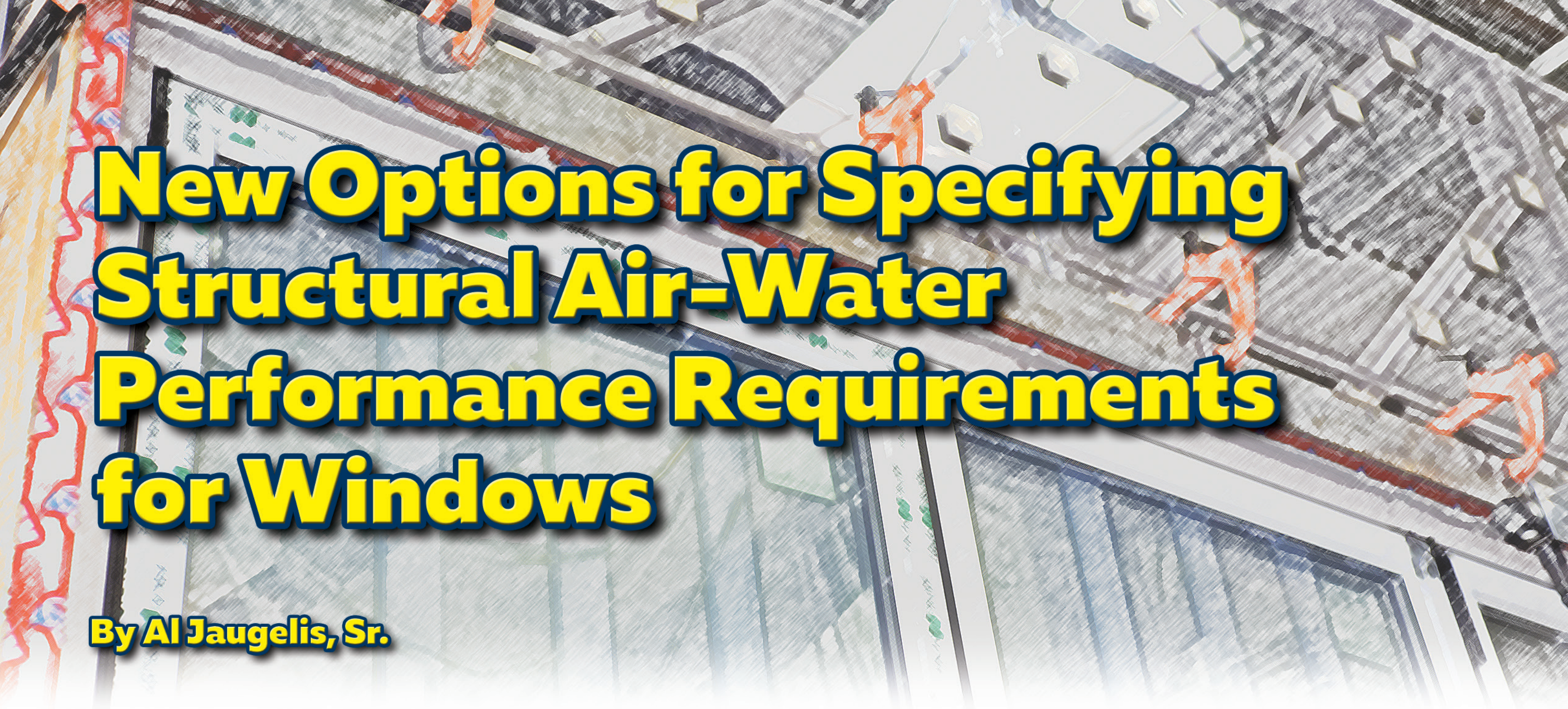

New Options for Specifying Structural Air-Water Performance Requirements for Windows

By Al Jaugelis, Sr.

