
Development of Industry Guidelines for Standard Practice of Fenestration Product Installation

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ABSTRACT

The requirements set out in building codes in the U.S. oblige window and door manufacturers to provide guidance on the installation of fenestration products, which includes proper integration with the building envelope. Historically, installation standards in the U.S. such as the ASTM E2112 Installation Practice for Window, Doors and Skylights and AAMA Installation Masters™ did not adequately address the wide variety of window and wall construction styles or the impact of exposure level on the installation methodology (2007). In addition, these standards are not written in a format that is user friendly for field-use, as might be required of a general contractor or builder when providing instructions to a window or door installer. To address this need, the three major fenestration industry organizations in the U.S., the Fenestration Manufacturers Association (FMA), the American Architectural Manufacturers Association (AAMA), and the Window and Door Manufacturing Association (WDMA), formed a joint committee to develop a series of illustrated, step-by-step installation guidelines for windows and doors in specific wall configurations, initially focusing on extreme wind and rain exposure conditions particular to the southeastern U.S. Representative installations from each standard practice were installed by committee members and tested to extreme exposure conditions using ASTM fenestration performance standards. Key discoveries were made as to the effectiveness and practicality of the methods that influenced the content of the guidelines. This paper provides details of the work of the FMA, AAMA, and WDMA installation committee in the development of guidelines for standard practices in the U.S. that have been published and also offers a brief summary of the future plans of this committee.

INTRODUCTION

The building envelope is defined by the American Society for Materials and Testing (ASTM) as the boundary or barrier separating the interior volume of a building from the outside environment (ASTM 2006). As such, the building envelope is the primary air and water protection to the building interior as well as the moisture sensitive components of the wall system. Thus, great attention must be given to ensure that the building envelope features continuous, redundant air and water protection consisting of durable materials applied with robust water-management principles and attention to workmanship detail. Water penetration through the building envelope, particularly with a building envelope discontinuity, can result in catastrophic damage to the building, especially if the water is not

properly managed through drainage to the exterior. There is no more prevalent or complex building envelope discontinuity than creating a large hole in the building envelope containing an item made up of highly complex and variable materials, such as a window or door (fenestration product). The interface between the fenestration product and the wall is recognized as the one of the most problematic areas for water intrusion into the building envelope (RDH 2002). Adding to this concern is the fact that the installation of fenestration products into walls features a vast set of considerations key to the proper integration with the building envelope. These considerations include the following:

- The fenestration product attachment system (integral flange frontal location, integral flange nonfrontal location,

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field applied flange, box-frame with jamb fasteners, brick mold casing, etc.);

- The fenestration product material of construction (vinyl, wood, aluminum, fiberglass, composite), which greatly impacts the structural and thermal performance of the building envelope integration;
- The flashing system used for integration (self-adhered, mechanically attached, liquid applied, among other types of flashing);
- The type of wall system (wood framed, concrete block, metal frame/commercial, open stud, insulated concrete forms, among others), as well as the wall dimensions/depth;
- The exterior cladding system (vinyl or wood composite siding, brick, various stucco finishes including direct applied, 3-coat, and exterior insulated finishing system, among others);
- The use of exterior insulating materials, such as foam plastic insulated sheathing, to comply with increasing energy code requirements;
- The anticipated environmental exposure of the installed product, including thermal cycles, wind driven rain and dust;
- Regional and local building practices;
- Continuity of the drainage plane at wall to window/door interface;
- Differential movement, based on the material variations noted above.

Each of the considerations listed above have the potential to significantly impact the air, structural, and moisture performance of the installed fenestration product and the building envelope. This does not consider the case of replacement of existing fenestration products, which adds an additional level of complexity of how to manage around the existing fenestration product frame, cladding when not removed, interior finish, and building envelope integration.

Consequently, the task for the fenestration product installer to achieve consistent performance with this multitude of installation variations is extremely challenging. In order for the fenestration industry to provide goodness to installers, one could propose to develop a comprehensive list of prescriptive installation details based on a matrix of the above considerations, but this is not, from a logistical point of view, possible. It was subsequently decided by the industry representatives to take two alternative approaches to resolve such concerns. Specifically:

1. Develop guiding principles for installation that can be applied generically to any combination of the above installation considerations;
2. Develop guidelines for specific combinations of fenestration/wall systems in given environmental exposure conditions, aiming to address specific common practices of most concern to the installers.

