WINDOW RECEPTOR FRAMES IN 2018:

More Than Just Accessories

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Figure 2 – Window unit installed in sill receptor.

INTRODUCTION

Window receptor frame assemblies (*Figures 1* and *2*), also referred to as “subframes” or—in the context of the sill condition, “subsills” or “starter sills”—have had a relatively enduring history in the aluminum-framed fenestration industry. In 2007, *RCI Interface* published “Window Receptor Frames: What You Need to Know,”[1] which examined the general advantages, disadvantages, and common challenges associated with receptor frames. In the 11 years since that publication, these authors have observed continued utilization of receptor frames in new commercial construction, particularly in high-rise multifamily buildings. Designers continue to specify receptor frames to benefit from their inherent features, including water management and accommodation of building structural deflection. Window installers often continue to exhibit a preference for receptor frames, given their ability to facilitate the window installation process—in particular, accommodation of construction tolerances.

The range of outcomes experienced by project teams on window receptor frame projects remains relatively wide. Some projects proceed smoothly, delivering on performance expectations in a timely and cost-effective manner. Other projects experience setbacks related to air infiltration or water penetration resistance problems during or after construction. These occur particularly when the performance attributes of the receptor components are overlooked or not coordinated with the window product and surrounding construction, and the receptors are underestimated as merely accessories to the window units.

Figure 1 – Window head receptor prior to installation of window unit.

This article complements the 2007 article previously mentioned by providing the following:

- An updated compilation of provisions in window standards and select institutional specifications relating to receptor frames, including commentary by the authors;
- A case study illustrating shortcomings in industry norms with regard to performance testing of window receptor frames; and
- Recommendations for industry housekeeping to bring receptor frame assemblies more in line with the fenestration units they retain.

INDUSTRY STANDARDS UPDATE

Outside of product-specific installation instructions, design and construction teams have limited published literature to guide the development and execution of window design when receptors are included. The industry resources that do exist are dispersed among several window standards and specifications. This section consolidates provisions pertinent to window receptor frames and provides related commentary from the authors.

AAMA/WDMA/CSA101/I.S.2/A440-17

AAMA/WDMA/CSA101/I.S.2/A440-17, *North American Fenestration Standard/Specification for Windows, Doors, and Skylights*[2] (AAMA 101), has, since 1985, been the building enclosure industry's basis for establishing window product evaluation and certification standards. Specifically, AAMA 101 stipulates laboratory test procedures with which the performance rating and performance expectations for a window product are generated. A performance rating applies only to individual window units, not to a series of individual windows mulled together within a receptor frame.[3] With regard to receptor frames, the current AAMA 101-17 includes the following:

- **Appendix A3:** Under the Window Wall definition, AAMA 101 states that receptor systems "can be designed as part of drainage and movement accommodation provisions." This definition was added in AAMA 101-11 (2011), subsequent to *RCI Interface's* 2007 "Window Receptor Frames."
- **Para. 9.2.1 Test Specimen Requirements – General:** AAMA 101 states that "Each specimen to be tested shall be a completely assembled, glazed, and functional product (including hardware)."

Appendix A3 now acknowledges the performance features that design professionals have come to seek from receptor frames. In the authors' opinion, Para. 9.2.1, with its use of "completely assembled" and "functional," leaves room for interpretation that the air infiltration/water penetration testing methodology that establishes a performance rating should include the window receptor frame, where one is present. Based on the general scarcity of window manufacturers' testing data that include receptor frames, we observe that few manufacturers interpret this provision in this manner.

AAMA 450-10

AAMA 450-10, *Voluntary Performance Rating Method for Mulled Fenestration Assemblies*,[4] describes procedures and requirements for determining the air infiltration, water penetration resistance, and

Figure 3 – Field-mulled window assembly.

structural performance of field-mulled fenestration assemblies. Field-mulled fenestration assemblies (*Figure 3*) are defined in AAMA 101 as formed by a combination of two or more separate fenestration products whose frames are mulled together, utilizing a combination mullion or reinforcing mullion. Products seeking qualification through AAMA 450 must first have satisfied the minimum requirements of AAMA 101. AAMA 450 does not explicitly mention receptor frames.

