

The role of third-party window certification in quality assurance and building commissioning

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Synopsis

Third-party certifications can be a commissioning agent's best friend. Because windows have structural, thermal, and durability considerations, it is important to understand the different (and sometimes exclusive) types of testing in order to responsibly value-engineer and site-implement window specifications. Third-party certification programs, especially ones with a labeling component, can free the commissioning agent from the time-consuming process of determining the validity of a manufacturer's claim and subsequent product performance.¹

About the Authors

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Robert J. Pecorella is president of Northern Building Products, Inc., based in Ridgefield, NJ, specializing in commercial and architectural windows. He holds a bachelor's degree in engineering from Princeton University and an MBA from Columbia University. Northern Building Products participates in structural, thermal and insulating glass certification programs.

Brad Schultz is vice president of Associated Laboratories, Inc. based in Dallas, TX. ALI is contracted as the administrator/validator of the AAMA Certification Program for Windows and Doors, and performs the NFRC Inspecting Agency function for AAMA. ALI has its own certification program for sealed insulated glass.

Why Look For Certifications?

Many commissioning agents are most familiar with the energy systems in a building. However, in mainstream construction, life safety requirements (manifested in structural, egress and durability specifications) take priority over energy considerations and it is often assumed that architects, engineers, and code officials will monitor these needs. Yet, if commissioning agents assume the role, "of ensuring, through documented verification, that *all building systems perform interactively* according the documented design intent and the owners operational needs,"² they must be aware that energy systems may potentially conflict with life safety ones. By having a rudimentary knowledge of window certifications, agents should be able to ascertain the type of performance criteria being addressed, if different criteria are in conflict, how the criteria can be better balanced and performance maximized. Understanding labels can facilitate quick evaluation windows upon delivery and provide documentation that applicable specifications have been met. Building owners can save money and hassles when the correct windows are used the first time!

Windows have many requirements to balance. They are arguably the weakest link in the building envelope, yet we could not imagine living in structures without them. Windows connect building occupants with the world outside, they protect against weather and intrusion and they allow escape, rescue, and ventilation. There are a multitude of code requirements that may be applicable in any given situation as well as requirements for above-code programs such as utility rebates and LEED. At times, the way to have higher performance for one criterion can adversely affect the performance of another criterion. Different types of buildings in different locations with different occupancy types and designs will yield different priorities and consequently, different window options. A commissioning agent should look across these different requirements to see which ones take precedent and how appropriate compromises can be made on lesser priorities to have an appropriate balance in the building.

For example, a project may specify that a window that can withstand a high wind pressure per square foot because of location, occupancy, and/or altitude. Commonly, in order to withstand such force, a window needs a large amount of metal in the framing, which will reduce its thermal performance because metal, while very structurally strong, may also be highly conductive. By taking a few moments to check various specifications and plans, the commissioning agent may be able to save the owner operational costs, discovering that a more energy efficient window can be used because the project uses a smaller window (and thus, does not require as much (or any) structural metal). Alternatively, the commissioning agent may find that the project needs a larger expanse of window because of design, egress or natural lighting requirements. If the commissioning agent merely value-engineers for better energy performance without crosschecking requirements, the agent may inadvertently compromise other needs.

Yet, in spite of the numerous situations and problems that can arise in building design, one thing remains constant. A balance must be struck between among the various needs for the building, especially in regard to building codes, mandatory programs, and owner requirements. The right balance is often dictated by location, type of structure, type of construction, type and level of occupancy, and budget. There are a host of standards and test procedures to measure the various aspects of window performance. Many are cited in building codes along with performance

minimums, but codes also allow manufacturers to self-certify. Third-party certification programs, especially ones with a labeling component, are designed to free the building official and, by extension, the commissioning agent, from the time-consuming process of determining the validity of a manufacturers' claim and subsequent product performance.