This article describes a set of optional structural air and water ratings available to users of the standard known as AAMA/WDMA/CSA 101/I.S.2/A440-17, *North American Fenestration Standard/Specification for Windows, Doors, and Skylights*, also called NAFS since the 2008 edition. These optional ratings were introduced in the 2005 edition of the standard, which harmonized window, door, and skylight testing and rating methods between the United States and Canada. They can be considered "new options" because they have not been widely used by American fenestration manufacturers or specifiers.

The optional ratings are provided to allow the three properties that are combined in the NAFS Performance Grade (PG)—wind load resistance, air leakage resistance, and water penetration resistance—to be specified and reported individually and independently of one another. This article contains defined terms and abbreviations in the standard that are familiar to its users.

Figure 1 – Folding door undergoing lab structural testing to the NAFS standard. Photo by Al Jaugelis.

NAFS PERFORMANCE GRADE

Section 1709.5.1 of the 2018 International Building Code, titled "Exterior Windows and Doors," recognizes testing to AAMA/WDMA/CSA 101/I.S.2/A440 (NAFS) to qualify the structural performance of fenestration products. A PG equal to or greater than 0.6 times the design wind pressure determined according to the American Society of Civil Engineers (ASCE) standard ASCE-7, *Minimum Design Loads for*

Reportable Performance Grades (arranged by Performance Class)				Reportable Design Pressure Values		Reportable Water Penetration Resistance Test Pressure Values			
						R-LC-CW		AW	
R	LC	CW	AW	Pa	(~psf)	Pa	(~psf)	Pa	(~psf)
15	–	–	–	720	(15.04)	140	(2.92)	–	–
20	–	–	–	960	(20.05)	150	(3.13)	–	–
25	25	–	–	1200	(25.06)	180	(3.76)	–	–
30	30	30	–	1440	(30.08)	220	(4.59)	–	–
35	35	35	–	1680	(35.09)	260	(5.43)	–	–
40	40	40	40	1920	(40.10)	290	(6.06)	380	(7.94)
45	45	45	45	2160	(45.11)	330	(6.89)	430	(8.98)
50	50	50	50	2400	(50.13)	360	(7.52)	480	(10.03)
55	55	55	55	2640	(55.14)	400	(8.35)	530	(11.07)
60	60	60	60	2880	(60.15)	440	(9.19)	580[1]	(12.11)
65	65	65	65	3120	(65.16)	470	(9.82)	620[1]	(13.03)
70	70	70	70	3360	(70.18)	510	(10.65)	670[1]	(14.04)
75	75	75	75	3600	(75.19)	540	(11.28)	720[1]	(15.04)
80	80	80	80	3840	(80.20)	5801	(12.11)	720[1]	(15.04)
85	85	85	85	4080	(85.21)	6101	(12.78)	720[1]	(15.04)
90	90	90	90	4320	(90.23)	6501	(13.53)	720[1]	(15.04)
95	95	95	95	4560	(95.24)	6801	(14.28)	720[1]	(15.04)
100	100	100	100	4800	(100.25)	7201	(15.04)	720[1]	(15.04)

1. Water penetration is capped at 580 Pa (12.11 psf) except when higher pressure is required by a designer.

Table 1 – Summary of NAFS-17 reportable PGs.

Buildings and Other Structures, is sufficient to qualify the wind load resistance of windows and doors.

Specifiers also rely on the NAFS standard to qualify lab-tested air leakage and water penetration resistance properties by reference to the PG. The PG is a single all-in-one rating that reports the highest lab-tested design pressure (rounded to the nearest 5 psf), the minimum water penetration test pressure, and conformance to the maximum allowable air leakage rate.

Table 1 summarizes the reportable NAFS PGs presented in tables 5.3, 6.3, and 7.1 of AAMA/WDMA/CSA 101/I.S.2/A440-17 (NAFS-17).

A PG confirms that the minimum air leakage and water penetration requirements of the standard are satisfied in addition to the structural requirements. But what is a specifier to do when greater-than-minimum airtightness or water penetration resistance is desired?

