Commercial Glazing and NAFS in Canada

By Al Jaugelis

Applying the North American Fenestration Standard (NAFS) in the commercial world of custom fabrication and site-glazed products is going to be tricky in Canada. Product labeling will not be an option in most situations.

While the National Building Code is clear that testing and labelling fenestration products to NAFS and the Canadian Supplement is mandatory for Part 9 buildings, the application of these standards to commercial fenestration products, in both Part 3 and Part 9 buildings, is less straightforward.

First, let's be clear as to what we are talking about. In this article, the acronym NAFS refers to AAMA/WDMA/CSA 101/I.S.2/A440-08—North American Fenestration Standard/Specification for windows, doors, and skylights, or to the more recent 2011 edition. "Canadian Supplement" refers to CSA A440S1-09, the Canadian Supplement to NAFS.

WHAT THE CODE SAYS ABOUT NAFS

The 2010 National Building Code ("the Code") and provincial codes based on it, such as the Ontario, Alberta, and British Columbia Building Codes, all use very similar language with respect to the application of NAFS and the Canadian Supplement in both Part 9 and Part 5. (Note to U.S. readers: Part 9 applies to small buildings that can be built without design professionals, while Part 5 applies to larger buildings that require oversight from design professionals.) The Code is clear that performance expectations for the wind and water resistance of fenestration products (called Performance Grades in the Code) must be determined on

Figure 1 – Shangri-La Hotel, Vancouver, BC, Canada, at right.

a building-by-building basis, taking into account each building's location, terrain, and the height of the fenestration product above grade. For products within the scope of NAFS, designers are directed to use the Canadian Supplement to determine the appropriate design pressure, water penetration resistance, and snow load (for skylights), though it is entirely appropriate to use it for fenestration products outside the scope of NAFS as well.

PERFORMANCE GRADE EXPLAINED

For products within the scope of the NAFS standard, these building-specific performance expectations are defined with respect to a property called performance grade. While performance-grade ratings are denominated in inch-pound (IP) unit design pressure increments of 5 psf, ranging from PG15 to PG100, they also include successful testing for air leakage, water penetration resistance, and several other properties.

But there are important differences in how performance grade is used in the United States and in Canada. In the U.S., a performance-grade designation such as PG40 denotes a product's tested design pressure, water penetration resistance, and air leakage. The PG rating alone describes the air and water structural properties of a product. In Canada, it serves to denote the tested design pressure only, as water penetration resistance and the air infiltration/exfiltration levels are independent of performance grade and reported separately. In Canada, unlike the U.S., it is possible to specify and report higher levels of airtightness and watertightness for any performance grade than the minimum values associated with the performance-grade tables in NAFS.

But NAFS testing does not end with the achievement of a performance grade. In addition to meeting the minimum test specimen size and performance grade requirements to qualify for one of the four performance classes (R, LC, CW, and AW), there are additional auxiliary tests that evaluate product durability features.

While products can achieve a performance grade by testing to the minimum specified Canadian requirements for air, water, structural, and forced-entry resistance, manufacturers selling products in Canada are well advised to test products to their maximum capabilities to ensure they have a larger market. After all, in Canada we have two levels of operable product airtightness, and depending on building location and height, products may require significantly higher water penetration resistance than the minimum test values required to achieve a performance grade. These higher-than-minimum air and water penetration resistance values are reported in the NAFS Secondary Designator.

PERFORMANCE CLASS

From reading the Code, one would never guess that performance class is the key concept at the heart of NAFS. The first of the general requirements in the standard is an introduction to the Gateway Performance Requirements used to assign products to one of four performance classes, summarized in Table 1 of NAFS-08. Eighty-three pages later, the standard concludes with Table 27, also titled Gateway Performance Requirements, which expands Table 1 to seven pages of detailed testing requirements that exist for one purpose only: to classify each of the 30 product types in NAFS to one or more performance classes.

Figure 2 – Shangri-La Hotel, Vancouver, BC, Canada, in the center.

The Code, however, says nothing at all about performance class, other than "the minimum level of performance required for windows, doors, and skylights shall be that of the Performance Class R," the lowest of the four classes (NBC 9.7.4.3.(3)).

It seems clear that while performance class distinguishes products on criteria that may be important to an architect or specifier, it is obviously not a topic of interest to the Code, which concerns itself primarily with performance grades.

NAFS IN PART 9

In Part 9, we see a distinction between two types of fenestration products: "manufactured and preassembled" products, whose performance is evaluated by testing to NAFS and the Canadian Supplement (Subsection 9.7.4.); and "site-built" products, whose performance is evaluated under Part 5 (Subsection 9.7.5.).