Look for the Label

In third-party certification programs, products are certified "to the applicable standard through testing of specimens, production facilities are subject to ongoing inspection, and samples are periodically tested to ensure that products conform to the standard, the certification program requirements and the manufacturer's specifications. While certification programs may vary slightly in the use of forms or program requirements, overall each program has four parties to the process...the program administrator, the auditor or inspector, approved laboratory test facilities and--the driving force behind the creation of any certification program-- the manufacturer."³

Many certification programs have a labeling component, indicating whole product performance in a consistent, though compact, way. A unique tracking number should allow the commissioning agent to obtain more detailed information about the certified product, found in an accessible directory maintained by the certifying agency. By matching the label information to the specifications, commissioning agents can ensure their clients are obtaining proper products for the job.

Fenestration Certification Programs

Structure

The first consideration in any construction project has to be safety, not only during construction but also during operation over the life of the building. While early building code concerns centered on fire prevention, protection against other natural disasters such as earthquakes, hurricanes, tornados and floods have made their way into the codes. Codes provide a good starting point as a minimum for life safety. Therefore, it is absolutely necessary to build structures to the local building code. Beyond code is better. In truth, we have no idea what Mother Nature will throw at us next, but thankfully, many mitigation techniques are cross-disciplinary, providing protection under different circumstances. Building codes also cite standards for determining the level of stress and strain a building will experience daily. These performance levels should be contained in the construction specifications, having been calculated by the engineer or architect.

Windows

The cornerstone certification for structural considerations in fenestration products is commonly called "air, water, structural [sic]." This refers to the ANSI/AAMA/NWDA 101.IS.2-97 standard. In a single identifier, called a design pressure (DP) rating, this standard provides performance information for the following:

- Air Infiltration

- Water Penetration
- Structural Wind load
- Forced Entry Resistance

Table 1: Minimum Structural Performance Requirements Listed by Class⁴

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

Each of these characteristics has a corresponding test standard. The 101 standard uses the individual standards to measure threshold limits for each window/door class. Each class has minimum dimensions for each type of window or door and minimum design pressure from which the other characteristic limits are derived. These serve as the 'gateway' into the class.

