are verified, the administrator/validator issues an Authorization for Product Certification to the manufacturer, who may then purchase AAMA Certification Labels for application to production line units that conform to the design that was tested. The product will also be listed in the AAMA Certified Products Directory (CPD), widely



LABEL KEY

A = Manufacturer's Code Number (Company name may also be shown)

B = Specification Identification (AAMA/NWWDA 101/I.S. 2-97 or AAMA/WDMA 101/I.S. 2/NAFS – 02)

C = Manufacturer's Series Number

D = Product Grade and Class Designation

E = Maximum Size Tested

recognized by specifiers as the definitive guide to performance-certified windows and doors. However, note that a product is only certified if it is labeled.

At least once every four years, the manufacturer must retest the product to verify that the design continues to comply with the standard's requirements.

This painstaking, consistent and carefully documented testing and inspection procedure, carried out by accredited independent laboratories, is the reason why the AAMA Certification Label has earned a reputation throughout the construction industry as a credible indicator of product quality and documented performance.

The AAMA Label

The AAMA "gold label" is permanently affixed to the qualifying product, typically on the frame in an area concealed by the operable sash when the window is closed. Typical labels include the manufacturer's code, reference to the performance standard, the certifying agency's identification and the rating achieved by the labeled product. Directories of certified products are available from AAMA, and a searchable CPD is available on the AAMA web site at aamanet.org.

What Does Product Certification Mean to the Building Owner?

The presence of the label tells the end user that a quality assurance process was invoked on his behalf and allows him to compare products in a fair and credible way without in-depth knowledge of product design and testing. Knowing that the products were uniformly rated and that the label assures the quality of production allows the consumer to concentrate on selection of product operator type and appearance.

Owners of large buildings rely on the architect or specifier to select the proper product and assure that only quality products are used. However, most windows and doors are installed in buildings where there is no agent representing the builder or the owner. By providing a fair and accurate rating system and assurance that the products used meet the tested performance levels, the certification process permits the owner or developer to concentrate on the issues of operator type and appearance.

Many state building codes now require third-party labeled products.

What Does Product Certification Mean to the Manufacturer?

One aspect of the certification process that is often overlooked is that it provides value to the manufacturer as well. He is provided with a simplified, uniformly accepted process whereby his product performance can be substantiated by an independent third party. When the specifier requires independent certification and labeling, he is also protected from unsubstantiated claims by his competitors that could skew the product selection process.

What Does Product Certification Mean to the Specifier?

Building specifications cover a huge number of individual components and the process of becoming knowledgeable on all of them can be an overwhelming task. If the specifying agency is also charged with maintaining compliance, the task becomes even more burdensome.

Most specifiers have determined that the use of nationally accepted performance-based standards and test methods helps simplify product selection. Specifying

QUESTION: *How can you be sure that if an AAMA-certified product is specified, there will be sufficient competitive products available to meet the project requirements?*

ANSWER: The AAMA/WDMA 2003 U.S. Industry Market Studies indicated that over 65 million windows and doors were sold in the United States. More than 45 million of those were AAMA certified!

products that are certified to meet these standards not only enhances the selection process, it also greatly reduces the complexity of determining product compliance. Third-party certification offers the best way to assure quality on the job, reduce the complexities of performance requirements into a systematic approach, and allow restriction of bidders to only those who have pre-qualified their products — without having to read and understand enigmatic test reports or interpret manufacturer's advertising claims.

For the comparison and evaluation of different types, classes and designs of fenestration products, third-party certification to IBC/IRC-referenced ANSI/AAMA/NWWDA 101/I.S. 2-97 or ANSI/AAMA/NWWDA 101/I.S. 2/NAFS – 02 offers that proverbial level playing field.

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