The first approach was initiated through a task group of the ASTM E06.51.11 committee responsible for the ASTM E2112 (2007) installation standard. This study will focus on approach number two through the work of the Fenestration Manufacturers Association (FMA), the American Architectural Manufacturers Association (AAMA), and the Window and Door Manufacturing Association (WDMA) installation committee to develop guidelines specific to windows and doors installed in wood frame and surface barrier concrete masonry unit (CMU) construction with extreme exposure to wind and water loads, which is typical of southeastern U.S. residential buildings.

STANDARD PRACTICES FOR EXTREME EXPOSURE IN THE FLORIDA WALL

After the extreme hurricane season in Florida in 2004, widespread water damage in residential buildings was reported, particularly through the rough openings of fenestration products (Lstiburek 2005). To address this concern, the Florida Building Commission called upon the fenestration industry to develop robust standard practices to enhance the water-management capabilities for the installation of fenestration products into residential construction common to Florida and the Gulf Coast. The FMA took on this challenge and formed the FMA installation committee. Soon after, as a means of enhancing consensus in the fenestration industry, the AAMA and then the WDMA joined the effort, and the FMA/AAMA/WDMA Installation Committee was officially formed.

In order to initiate the development of installation standard practices for the southeastern U.S. region, the considerations previously noted above needed to be carefully evaluated. The original FMA installation committee recognized the unique characteristics of residential construction common to the southeastern U.S. and the challenges associated with these types of wall systems. Specifically, whereas some parts of the region build with standard wood frame construction, there is also a tendency to build residential homes from CMU. To further complicate matters, as shown in Figure 1, it is quite common for two-story residential structures to feature both types of walls, with wood frame construction installed on the second floor on top of a CMU wall. While the façade system for these buildings is predominantly stucco, the application of the stucco is dramatically different in the two-wall systems. In the case of wood frame construction, the stucco is applied on a lath with a WRB (water-resistant barrier plane behind the stucco, creating a standard-membrane drainage wall system. However, for the CMU walls, the stucco is directly applied onto the CMU with no drainage plane, thus creating a surface-barrier mass wall system. The combination of a drainage wall installed on top of a surface-barrier mass wall creates a challenging environment in order to maintain building-envelope protection. Given that the scope of this effort is to focus on the fenestration product integration with the building envelope and not the interaction between the two-wall systems, the FMA Installation committee decided the best approach was to consider the wood frame construction

separate from the surface-barrier CMU and develop independent practices for each of these wall systems.

However, of importance is the fact that the FMA/AAMA/WDMA installation committee set forth common features for all wall types. First, in all standard practices, representative installations are to be water tested according to either the standard test method given in ASTM E331 (2009) or that of E547 (2009) up to 575 Pa (12 lb/ft²) pressure differential in order to simulate extreme exposure conditions, as installed by those developing the guideline. This practice has proven to be highly valuable in not only testing the effectiveness of the water management of the installations, but also in evaluating the practicality of the installation method—i.e., is this installation one that a typical installer is likely to undertake? Second, all standard practices contain a set of related issues that provide valuable guidance to any installer, such as principles for continuity between the fenestration product and the building envelope/drainage plane, sealant selection and application, and compatibility concerns. And third, all standard practices include an Appendix that provides guidance as to trade responsibilities for the various steps covered in the documents. These common features provide reality-based, valuable information to the installer for any fenestration product installation system.

Wood Frame Construction Exposed to Extreme Wind and Water Exposure

The first wall system addressed by the original FMA installation committee was wood frame construction exposed to extreme wind and water loads. There are two distinct standard practices published for this type of wall system, one focused exclusively for windows (FMA/AAMA-100, *Standard Practice for the Installation of Windows with Flanges or Mounting Fins in Wood Frame Construction for Extreme Wind/Water Exposure*) (2012) and the other focused exclusively on

doors (FMA/AAMA/WDMA-300, *Standard Practice for the Installation of Exterior Doors in Wood Frame Construction*) (2012). The attributes of both these practices are as follows.

FMA/AAMA 100 (2012). Whereas the well known ASTM E2112, *Standard Practice for the Installation of Exterior Windows, Doors and Skylights* provides a wealth of essential information to guide a design professional or general contractor for the proper installation of fenestration products, it is not presented in a user friendly format that can be given to an installer to follow step-by-step illustrated instructions (2007). This, in addition to the need to address extreme exposure considerations, as noted above, became a primary objective for the development of these FMA standard practices. As such, the installation committee set forth to make the FMA/AAMA 100 document a brief, yet detailed guide for specific window systems (flanged or mounting fins) subjected to specific exposure conditions (e.g., extreme wind and water) in wood framed construction having exterior wood sheathing panels (e.g., not open stud) (2012). While the original emphasis was on the Gulf Coast/Florida region, it was considered that other climates with similar attributes, such as the coastal Pacific Northwest, may benefit from these installation principles. Because the scope of this guidelines is to address extreme wind and water exposure, preventative measures were taken that are above normal installation practices, such as those referenced in ASTM E2112 (2007).