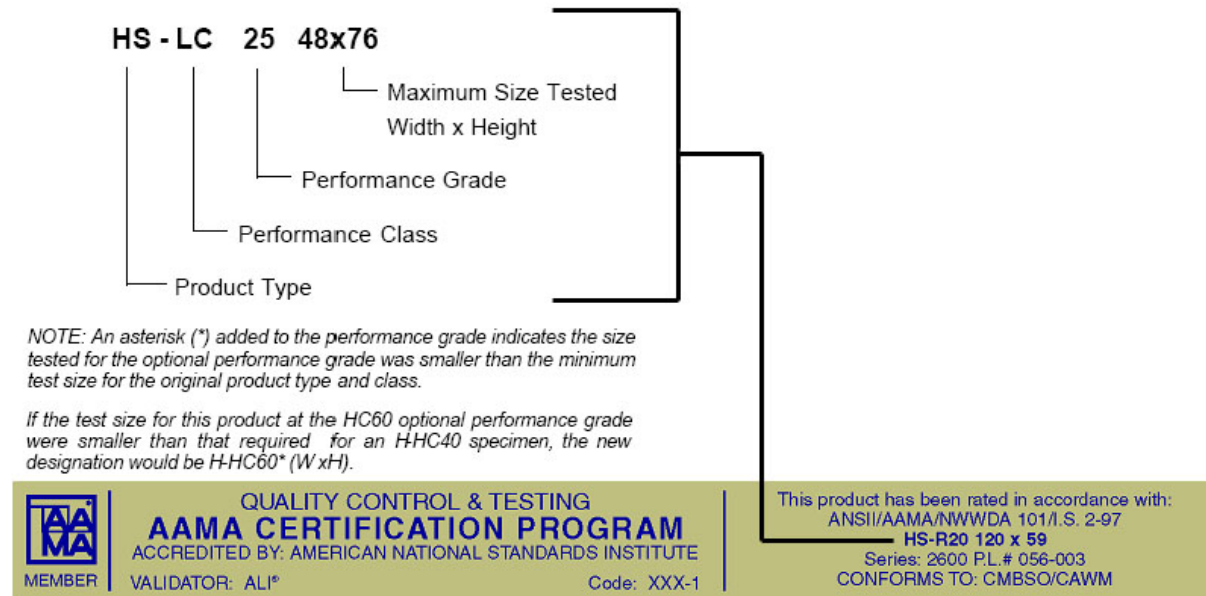


Figure A: AAMA certification label, courtesy of the American Architectural Manufacturers Association.⁶

AA MA		PRODUCT EVALUATION	AA MA																																									
Manufacturer stipulates that these performance ratings were determined in accordance with AAMA procedures and have been verified by test, calculation and affidavit on file with AAMA.																																												
MFG LOGO	AAA Manufacturing Company 3637 S. Smith Rd. Hometown, ST Zcode TEL: (123) 456-7890	For additional product performance information, consult evaluation report # XXXXXXXX which may be obtained from the manufacturer of the product on which this label appears																																										
PRODUCT CERTIFICATION		STRUCTURAL ANALYSIS																																										
Manufacturer's Code: ABC-1 Product/Model #: Series 1957 Wonder Window Certified Design Pressure: 35 psf (DP=35) Forced Entry Resistance Test: ASTM F 588 - 97 Maximum Size Tested: 48" W x 66" H Certified Performance Rating: H - R35 48 x 66 Certified to AAMANNWDA 101/IS. 2 - 97 Tested Glass Thickness & Type: 1/2" Annealed		This product meets the requirements for higher design pressures than the tested design pressure at the following reduced product sizes as verified by structural calculations performed by a registered structural engineer. Calculated mullion deflections do not exceed L/175 for the design pressures indicated.																																										
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OTHER QUALIFICATIONS: This product has been approved by Metro Dade County, Florida for impact resistance at wind speeds up to 120 mph when glazed with laminated glass consisting of two lites of 1/8" glass laminated with 0.062" PVB interlayer.																																												
American Architectural Manufacturers Association, 1827 Walden Office Square, Suite 550, Schaumburg, IL 60173, 847-303-5664																																												

Figure B: AAMA WINS label, courtesy of the American Architectural Manufacturers Association.

The gold label for the American Architectural Manufacturers Association (AAMA) will include the operator type, performance class, performance grade (DP), the size tested and any optimum performance grade variations (see Figure A).⁵ Additional tabs are added to the gold label for optional tests like condensation resistance, impact resistance or acoustical strength. As Table 1 shows, as the classes advance, the requirements to enter the class become more stringent. Moreover, other criteria are added, sometimes depending on the type of window.

It is more important for commissioning agents to have a sense of how and why the structural classes change, rather than actually memorizing class nuances (those can always be looked up). The wind zone in which the building is located, building height, the occupancy type, and the corresponding importance factor often dictates these structural needs. A commissioning agent should know to question why LC40 windows have shown up on the jobsite when C50 windows were ordered (examples to follow later in this paper).

AAMA provides downloadable information to further explain classes and tests and can help the agent determine if the difference is substantive or cosmetic. The International Codes Council can

also provide guidance for agent questions and is a good reference to learn about the latest trends in building safety.

AAMA also developed the Window Inspection and Notification System (WINS) label for building officials in Florida that may be helpful to commissioning agents. This label provides additional detail on an 8 × 11 label. This label should be requested in the specifications, as it is not commonly provided (see Figure B).