SPECIFYING FOR GREATER-THAN-MINIMUM PERFORMANCE LEVELS

It is not unusual for specifiers to require windows with a lower rate of air leakage than defined in NAFS for a given Performance Class, or a greater level of water penetration resistance than 15% or 20% of design pressure.

When these properties will be confirmed by field testing, specifiers must also contend with AAMA 502, *Voluntary Specification for Field Testing of Newly Installed Fenestration Products*. This industry standard does not permit products to be field tested to the same performance levels as were achieved in the lab; AAMA 502 limits the jobsite water test pressure to two-thirds of a product's lab test pressure, and requires field-tested air leakage to be not less than 1.5 times greater than the product's lab test pressure. While AAMA 502 recognizes that specifiers may override these recommendations in project specifications, on-the-job experience confirms that product suppliers are sometimes reluctant to cooperate.

Today, upgrading the Performance Class or the PG are the only options specifiers believe they have to request a higher level of lab-tested performance. It is not unusual for a specifier needing only a PG30 level of wind load resistance, and—wanting a field water test pressure of 6 psf—to specify a PG60 product, which will have a lab-tested water test pressure of at least 9 psf. The AAMA 502 field water test would subsequently be conducted at the desired 6 psf.

Specifiers have relied on measures such as increasing the PG far beyond the building's design wind pressure to obtain a higher lab-tested water test pressure, or upgrading the Performance Class to AW to achieve a significant reduction in lab-tested air leakage. Both of these measures have the potential to increase the product cost, as they are likely to result in use of a framing system that is over-built for the intended use.

Figure 2 – Close-up of folding door undergoing lab structural testing. Photo by Al Jaugelis.

PURPOSE OF THE SECONDARY DESIGNATOR

NAFS-05 also introduced two designations that are still in use: the Primary Designator, and the Secondary Designator. The Primary Designator is composed of the Performance Class, the PG, the Product Type, and the Maximum Size Tested. The Primary Designator is reported in a single line on test reports and product labels.

The Secondary Designator allows the reporting of one or more of the following lab-tested attributes, in conjunction with the Primary Designator, using the available pressure increments in the standard (also summarized in *Table 1*):

- Positive design pressure
- Negative design pressure
- Water penetration resistance test pressure
- Air infiltration/exfiltration level

When supported by testing, the Secondary Designator is reported together with the Primary Designator on the Summary of Results that appears on the first page of a NAFS test report or on a label format that can accommodate the additional lines.

The Secondary Designator is described in detail in Clause 4.4.3 of the 2008, 2011, and 2017 editions of AAMA/WDMA/CSA 101/I.S.2/A440. The 2008 edition provides more examples of Secondary Designator use than subsequent editions.

Allows Reporting of Better-Than-Minimum Structural, Air, and Water Performance

Whereas the PG combines the structural air-water characteristics into a single rating, the Secondary Designator was introduced to allow these characteristics to be specified and reported individually to be more stringent or more informative than the PG alone.

The existence of the Secondary Designator allows manufacturers to report better-than-minimum structural, air, and water test pressure ratings. It also allows specifiers to request what was once a unicorn: A PG30 window with a 9 psf, or even a 12-psf water test pressure. (It also allows them, if desired, to demand air infiltration/exfiltration levels that are considerably more stringent than the air leakage levels permitted under the PG.)

In a project specification, Secondary Designator characteristics could be incorporated in ways such as:

- Lab-tested performance: casement window, Class CW-PG30, water penetration test pressure 12.11 psf
- Lab-tested performance: awning window, Class CW-PG 40, water penetration test pressure 9.19 psf, air infiltration/exfiltration level A3

Reveals Differences Between Products Having the Same Performance Grade

Use of the PG alone to compare products within a Performance Class reduces awareness of tested structural, air leakage, and water penetration differences among them. The following examples illustrate how significant these differences can be, and how they affect the decisions of product manufacturers as well as specifiers.