What were the preventative measures that were taken that are above normal installation practices? First and foremost, the committee focused on implementing the principle of robust water-management protection through the practical application of a drainable installation. This, as was learned through the water testing of representative installations for both the FMA/AAMA 100 (2012) and FMA/AAMA/WDMA 300 (2012) standard practices, is not as simple as installing sill pan flashing, as recommended for all installations in ASTM E2112, Section 5.16.3 (2007). As will be described below in more detail, two key observations will be highlighted that were obtained from results of wall testing and that aid in the practical application of drainable installations for protection to extreme exposure conditions:

1. Taking steps to prevent incidental water intrusion under extreme exposure that could migrate behind the WRB due to penetrations, fasteners, or cladding attachment and may migrate into the window rough opening.
2. It is critical that the perimeter interior air and water seal between the fenestration product and the sill-pan flashing is able to withstand the anticipated pressure differential without air and water leakage.

Preventative Measure Number 1: WRB Wrap Methods for Resisting Exposure to Extreme Wind and Water Loads. Results from wall testing for water intrusion of representative installations for FMA/AAMA/WDMA 300 (2012) differed than that which was reported for FMA/AAMA 100 (2012) testing as summarized in an earlier publication



Figure 1 Typical two-story residential construction in southeastern U.S./Florida.

(Katsaros 2007), in that vinyl siding cladding was applied to the wall, creating numerous unsealed penetrations into the WRB. It was found that at water-test pressure differentials roughly above the typical threshold for standard windows and doors in residential applications (e.g., 300 Pa [6.24 lb/ft²]), which corresponds to a design pressure 45 rated window, water intrusion through the cladding fasteners could penetrate into the rough opening behind the WRB (note: air barrier performance considerations of the WRB were not taken into account). Although this was considered out of scope of the fenestration product installation itself, which focused on the integration of the fenestration product with the WRB and drainage plane, this observation was considered of consequence to address in the FMA/AAMA 100 (2012) and FMA/AAMA/WDMA 300 (2012) documents.

As such, given the extreme exposure scope of these documents, it was recommended that the underside of the WRB be sealed at the rough opening according to three prescribed methods that provide protection beyond that described in standard installation practices such as ASTM E2112 (2007) or the AAMA Installation Masters™ course (2004–2010). These three methods are illustrated as follows:

WRB Method A. This method is similar to what is often done in commercial construction in the U.S., where the WRB is cut around the perimeter of the rough opening and sealed with self-adhered flashing. The detailed steps with illustrations taken from FMA/AAMA 100 (2012) include: cut the WRB flush at the rough-opening perimeter (Figure 2), and seal the WRB to the rough opening with the application of 100 or 150 mm (4 or 6 in.) self-adhered flashing between the jamb corner at the head, such that self-adhered flashing covers 50 mm (2 in.) on the

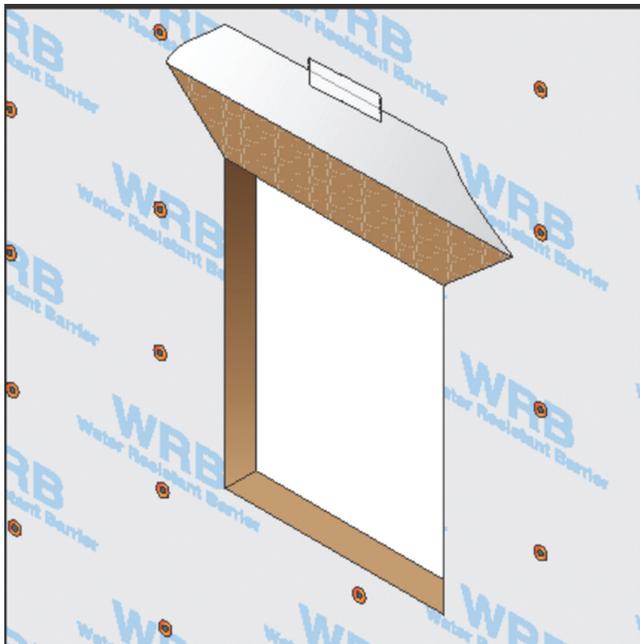


Figure 2 WRB wrap method A, step 1.