Curtain Walls

Storefronts and curtain walls and commercial entrances are separated from traditional windows. (Windows referred to as 'punched openings because they are inserted into an opening in the wall.) They are specifically excluded from the 101/I.S.2 standards in the scope. (However, some persons will use the AW Fixed or AW Operable performance class to rate these products for marketing purposes. This should not be confused with the actual requirements specified.) AAMA 501-05 should be referenced for laboratory testing and simple field water testing for these glazed systems. Field-testing can be done according to AAMA 503-03 for air infiltration, cyclic and static water penetration and should be included in the specification. The testing agent should assume responsibility for ensuring that fenestration system meets the specifications.

Energy

The second consideration is likely to be more familiar to commissioning agents, especially those with their roots in HVAC. These energy performance criteria, commonly called "thermal ratings," are determined by the National Fenestration Rating Council (NFRC) procedures. NFRC certified ratings measure whole window performance so that architects, engineers, building officials and commissioning agents can compare products equally without getting bogged down in glass and framing types. Even better, NFRC ratings can be used with computer simulation tools so that HVAC systems can be sized more accurately and building energy efficiency can be enhanced.

Three ratings are mandatory on every NFRC label with other optional ratings available:

- U-factor measures how well a product prevents heat from escaping. The lower the U-value, the greater a window's resistance to heat flow and the better its insulating value.
- Solar Heat Gain Coefficient (SHGC) measures how well a product blocks heat caused by sunlight. The lower a window's solar heat gain coefficient, the less solar heat it transmits
- Visible Transmittance (VT) measures how much light comes through a product. The higher the VT, the more light is transmitted.
- Air Leakage (AL) is indicated by an air leakage rating expressed as the equivalent cubic feet of air passing through a square foot of window area (cfm/sq ft). NFRC's optional air leakage standard is derived from the same standard as AAMA's air leakage standard in the structural rating.
- Condensation Resistance (CR) measures the ability of a product to resist the formation of condensation on the interior surface of that product. (This rating also has an AAMA counterpart and both are optional ratings in their respective certification programs.⁷)

	World's Best Window Co. Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E Product Type: Vertical Slider	
	ENERGY PERFORMANCE RATINGS	
U-Factor (U.S./I-P) 0.48	Solar Heat Gain Coefficient 0.32	
ADDITIONAL PERFORMANCE RATINGS		
Visible Transmittance 0.51	Air Leakage (U.S./I-P) 0.2	
<small>Manufacturer stipulates that these ratings conform to applicable NFRCC procedures for determining whole product performance. NFRCC ratings are determined for a fixed set of environmental conditions and a specific product size. Consult manufacturer's literature for other product performance information. www.nfrc.org</small>		

Figure B: NFRCC certification label with three mandatory and one optional rating, courtesy of the National Fenestration Rating Council.

Commissioning agents should be aware of the difference in R-value used to describe window performance. For measuring thermal performance, insulating value of any single material is indicated by an R-value. U-value is not merely the inverse of R-value. They are the thermal performance of an assembly with many different R-values. Windows have components of differing thermal characteristics and to assign a single R-value to a product based on only one of those components is misleading and inaccurate.⁸ Additionally, commissioning agents should know that insulating performance for windows rarely exceeds R = 8 and any attempt to use a higher R value in a thermal calculation or for rudimentary comparison is mostly likely a misreported structural rating for a residential class window (see Table 1).

NFRCC offers a certificate option for large projects. Construction clean up costs can be decreased if the certificate option is chosen because the temporary label does not need to be removed from each window.

Curtain Walls

NFRCC offers a certification for fenestration systems that are 'site-built.' See Figure C. While the scope of this paper does not allow opportunity to discuss the specific certification process, it is an option that is becoming more applicable for code compliance. Site-built certification also offers commissioning agents an opportunity to expand their services since the program requires a 'responsible party' that is willing to track system components among the various contractors, testing labs and inspection agencies.

NFRCC is currently developing a component-based whole window certification program that is uniquely suited for the commercial fenestration market. It is expected that this new system will provide better information to professional engineers working on commercial building design and analysis.