Despite the lack of a direct window receptor reference, AAMA 450 includes fundamental parallels that make it relevant to receptor frames. Primarily, AAMA 450, as the name implies, is a voluntary standard. Since receptor frames (particularly head receptors and sill receptors) are frequently used in mulled window assemblies, the voluntary nature of AAMA 450 implicitly authorizes the foregoing testing and rating of the complete mulled fenestration assembly, including applications where the mulled assembly is captured in a receptor frame.

AAMA 502-12

AAMA 502-12, *Voluntary Specification for Field Testing of Newly Installed Fenestration Products*,[5] establishes a method to evaluate the installed performance of fenestration products for air leakage resistance and water penetration resistance under reproducible conditions (*Figure 4*). This standard is a routine construction-phase requirement in contemporary project specifications for windows on commercial projects. With regard to receptor systems, the current AAMA 502-12 has changed since AAMA 502-02,[6] which was contemporaneous with *RCI Interface's* 2007 "Window Receptor Frames" publication.

AAMA 502-12 includes the following:

- **Para. 3.2 – Test Chamber Arrangement:** AAMA 502-12 mandates that the test specimen include window receptors, stating, "The test chamber shall be attached and sealed to the wall/roof construction in such a manner as to create a pressure differential across the entire specimen (including subframe/receptor and/or panning) and the perimeter seals."

Contrasting with AAMA 502-12, AAMA 502-02 included the following:

- **Para 2.0 – Test Methods:** This section provided two test methods, Method A and Method B, that differed in their location of the test specimen perimeter and consequently whether the specimen captured the window receptor, when present. Method A was a test of the window product alone; the receptor frame was not tested under pressure. AAMA 502-02 noted that the receptor frame limitation of Method A should be clearly understood by the project stakeholders. To partially compensate for this limitation, Method A featured an Optional Sill Dam Test, in which the testing party applied (by plugging the receptor weeps) a static water head height in inches (0.192 multiplied by the specified test pressure in psf) into the sill receptor while monitoring the specimen for water penetration through the receptor frame. Method B configured the test chamber to include the receptor frame and perimeter seals of the fenestration assembly, similar to the mandate in AAMA 502-12.

The development between AAMA 502-02 and 502-12 that now mandates inclusion of the sill receptor in field performance testing is an improvement with regard to limiting risks to project stakeholders. There remains a disparity between the fact that AAMA 101,

Figure 4 – AAMA 502 test in progress.

which establishes a window performance rating, does not clearly require the inclusion of receptors in laboratory testing, but the field testing standard AAMA 502-12 now does.

ASTM E2112-18

ASTM E2112-18, *Standard Practice for Installation of Exterior Windows, Doors, and Skylights*,[7] provides technical guidance related to the installation of fenestration units on low-rise residential and light commercial structures. With regard to receptor systems, the standard notes the following:

- **Para. 3.2.130:** ASTM E2112 defines a "subsill" as "a separate framing member that, when installed on the underside of a sill, becomes an integral part of the sill."
- **Para. 5.16 – Pan Flashing Systems and Subsills for Weatherability:** ASTM E2112 notes, "The height of the pan shall be appropriate for the fenestration product being installed, according to manufacturer's instructions or the advice of the design professional. To determine the minimum height requirements for the interior height of the pan flashing, refer to Annex 3."
- **Annex A3.1 – Determining Interior Leg Heights:** The annex includes Table A3.1, which provides a water height and corresponding minimum leg height for the pan flashing/subsill for several water test pressures and design pressures. The annex states, "The pan flashing height represents the known rise of a vertical column of water with an unsealed pressure differential (plus ⅛ in. for a frame-leveling allowance)."
- **Para. 5.16.3 – Use of Pan Flashings, Note 16:** ASTM E2112 states, "Pan flashings may not be applicable for certain installations, for example...window receptors..."

ASTM E2112 implicitly acknowledges the relationship between the receptor and the window assembly as "integral." Additionally, the standard notes that the height of the receptor's vertical back leg should be coordinated with the window product. Also, despite the standard's statement that pan flashings "may not be applicable" to receptor frame systems, our experience is that since receptor frames rely heavily on sealants, they have inherent vulnerabilities that warrant complementing the sill receptor with a durable sill pan flashing system in most applications. Additionally, regardless of whether the window design includes a pan flashing system below the sill receptor, we note that the air/water barrier of the surrounding opaque wall assembly must be flashed into the rough opening and integrated with the window product with accessory materials (e.g., flexible sheet membranes and sealants).