WRB as well as into the rough opening return at least to the depth of the window (Figure 3). Apply sealant at jamb/head interface (Figure 3). See Schematic 1 for jamb detail.

WRB Method B. This method (for use with mounting flanged windows only) treats the side jambs of the window in the same fashion as the head, where the WRB is cut away and then integrated after the window is installed and the flashing is applied. This is also a modified wrap after the WRB method, as described in ASTM E2112 (2007). The detailed steps from FMA/AAMA 100 (2012) include: cut the WRB flush at the rough-opening perimeter, and make a cut onto the face of the wall at each jamb corner and fold back the jamb as with head flap, ensuring that the jamb cuts at the sill are angled upwards (Figure 4). After the window is installed, apply sealant along the jamb and bring over the previously-folded WRB jamb flap

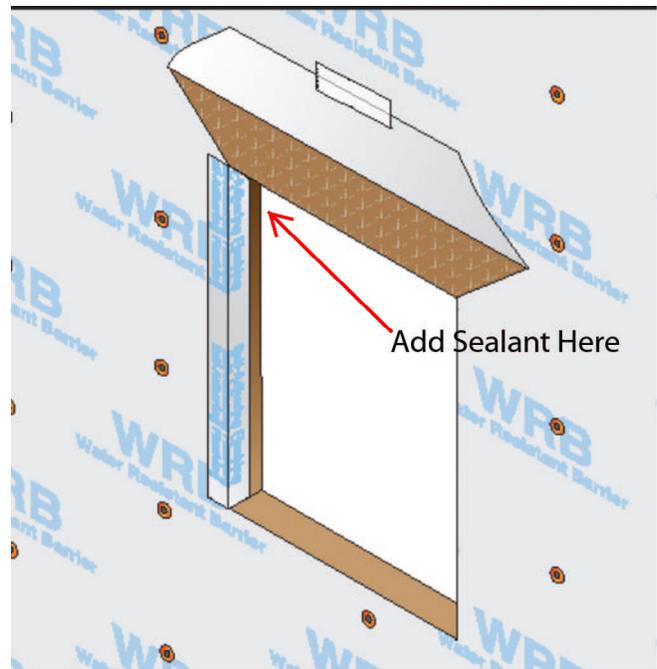
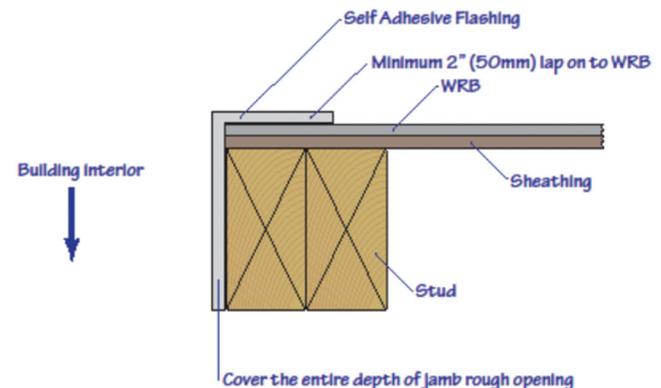


Figure 3 WRB wrap method A, step 2



Schematic 1 Top view: WRB wrap method A.

allowing it to integrate with the sheathing window frame (Figures 5a and 5b). Press down on sealant bead under the WRB. Integrate the WRB to the window with sheathing tape or self-adhering flashing. See Schematic 2 for jamb detail.

WRB Method C. This method is very similar to the standard WRB wrap methods described in ASTM E2112, except that sealant is applied under the WRB at the exterior side jambs (2007). The detailed steps from FMA/AAMA 100 (2012)

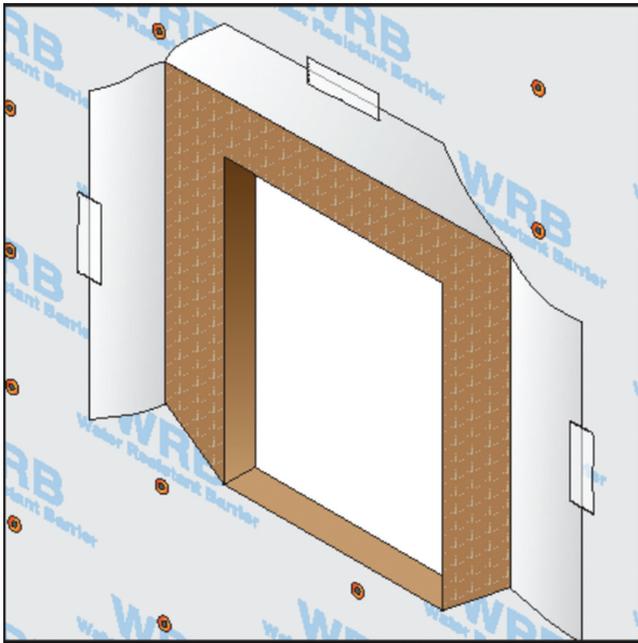


Figure 4 Wrap method B, step 1.