<p>NFRC PRODUCT CERTIFICATION PROGRAM</p> <p>NFRC Label Certificate for Site-Built Products</p> <p>Project Location Street Address: _____ City: _____ State: _____ Zip Code: _____ Project Name: _____ Designer: _____ (Optional): _____ (Optional): _____</p> <p>Product Line Information Operator Type (per Table 4-3 of NFRC 100): _____ Product Line ID No. _____ Individual Product ID No. _____ How many of this individual product: _____ Location in building: _____ Elevation drawing page: _____ Fenestration (window & door) schedule page: _____</p> <p>Frame Material Supplier Company name: _____ City: _____ State: _____ Zip Code: _____ Street Address: _____ Contact: _____ Phone: _____ Fax: _____</p> <p>Glazing Material Supplier Company name: _____ City: _____ State: _____ Zip Code: _____ Street Address: _____ Contact: _____ Phone: _____ Fax: _____</p> <p>Glazing Contractor/Installer Comp. name: _____ City: _____ State: _____ Zip Code: _____ Street Address: _____ Contact: _____ Phone: _____ Fax: _____</p> <p>Certification Authorization Independent Certification & Inspection Agency (IA): _____ Date Certification Authorization Issued: _____</p>	 <p>World's Best Window Co. Millennium 2800® Original Invention Double Glazing • Argon Gas Layer Product Type: Window Wall • 82387</p> <table border="1"> <tr> <th colspan="2">ENERGY PERFORMANCE RATINGS</th> </tr> <tr> <td>U-Factor (U.S.A.P.)</td> <td>Solar Heat Gain Coefficient</td> </tr> <tr> <td style="font-size: 1.2em;">0.48</td> <td style="font-size: 1.2em;">0.32</td> </tr> <tr> <th colspan="2">ADDITIONAL PERFORMANCE RATINGS</th> </tr> <tr> <td>Visible Transmittance</td> <td>Air Leakage (U.S.A.P.)</td> </tr> <tr> <td style="font-size: 1.2em;">0.51</td> <td style="font-size: 1.2em;">0.2</td> </tr> </table> <p><small>Reference: requires full-scale single window upgrade (SW) panels to be designed and constructed. All ratings are based on a window or door assembly with a depth of 2 1/4 inches. See the order form for details.</small></p>	ENERGY PERFORMANCE RATINGS		U-Factor (U.S.A.P.)	Solar Heat Gain Coefficient	0.48	0.32	ADDITIONAL PERFORMANCE RATINGS		Visible Transmittance	Air Leakage (U.S.A.P.)	0.51	0.2
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Figure C: NFRC Label Certificate for Site-Built Products, such as Curtain walls and Store Fronts, courtesy of the National Fenestration Rating Council.

Balancing Structural and Thermal Requirements

Commissioning agents know 'value engineering' does not merely mean bringing the project in cheaper. It means maximizing performance potentials across many systems to kill two (or more) birds with one stone. However, in order to do this, careful consideration of consequences needs to be given. Windows are a complicated component of the building envelope because they serve multiple purposes, such as: egress, lighting, ventilation, load transfer, thermal protection, and the like.

As alluded to earlier, thermal performance can have an inverse relationship to structural performance. That is, when a window requires additional structural strength, the most common way to obtain it is to incorporate metal, either as the primary framing material or as reinforcement. Consequently, because metal is a very good thermal conductor and thus has very poor thermal resistance, the U-factor inevitably goes up. When structural performance increases, thermal performance decreases. When thermal performance increases, structural performance decreases (see Figure D).