Without the use of the Secondary Designator's optional ratings, all Class CW-PG 30 products are identical to a specifier or to the marketplace. One may be a sliding sash product with a higher rate of air leakage than a compression seal product of the same grade. The compression seal product likely has lower air leakage and water penetration resistance test values, and may perform better than the class and grade thresholds, but the superior performance would not be reportable using the Primary Designator alone.

When the only non-class rating is PG, other product performance differences are obscured. A side-hinged door with a tested design pressure of 60 psf and a water test pressure of 3.5 psf must be downgraded to PG25, and its superior structural performance will not be evident. Similarly, a dual-action window with a water penetration test pressure of 9 psf and a tested design pressure of 35 psf would be downgraded to PG35, and marketing its superior PG60 level of water penetration resistance, buried in the test report, would be difficult.

An architect may logically believe it is necessary to upgrade the specification for a dual-action window from Class CW-PG30 to Class AW-PG40 to obtain the lowest reportable air leakage rate in NAFS-11: ≤0.10 cfm/ft^2. Only the AW class of product is permitted to be evaluated at this rate. (The Class CW air leakage threshold is three times higher at 0.30 cfm/ft^2). A vendor with a Class CW-PG40 dual-action window with an air infiltration/exfiltration rate of 0.06 cfm/ft^2, tested at the Class AW pressure differential, would find it difficult to have the product considered because it would be from the "wrong performance class" and, therefore, unsuitable.

Use of the Secondary Designator options could reveal what the PG simplifies and conceals.

Use of the Secondary Designator Can Foster Innovation

Reliance on PG alone to report the structural air-water performance properties of windows has the potential to inhibit innovation among window, door, and skylight manufacturers. Why maximize the water penetration or air leakage resistance of products when superior performance cannot be reported on a product label, or on the one-page summary of a NAFS test report?

Use of the individual ratings permitted in the Secondary Designator, together with the Primary Designator, allows better-than-minimum performance to be marketed, and superior products to be distinguished from lower-performance "peers" within a given PG and Performance Class.

CONCLUSION

The NAFS Secondary Designator gives specifiers additional reportable performance metrics to supplement Performance Class and PG. These metrics can be used to more accurately characterize the desired performance characteristics of window, door, and skylight products within the scope of the NAFS standard, and allows specifiers to define higher-than-minimum levels of air leakage and water penetration resistance. The Secondary Designator is present in all editions of the NAFS standard currently recognized in state building codes.

The NAFS Secondary Designator gives manufacturers of superior-performing products the ability to test, market, and label those properties. Several U.S. certification organizations offer labeling options for Secondary Designator characteristics. It is possible that wider use of the Secondary Designator could foster the development of better-performing products in all Performance Classes.

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World's Second-Highest Skyscraper Planned

Upon completion, the Shenzhen-Hong Kong International Center (SHKIC) in Shenzhen, Guangdong, will be the tallest building in China, at 668 meters (approximately 2300 feet) and the second tallest in the world, after Dubai's 828-meter Burj Khalifa. (It is possible that by the time of its completion, however, that Dubai One Tower, planned at 711 meters, may overtake SHKIC in height.) It will contain 140 floors and 321,900m^2 (3,465,000 sq. ft.). Construction began in March 2018 between the foothills of Longcheng Park and Dayun National Park, and the building is expected to open in 2024 and cost $6 to $8 billion U.S.

The building is slated for LEED Platinum certification. High-performance glass will be used to reduce heat gain. Winds predominantly from the east and northeast will be funneled into the open spaces to provide natural ventilation.

The complex will contain a convention and exhibition center, startup incubators, residential buildings, office and performance centers, five-star hotels, schools, and shopping malls. It will include one of the world's highest observation points.

SHKIC will have one of the world's highest observation points. Rendition by Adrian Smith + Gordon Gill Architecture.

The planned tower will twist high above Shenzhen. Rendition by Adrian Smith + Gordon Gill Architecture.