The list of products the NAFS standard identifies as being outside its scope includes curtain wall and storefront, commercial entrance systems, revolving doors, commercial steel doors, and sloped glazing systems (other than unit skylights and roof windows). Window wall products, while not named in NAFS-08, are defined in NAFS-11, where they are implicitly treated as mulled windows, and as such are legitimately within the scope of NAFS.

The use of the term "site-built" to refer to products outside the scope of NAFS is all the more striking given that there is no other meaning defined for this term in the Code. These commercial glazing products are not actually built on-site—the frames are typically fabricated in an indoor manufacturing environment. It is possible that here the Code is referring to site-glazed products, as the "manufacturing" of a fenestration product is not considered complete until the glass is installed. The distinction between site-glazed and factory-glazed is an important one in the context of product labeling.

Subsection 9.7.5. makes it clear that under Part 9, the design and performance verification of commercial fenestration products that are outside the scope of NAFS is to be handled in the same way as in Part 3 buildings: with reference to Part 5 requirements for professional design and supervision.

NAFS IN PART 5

Fenestration performance in Part 5 is addressed in Subsection 5.10.2., titled "Windows, Doors, and Skylights." Article 5.10.2.3. describes the structural, air leakage, and water penetration design and performance requirements in this way:

> 5.10.2.3. Structural Loads, Air Leakage and Water Penetration
> 1) Windows, doors, skylights, and their components shall be designed and constructed in accordance with
> a) Article 5.1.4.1., Section 5.4. and Section 5.6., or
> b) Article 5.10.2.2., where they

Need to learn more about the NAFS standard as it is applied under Canadian building codes?

The NAFS standard introduces several new concepts, such as performance class and performance grade, and provides us with new performance rating designations for fenestration products within its scope. The companion document known as the Canadian Supplement to NAFS provides guidance on how to determine location-specific design wind pressure (DWP) and driving rain wind pressure (DRWP), and addresses Canadian-only quality and testing requirements that are not contained in NAFS.

To help building designers and the fenestration industry understand and address the challenges of working with NAFS and the Canadian Supplement, the author writes about the many facets of this subject at the NAFS in Canada blog at rdh.com/nafs.

> are covered in the scope of the standards listed in Sentence 5.10.2.2.(1)

It is interesting that this article points to two ways of addressing air-water-structural performance: Clause (1)(a), which refers to the specific Part 5 design and performance requirements for structural and environmental loads, air leakage, and water penetration resistance; and Clause (1)(b), which refers to NAFS and the Canadian Supplement, but only for products within the scope of NAFS.

The use of "or" at the end of Clause (1)(a) suggests the NAFS compliance path in Clause (1)(b) is an alternative to the Part 5 design parameters we used to design commercial glazing systems in previous editions of the Code.

NAFS VS. DESIGN TO PART 5

Designing fenestration systems to comply with the performance requirements in Clause (1)(a) of Article 5.10.2.3. is the domain of professional architects and engineers who determine the appropriate design parameters for a particular building, select suitable products, design their integration with adjoining building assemblies, and verify the performance of designs through a combination of engineering, lab testing, site testing, and field review. Design professionals communicate the design and performance parameters through project