UNIFIED FACILITIES CRITERIA (UFC)

Unified Facilities Criteria (UFC) documents provide planning, design, and construction criteria required for all United States Department of Defense (DOD) facilities (e.g., U.S. military departments and the defense agencies). The DOD portfolio of facilities consists of several hundred thousand buildings and structures. The UFC documents include technical specifications referred to as Unified Facilities Guide Specifications (UFGS). UFGS Section 08-51-13 (dated May 2011)[8] relates to aluminum windows and includes the following related to receptor frames:

- **Section 2.3.8 Accessories:** This section is the only location within the UFGS aluminum window document that references receptor frames: "Provide windows complete with necessary hardware, fastenings, clips, fins, anchors, glazing beads and other appurtenances necessary for complete installation and proper operation. [If applicable], furnish extruded aluminum subframe receptors and subsill with each window unit."

We note that the only place UFGS Section 08-51-13 mentions receptor frames is in the accessories provision, alongside other appurtenances. We suggest that this and similar methods of specifying receptor frames promote an unintended association of the receptors as an appendage, rather than an element with a direct relationship to performance of the overall window assembly.

Figure 5 – Remedial sill receptor with upturned back leg extension.

CASE STUDY

The following case study illustrates the relatively common occurrence of a project team learning of a receptor-related performance shortcoming only after construction had begun.

The authors provided building enclosure consulting services on a mixed-use development that included a multifamily high-rise component. The design for fenestration systems typically included window products in a window wall application. The window wall assemblies were designed to be retained in head, jamb, and sill receptor frames. The project specifications defined the performance criteria for the window to resist water penetration at 12 psf differential pressure. The submitted window product was rated under AAMA-101 to meet those performance criteria. However, as of the commencement of window installation, the sill receptor had not been demonstrably tested in conjunction with the window product at a differential pressure that met or exceeded the specified performance criteria.

After the windows had been ordered and shipped, and approximately one-fifth of the window units had been installed, the team learned the sill receptor would require field modifications to achieve the window system rating required by the project specifications. The upturned back leg of the installed sill receptor was not tall enough to resist the rise of a vertical column of water produced by the design pressure in the absence of a continuous air seal between the receptor and window frame that extended to the jamb of the rough opening. Such air seal continuity is notoriously challenging to achieve, especially in the context of mulled windows; and in this case, the continuity was unknown, given the "blind" (i.e., concealed by window components) response of the sealant during the setting of the window frame extrusion into the receptor raceway. The contractor therefore made a remedial modification to the sill receptor on every window on the building to increase the vertical back leg of the sill receptor height at the sill-to-jamb corners and corner mullions with a discrete aluminum extension. The extensions were sealed in place with gun-grade sealant applied from the interior (*Figure 5*).

This project setback had the following consequences:

- The performance of the windows on the overall project is now more dependent on workmanship-sensitive details, given the field-installed remedial nature of the work. If the performance incompatibility between the window product and the receptor had been identified before the construction phase, a factory component (e.g., receptor with a continuous, taller back dam) could have been provided, making the ability for the window installation to meet the specified performance criteria readily reproducible and without undue reliance on field-applied sealants.
- The sequence of the window installation was such that an interior trim piece covered the remedial extension immediately following installation, making it difficult for the project team to perform quality assurance measures related to the remedial work.
- Subsequent windows required additional validation testing and the associated effort from the entire team as a response to the in-situ remediation. Most of the project windows will never be tested to validate the performance of the in-situ remediation.

RECOMMENDATIONS AND INDUSTRY HOUSEKEEPING

Some window standards have begun to acknowledge window receptor frames and their relationship to water penetration resistance of the window assembly, but overall, the building enclosure industry has developed only minimally since 2007 in the context of understanding and avoiding receptor-related performance pitfalls. Though receptor frames are not a new technology, many project teams do not learn that a receptor frame assembly does not meet the specified performance standards until the construction phase is underway, when remedial options are costly and time consuming, and options for technical adjustments to the window system are limited. At the same time, although it is reasonable for a building owner to expect that their investment in a window assembly is buying them a level of factory-manufactured performance that meets or exceeds specified performance requirements, we find that project stakeholders are often surprised—unfortunately late in the construction process and especially when project teams forego project-specific mock-up testing—that the windows they purchased need to receive relatively impromptu applications of sealant in the field to enable the window assemblies to pass performance tests. With that said, we recommend the following to bring receptor frame assemblies more in line with the fenestration units they retain:

