Fenestration foundations for building envelope performance

Empowering Trust®

Introduction

Fenestration product testing and certification can be a challenging hurdle to overcome, all before your windows, doors or skylights even have the chance to enter the market. If you don't start out on the right path, the requirements, rules and regulations of the industry can make your journey more difficult. The methods for testing and evaluating fenestration performance comes from the building codes of your product's intended region.

When incorporating fenestration products into a building envelope design, there are many aspects of performance to consider, such as security to aid against intrusion, resistance to water penetration, air leakage and wind load resistance. Aesthetics also play an important role in the design function for an architect or building owner, but building performance, security and appropriate installation are the critical roles.

Additional considerations are performance against debris impacts (for hurricane-prone regions), thermal issues, acoustics and many more. Fortunately, there are many ways to help ensure proper performance of these products throughout the design and in-service life cycle. Scientific testing is one of the most effective ways to verify and validate future performance and expedite time to market.

Why is it important to test and certify your building envelope products?

Many municipalities' laws, codes and regulations require certain building products and systems to be tested and evaluated before they can be installed in a jurisdiction. A product can be tested and may not necessarily be third-party certified. Being third-party certified means the product has been evaluated, complies with the requirements of the third-party organization and is manufactured under a quality control program with third-party inspections/ follow-up service. Some companies choose to certify with a third-party to minimize the safety risk that may be associated with their products.

The three phases of fenestration product testing

Fenestration and building envelope products can be analyzed and tested well before purchase and installation. They can also be tested during the installation phase on the building itself, and field tested once the building has been occupied and is in use. These three phases of testing can provide greater assurance of achieving long-term performance within the building envelope when these products are properly specified and considered.

PHASES OF TESTING

1

Products tested in the laboratory

- Windows, doors, curtain walls, louvers, skylights
- Verify the product's ability to perform under weather conditions
- Product is tested to building codes and market requirements

2

Pre-construction mock-up testing of exterior wall systems

- Exterior wall systems including windows, doors, curtain walls, concrete, steel, brick, glazing and sealants
- Verified to meet the requirements of the architect to determine that the system will meet requirements and materials will work together

3

Installed windows tested in the field

- Windows, doors, curtain walls and glazing after installation
- Verify proper installation and air and water tightness

Performance requirements

Building codes and owner specifications usually form the foundation of performance requirements and test methods for fenestration products used within the building envelope. In some cases, such as Secured by Design (SBD) in the United Kingdom, the police force also has its own requirements.

In the United States, the International Code Council (ICC) through the model codes, such as the International Building Code (IBC) (Chapter 17), or the International Residential Code (IRC) (Chapter 6), requires window and door assemblies be tested and labeled as conforming to the North American Fenestration Specification, otherwise known as NAFS (AAMA/WDMA/CSA 101/I.S.2/A440). This specification outlines laboratory performance requirements for water penetration resistance, air leakage resistance and wind load resistance for windows, doors, and skylights in the United States and Canada. Doors are allowed by code to perform to NAFS, however, an exception exists that they only have to be structurally tested, if applicable.

Industry standard specifications for fenestration products differ by region and regulation body. UL has the global and regional expertise to help you on your pathway to testing and certification.

NAFS identifies how these products are to perform and/or be rated. Standards development organizations (SDOs), such as the American Society for Testing and Materials (ASTM) and American Architectural Manufacturers Association (AAMA), typically establish the test methods to evaluate laboratory, mock-up and field performance.

The National Building Code of Canada (NBC) within Part 5 and Part 9 requires that windows, doors and skylights only be tested, not labeled, to the requirements in NAFS as well as CSA A440S1 (Canadian supplement).

In the U.K., Conformité Européenne (CE) marking is mandatory, and the Construction Products Regulation (CPR), as well as the National House-Building Council (NHBC) and SBD, determines performance.

Test methods

Laboratory testing

Building science laboratories that test fenestration and building envelope products are busy with air cycling experiments, water exposure simulations and lumber impacts. These tests determine whether the fenestration products and design will perform once installed in a building and exposed to outside conditions like wind, rain, natural weather events, heat, cold and even flying debris.

Laboratory tests measure certain material properties, component and system durability and performance, as well as methods of assembly and installation.

- Material testing is usually considered since these properties will play a role in the final component or assembly performance.
- Assembly or component testing in the laboratory helps to provide a better understanding of product design and performance, but full system tests are still recommended for a more complete assessment

System tests can be conducted on full-size prototypes, comprising both fenestration elements and portions of an exterior wall, to determine the performance of the full system assembly before construction and installation.

For results and conclusions to be accepted as compliant, an accredited laboratory must conduct the testing according to standard procedures. Accreditation is an official recognition and acknowledgment that an organization is competent to conduct conformity assessments and to determine whether products, services or systems meet applicable standards.

Choosing an accredited laboratory

When choosing an accredited testing and certification laboratory, you want to ensure this laboratory is capable of providing you with dependable and accurate test results. Aside from technical competence, a few other factors include:

- Independent and nonbiased evaluation
- Qualified, well trained, knowledgeable staff
- Proper sampling practices
- Correct testing procedures
- State-of-the-art testing facilities
- Properly calibrated and maintained equipment
- Quality assurance procedures
- Accurate recording and reporting procedures

"Based upon my experience having been in labs all across the country, the UL lab is state-of-the-art. It has the equipment, the people, the overhead cranes and access to Chicago. It has everything you need to test any type of building."