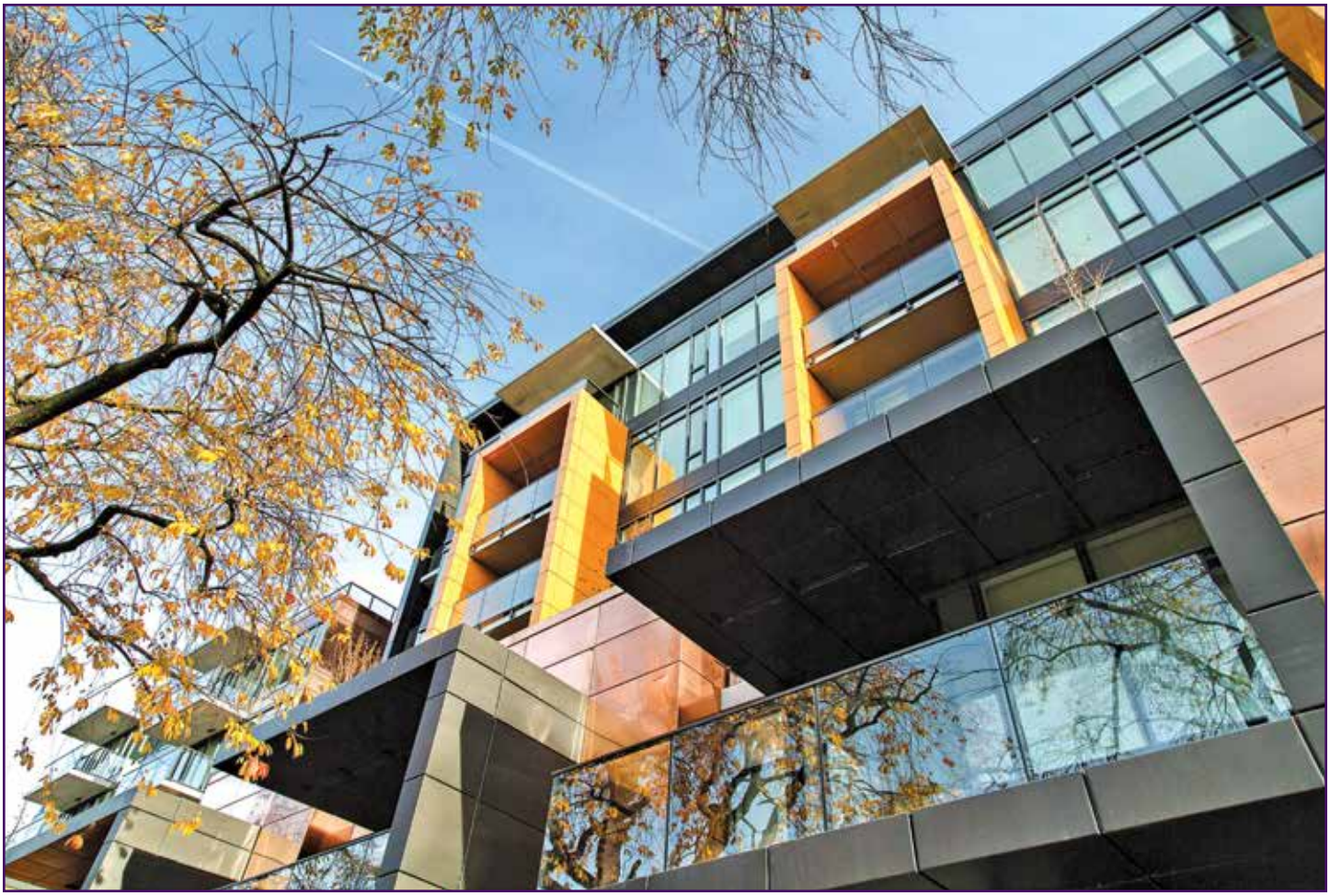

Figure 3 – Granville at 70th Condominiums, Vancouver, BC, Canada.

specifications and drawings, suppliers offer products known to be capable of meeting these requirements on the basis of laboratory testing and site-specific engineering, and after the products are installed, additional testing for properties such as air- and water-tightness is often employed to verify the installed product performance.

Everyone involved in the design, specification, supply, and installation of commercial fenestration is well acquainted with this process. So why am I describing it here? To contrast the difference between Part 5 design and NAFS testing, and to demonstrate that they are not, in fact, equivalent.

LIMITATIONS OF NAFS TESTING

NAFS testing is not without value. Conducted properly, with products anchored in realistic ways, it can validate the wind load performance of a particular product installed in a particular way. When products are tested to their limits and beyond, manufacturers can learn a lot about a product's failure modes and how product performance is affected under different installation conditions.

But NAFS testing provides considerably less assurance about the real-world performance of installed products than one might expect, and to my mind it is not a substitute for Part 5 design. Here are four reasons why.

First, for vertical fenestration, NAFS testing evaluates only wind-load resistance. But a fenestration product designed to Part 5 must also consider guard loads and human impact loads—important code requirements that affect windows with sills below guard height in most buildings.

Second, NAFS performance ratings are intended to validate the performance of the product only and not the installation method. So the NAFS-tested performance grade may provide a pretty reliable measure of the air- and water-tightness of the product to the edges of its frame. While this is useful information, a Part 5 designer is also interested in the performance of the interface between the fenestration product and the wall. Additional testing at the jobsite will be required to verify what NAFS cannot.

Third, NAFS testing for wind load resistance is based on a fallacy: that one can separate the structural performance of a product from how it is anchored to a particular substrate. NAFS explicitly states that testing for performance grade is a test of the product and not the installation method. The test specimen installation language in the standard is so permissive that a large proportion of manufacturers anchor-test specimens in ways that maximize performance grade ratings but could not responsibly be replicated in most buildings. In my view, this makes NAFS-tested performance ratings an unreliable indicator of real-world structural performance.

Figure 4 – Granville at 70th condominiums, Vancouver, BC, Canada.

Because a product's ability to resist imposed loads is critically dependent on anchoring, and anchoring methods must address particular substrate assemblies (as well as building movements due to wind and seismic events), understanding how a product is anchored is critically important to the structural designer. This information should be available in a NAFS test report, but in my experience test reports generally do not describe test specimen installation in enough detail to verify applicability to project conditions.

Fourth, there can be questions about the extent to which the NAFS-tested performance represents the work of the same party that will supply and install the product to a particular building.