- Designers should carefully specify and enforce a competent fenestration performance testing program.[9]
- Like the AAMA-502 field tests, AAMA-101 should be updated to

require that window receptor frames are laboratory tested/rated with the window products retained by the receptor. If window manufacturers determine that it is not feasible to test every possible combination of window products with and without receptors, at a minimum, AAMA 101 should be updated to clarify that where receptors are utilized, their performance attributes (e.g., height of the vertical back leg of the sill receptor) shall be coordinated with the window product. Additionally, lacking laboratory testing with the receptors, designers should specify project-specific laboratory validation testing that includes the receptors as part of the submittal phase.

- AAMA 450 should be updated to require that window receptor frames are laboratory tested with the mulled window products retained by the receptor. Window manufacturers should design their receptor systems to meet the stated performance level of the window product retained, as it is not the consumer's expectation that the overall window assembly would have varied performance criteria between the window and receptor frame.
- Designers should specify, and building owners should enforce the implementation of project-specific mock-up testing (on site or in an appropriate fabrication shop/laboratory) that includes the surrounding window conditions (rough opening, air/water/vapor barriers, flashings, and sealants) well before wholesale installation of fenestration systems begins on the building.
- Given the unpredictability of continuous air seals between window-sill/jamb receptors and the window product when the sealant is installed in a blind manner, we recommend that designers specify a gasketed or positively installed (i.e., from the interior side of the window after the window product is set into the receptor) continuous air seal that is able to be subjected to quality assurance review. With the same logic, receptor frames at the windowsill should be designed with a height that is calculated to exceed the rise of a vertical column of water produced by the design-level wind pressure.
- Since receptor frames include inherent vulnerabilities, given their reliance on gun-grade sealants and the associated workmanship sensitivity, projects seeking a very low-risk profile should include a durable watertight sill pan flashing system to complement the sill receptor. Care must be taken to coordinate attachment provisions of the sill receptor with the sill pan flashing to avoid compromising the watertight integrity and performance of the sill pan flashing system (e.g., avoid fasteners that extend down directly through the horizontal leg of the sill pan flashing).
- The Optional Sill Dam test included in AAMA 502-02 was a valuable and easy-to-perform quality control measure and should be reincorporated as an option in future versions of AAMA 502.
- UFGS specification developers (and similar entities that produce institutional specifications regarding commercial window requirements) should consider rephrasing the receptor-related text in UFGS Section 08-51-13 to clarify that window sill receptors, given their direct relationship to water penetration resistance of the window assembly, shall be tested in the same manner as the window product.

The authors anticipate that if the steps above are adopted more rigorously by the building enclosure industry, and if window receptor frames are given the respect they deserve, the industry will see a reduction in the frequency of unnecessary project setbacks related to window assemblies with receptors.

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OSHA's Use of Drones for Building Inspections Raises Concerns

The Occupational Safety and Health Administration (OSHA) has authorized its inspectors to use camera-equipped unmanned aircraft systems (UAS or drones) to collect evidence during inspections—with the consent of the employer. OSHA guidance states that inspectors must "obtain express consent from the employer" before operating a drone for inspection purposes over a workplace. OSHA says that if it is notified of an objection by the employer, it will not fly the drone.

During 2018, OSHA used drones on at least nine inspections—most frequently following accidents at worksites that were considered too dangerous for OSHA inspectors to enter.

Some employers have expressed fear that OSHA's use of drones has the potential to expand its violation-finding capabilities during such inspections. OSHA can cite employers for violations that are in plain sight.

OSHA has also revealed that it is exploring the option of obtaining a Blanket Public Certificate of Waiver or Authorization (COA) from the Federal Aviation Administration (FAA) to operate drones nationwide. If it is granted such permission, it is unclear whether the agency's policy requiring employer permission will survive.

Attorneys have advised that if an employer decides to consent to OSHA's request to employ a drone, they should consider reaching an agreement with the agency to include the specific flight plan and agree that all photos will be promptly shared and to have an authorized representative observe the drone's operation.

Another concern is an employee's Fourth Amendment right to object to the expansion of an overbroad inspection. The Fourth Amendment prohibits unreasonable searches and seizures.

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