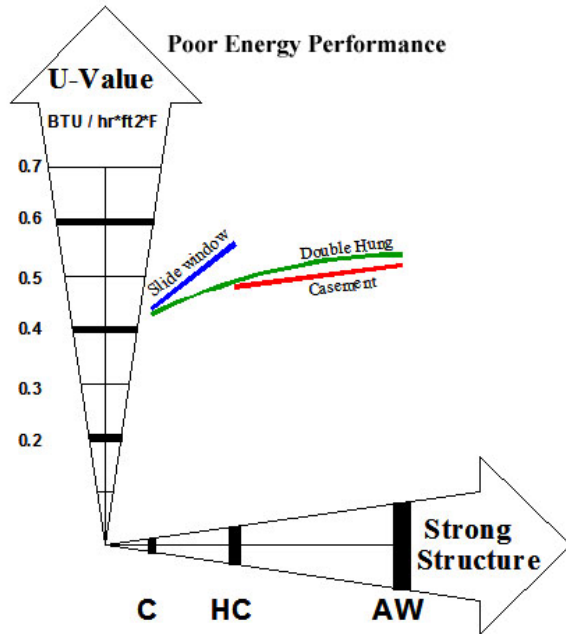


Figure D: Correlation between structural and thermal performance in commercial windows, courtesy of TRACO.

It cannot be stressed enough that cross checking specifications and code requirements is of paramount importance. To illustrate, assume that C40, double hung windows with 0.55 U-factor and 0.38 SHGC were specified but LC40 windows were delivered to four projects: a six-story apartment in Seattle, a four-story office building in Bozeman, a two-story school in Boston and a thirty-story hotel in New York City.

Substituting a LC40 for a C40 may seem reasonable. After all, they are both rated to a design pressure of 40. However, recall that the C40 window is subjected to more pressure per square foot because of the larger gateway size, plus it has an additional water test. Cross-referencing specifications and code requirements would most likely indicate that the substitution was acceptable for a six-story apartment in Seattle, because the wind zone is the lowest in the country. However, this cross-referencing would also show that the U-factor did not meet the energy code, because all residential structures in Washington State are subject to the residential energy code, not the commercial one, regardless of height.

The LC40 might be acceptable for a four-story office building in Bozeman, but it would be smart to cross check the importance factor in the International Building Code against the total occupancy to make sure that the building is not required to build above the minimum. If there is none, it might be prudent to require a lower U-factor for occupant comfort and better energy savings.

In Boston, the commissioning agent might be apt to value-engineer to the LC40 because, in general, there is a more diverse cross-section of thermally efficient materials found in the R and LC classes. After all, it was the right decision in Seattle and Bozeman, plus City-owned properties are required to be LEED-certifiable. However, the C40 would probably be correctly specified for the two-story school. Not only do schools have a higher importance factor because

they serve as secondary shelters in case of emergency, but also because Boston is in a high wind zone. While a low U-factor would certainly help create a more efficient building envelope, there are life-safety issues that must come first. In this case, the agent may find that the specified product is, in fact, the most efficient window for the structural performance required.

In New York City, the thirty-story hotel might have the same occupancy class as the Seattle apartment, but the higher altitude would put the window under additional wind pressures. NYC also has window-to-floor area requirements for natural lighting (a legacy response to turn of the century tenements), so it is possible that the specified window has a very wide span. Because the window is a double hung, an HC40 might be better since that operator type in that class is required to meet a deflection limit equal to the other wall materials. The commissioning agent would then need to look at HC window products to determine if a lower U-factor was available.

Commissioning agents should also check to make sure that the thermal and structural labels for windows match each other with regard to product description. Remember, structural capacity often has an inverse relationship to thermal capacity. As higher structural ratings are met, often windows need additional metal reinforcement, raising U-factor ratings. If a product is described as being reinforced for structural certification, the thermal certification should also be for the reinforced product. It is unknown how likely or common it is that manufacturers certify with one agency for a low U-factor without reinforcement and another agency for higher structural ratings with reinforcement. AAMA, the Window and Door Manufacturers Association (WDMA), FMA/Keystone Certification and National Accreditation and Management Institute, Inc. (NAMI) certify for both structural and thermal performance. Often they inspect for both programs at the same time, cross referencing to insure consistency.