There are several things designers need to be aware of here. For one, there are certification programs that allow fenestration product manufacturers who have never tested the products they build to label those products with NAFS ratings based on testing performed by other parties such as the developer of the fenestration system. The rationale is that as long as the untested manufacturer uses the same components and follows the test documentation, the products should perform identically. This is, in my opinion, another fallacy. While this approach may be adequate to validate the performance of products such as fire doors, it is not robust enough to validate air or water performance, which are affected by the most minute and subtle deviations in manufacturing processes and the tolerances of key components. Documentation is no substitute for testing of these properties.

The same concern applies to the advertised NAFS ratings from major fenestration system developers whose products come to market through fabricators and glazing contractors. If the party fabricating and glazing the product is not the party that tested the product, the work of the fabricator and glazier will need to be independently tested to learn if it has the performance attributes advertised by the system developer.

NAFS LABELING OF SITE-GLAZED PRODUCTS?

NAFS performance ratings are generally reported on product labels, and some architects and building officials expect to see NAFS labels on all products, including site-glazed products on Part 9 buildings. Unfortunately, this is not possible—or meaningful—for site-glazed products. (One possible exception could be site glazing by the manufacturer who tested the product and uses the same materials and methods used when factory glazing.)

All NAFS certification programs require labeling to take place at the manufacturing facility. Site labeling is not permitted except in extenuating circumstances and under special dispensation. The act of applying a label constitutes a declaration by the manufacturer that the product rating is valid because the rating is based on the testing of a production line sample that is identical in every significant way to the labeled product. It presupposes that the manufacturer has control over all the components, fabrication, assembly, and glazing operations, and can assure the purchaser of the labeled quality.

Figure 5 – None of the vertical or sloped glazing products in this photo is within the scope of the North American Fenestration Standard. Tapestry at Wesbrook Village UBC, Vancouver, BC, Canada.

This is only possible for factory-glazed products.

In the case of site-glazed products, they are not generally glazed by the same party that built or tested the product line. What testing exists was likely performed by the system developer some time ago. The fabricator may or may not have access to the detailed test reports or to the detailed fabrication instructions that would be required for the fabricator to attempt to replicate the product as it was tested. The glazier may or may not have access to the same information, but is generally not under the supervision of the party that tested or regularly manufactures and glazes that product. When there is no single party in control of production, testing, and labeling, there is no party with the authority or credibility to apply a label.

NAFS AND COMMERCIAL FENESTRATION: THE BOTTOM LINE

The Code is clear: many commercial fenestration products are outside the scope of the NAFS standard. The Code refers to these products as "site-built" in Part 9. Regardless of whether these products are installed in Part 3 or Part 9 buildings, the Code expects them to be designed to Part 5 as we have always done, and as if NAFS didn't exist.

The Code is also clear that for commercial fenestration products within the scope of NAFS, NAFS testing is permitted to demonstrate compliance with the air-water-structural requirements of the Code in both Part 3 and Part 9 buildings. While the Code permits this, designers need to be aware that NAFS testing is not intended to validate the installation method, and the unfortunate reality is that the standard permits manufacturers to anchor NAFS test specimens in a manner that differs from their usual and published installation practices. It would not be prudent to assume that tested ratings are valid when the test specimen's installation method differs significantly from the installation method to be used at a particular building.

It is also worth considering whether NAFS wind-load resistance testing addresses all the Part 5 structural design and performance requirements applicable to fenestration products on a given building. For many buildings, there will be good reasons to not rely on NAFS testing alone, but to supplement it or even replace it entirely with Part 5 design.

NAFS testing is not without value, however. Conducted properly, with products installed and anchored as they would be installed in the field, it can validate the performance of the product and the installation method, even if that is not the stated intent of NAFS. When products are tested to their limits and beyond, manufacturers can learn a lot about a product's failure modes and improve designs to make them more robust.

With respect to NAFS labeling, it is not possible to label site-glazed products with NAFS performance ratings unless the labeler is the entity that controls the entire manufacturing process, including glazing, and can vouch that the tested performance applies to the labeled production line specimens. But even in this situation, site labeling would not be permitted by a third-party certifier.

On large buildings, it is not always desirable to have labels applied to each product. In this context, there is good reason to accept the manufacturer's reporting of applicable NAFS ratings on the project shop drawings. These will be retained long after labels are gone.

To my mind, the chief value of NAFS testing and labeling is to verify that products comply with the requirements of a performance class, a property critically important to NAFS but of little interest to the code. The ability to compare products on the basis of performance class is the chief innovation in the NAFS standard and one that gives designers a specifiable property they did not have before—a better set of criteria to both prequalify products and evaluate proposed substitutions and claims of equivalency.

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