Mark Meshulam, owner of Chicago Window Expert Consultancy

The following test methods and standards evaluate mock-up performance:

- Air leakage to ASTM E283
- Water penetration under static air pressure to ASTM E331
- Water penetration using dynamic pressure to AAMA 501.1
- Vertical inter-story movements to AAMA 501.7
- Structural performance to ASTM E330
- Seismic and wind-induced inter-story drifts to AAMA 501.4
- Thermal cycling to AAMA 501.5
- Seismic drift causing glass fallout testing to AAMA 501.6
- Acoustical performance to AAMA 1801

Preconstruction mock-up testing

Before installing the first window or door, or laying the first bricks or blocks of a carefully considered architectural design, a preconstruction mock-up test is a valuable means to evaluate air resistance, water resistance, structural integrity, and even thermal performance of fenestration and curtain-walls. Evaluation results help validate installation, design, workmanship and material selection of the complete envelope system.

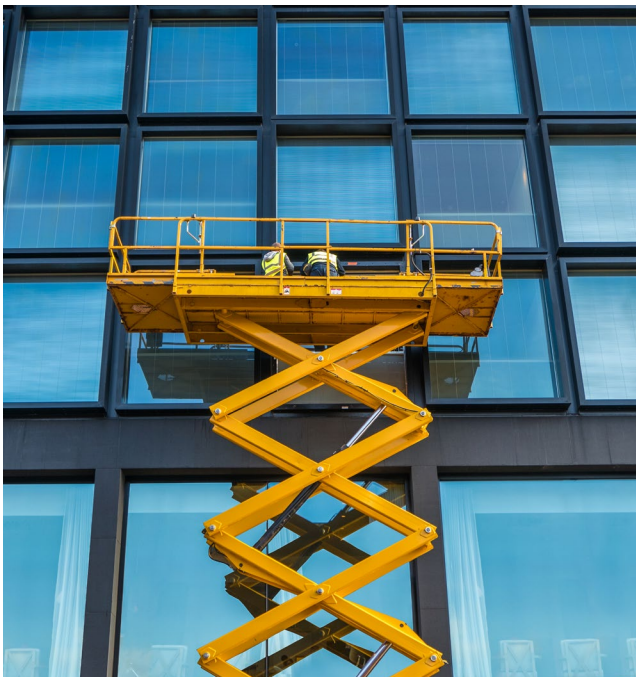
Preconstruction mock-up testing allows building owners, architects, consultants and manufacturers to represent the actual elements that will be used in the final work, as well as focus on specific areas such as the fenestration system compatibility to the wall interface. This testing also allows the actual contractors to install and become familiar with the products, as well as the methods of installation.

Before testing a mock-up, the owners, building consultants and contractors must discuss design and installation details, since this crucial information defines the mock-up construction. This information will also be used to document any remedial changes to the design or installation during the testing phase, as well as during actual construction.

As laboratory and field testing is required to be conducted by an accredited laboratory, it is also important that mock-up testing is completed by an independent AAMA approved testing agency, ensuring the laboratory is experienced with the required tests and approved by the owner.

Field testing

Too often we see promising material, product and component designs do well under laboratory testing, only to have difficulties when installed and in service within the final building envelope. Field testing validates the performance and compliance of building envelope systems and assemblies during and after installation, confirms quality of workmanship, and helps reduce future risk.



The most common problems are attributed to excessive air leakage and water intrusion, often due to the interface with the adjacent wall construction and the envelope's ability to perform as an integrated system. While laboratory testing demonstrates individual product performance, it does not always allow for a complete understanding of how the product will perform in combination with transitions or other integrally connected wall components. These interfaces are often the most critical elements of the individual product installation and may not have been fully validated by limited testing in the laboratory.

Actual field testing of fenestration products and their interaction with the building envelope can illustrate how the building will function as an integrated system while identifying sources of problems and providing information on how to mitigate or remediate those problems. It also helps to assure the building owners, contractors and architects that the products perform as expected after they have been installed.

When considering field testing, it is important to identify the areas that are most representative of the building design, as well as including critical interface connections of fenestration products with the building envelope wall assembly. Field testing can also be conducted at different stages of construction, or even years after in-service use.

Summary and conclusion

The building code requirements and methods of testing for evaluating fenestration performance and the interaction these products have within the building envelope can be determined in multiple ways. Three primary methods used today are:

1. Laboratory testing on representative samples of manufactured products
2. Full mock-up testing within the laboratory or at the job site
3. Evaluating performance after installation in the field as a quality control measure

Whatever method is used, it is helpful to understand the full requirements of the specification and standardized testing methods. It may make sense to enlist experts who are familiar with the process and conduct building envelope testing daily.

Assessment and evaluation are key to the overall building performance, so it is important to remember the following:

- Work with an accredited testing agency to evaluate the performance of the fenestration and wall systems that form part of the building envelope.
- Mock-up evaluations can provide quality assurance and an opportunity to remediate design changes before full construction.
- Field testing is part of a quality control measure on installed fenestration products within the building envelope and can provide a more complete assessment of the overall construction.

Why trust UL

UL offers the complete package of building envelope testing. We maintain a global network of technical experts, state-of-the-art test facilities, and long-standing relationships with the design and construction community, regulatory authorities, industry technical leaders, trade associations, and universities. Knowledge from this network helps manufacturers gain the compliance credentials they need to compete in a complex global supply chain. It also supports the design and construction community to assess and verify building envelope products, systems and structures before, during and after construction.

For more information, contact BuildingEnvelope@ul.com or visit UL.com/BuildingEnvelope

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