Insulating Glass

Another critical, but less visible, certification is for insulating glass (IG) units. It is hard to believe that insulated windows have only been used in the mainstream since the early 1980s. Energy performance continues to improve as low-E coatings, gas fills and warm edge spacers become more widely used. Again, commissioning agents are aware of the importance of systems integration. The same applies to insulating glass units. As more technologies make their way into IG units, quality assurance and attention to detail in the manufacturing process is of paramount importance to ensuring optimum unit performance.

The Insulating Glass Manufacturers Alliance (IGMA) provides IG certification in North America for:

- weathering cycling, used to simulate changes from hot to cold extremes with moisture added during the hot cycle and UV radiation.
- high humidity, where moisture is forced into the hermitically sealed cavity of the IG unit.
- volatile fog determination, used to show that the components in an insulating glass unit will not out-gas a volatile fog, which could result in a deposit on the interior glass surfaces. (The test uses UV radiation and elevated temperatures to accelerate the effects.)
- Initial gas fill (argon), to test the IG fabricators ability to fill to a known amount, typically 90% initial gas fill

The testing simulates a 20-year duration. Certified products are identified by a permanent certification marked imprinted or stamped on the spacer bar and visible to the end user, with:

- Identification of manufacturer
- IGMA trademark
- location of production facility
- year of manufacture

This information can be used to identify the product in the IGMA Certified Products in the Certified Products Directory (CPD). Effective January 1, 2005, the IGMA Certification Program is administered by the Insulating Glass Certification Council (IGCC).

Recommended To Do List

- Become more familiar with labeling options for windows
- Download free materials from certification programs
- Specify the types of labels you want to see on-site in the bid documents for the corresponding performance criteria (AAMA Gold label or equivalent and WINS for structural; NFRC label, label certificate or site-built certification for thermal, IGMA or equivalent for IG)
- Make sure labeled product shows up on site
- Cross check products with specifications AND other window certification programs

Acknowledgements

The authors of this paper gratefully acknowledge the American Architectural Manufacturers Association, the National Fenestration Rating Council and the Insulating Glass Manufacturers Alliance for granting permission to use their existing educational materials liberally.

Endnotes

1. There are numerous for-profit or non-profit third-party certification programs available for fenestrations. Due to the limited space, the authors have opted to focus on the ALI programs since they are administered in conjunction with the non-profit associations that developed the corresponding standards for structural (ANSI/AAMA/NWWDA 101.IS.2), thermal (NFRC 100, NFRC 200) and IG (ASTM E 2190) certifications. While other certifying agencies administer one or two programs based on structural, thermal and IG standards, the National Accreditation and Management Institute, Inc. (NAMI) is the only other program to offer all three certifications.
2. Participants in the first National Conference on Building Commissioning.
3. Webb, Margaret. US Glass, Volume 40, Issue 2. Available at <<http://www.usglassmag.com/backissues/Feb2005/Certification%20for%20Dummies.html>>
4. Lewis, Dean. American Architectural Manufacturers Association. 2003. Presentation to the Building Officials Association of Florida.
5. This paper cites the 97 standard. The structural standard has been updated twice as part of harmonization efforts with Canada. The 02 version is commonly referred to as NAFS-02 (as the North American Fenestration Standard) and the 05 version is commonly called A440.
6. American Architectural Manufacturers Association. 2005. "ANSI/AAMA/NWWDA 101/I.S.2 – 97: EXCERPT EDITION Product Designations (Product Types, Performance Classes & Grades), and Gateway Performance Requirements." Available at <<http://www.aamanet.org/upload/CMB-3.pdf>>
76. National Fenestration Rating Council. 2005. "Fenestration Facts." Available at <<http://nfrc.org/fenestrationfacts.aspx>>
8. In fact, NFRC has its origins as a response to Department of Energy and Federal Trade Commission pressure to create a fair and credible way to evaluate thermal performance in windows. National Fenestration Rating Council. 200e. "NFRC Behind the Glass." Available at <<http://nfrc.thecornerstonepros.com/documents/NFRC%20History.pdf>>

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