Figure 5a Wrap method B, step 2a.

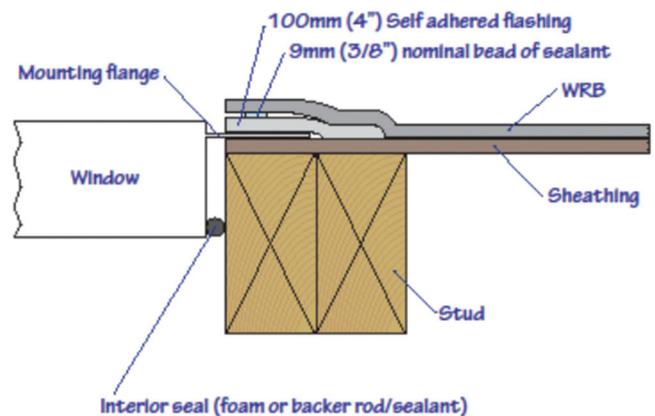
include: cut the WRB in an I-cut (Figure 6a) or modified I-cut (Figure 6b), apply sealant onto sheathing under WRB at jambs (Figure 7), and wrap into cavity and secure (Figure 8). Attach the WRB into position on the inside of the rough opening and trim any excess as required (Figure 9). Press down on sealant bead below WRB. See Schematic 3 for jamb detail.

Extreme Exposure WRB Wrap Methods—Summary.

Note that in the three methods described above, only the side jambs of the rough opening differ from the standard WRB wrap methods described in ASTM E2112 (the head and sill details are the same in each case) (2007). Thus, these methods describe the situation where the exterior wind pressure is high enough to drive incidental water through fastener penetrations in the WRB and horizontally into the rough opening. This pressure thus



Figure 5b Wrap method B, step 2b.



Schematic 2 WRB wrap method B.

helps define what is extreme and justifies the extra preventative measures above normal practices. Representative installations for all three extreme exposure WRB wrap methods were successfully tested (which will be explained in more detail for the FMA/AAMA/WDMA 300 testing for doors) up to 575 Pa (12 lb/ft²) of pressure differential, which correspond to level 1 hurricane force winds, as installed by members of the FMA/AAMA/WDMA Installation Committee (2012).

Preventative Measure Number 2: Interior Air/Water Seal. A drainable installation of a fenestration product is one that enables an exit path for any water intrusion that could occur either through the fenestration product itself (such as joinery, welds, and seams), or by entering the rough-opening cavity from the interior wall or building exterior. If not properly managed or drained, as with a nondrainable or barrier installation, such water intrusion will tend to collect and be

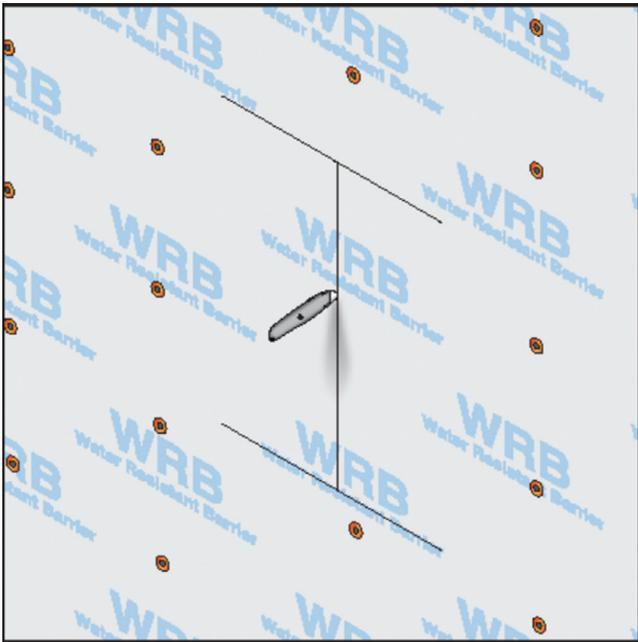


Figure 6a WRB wrap method C, step 1.

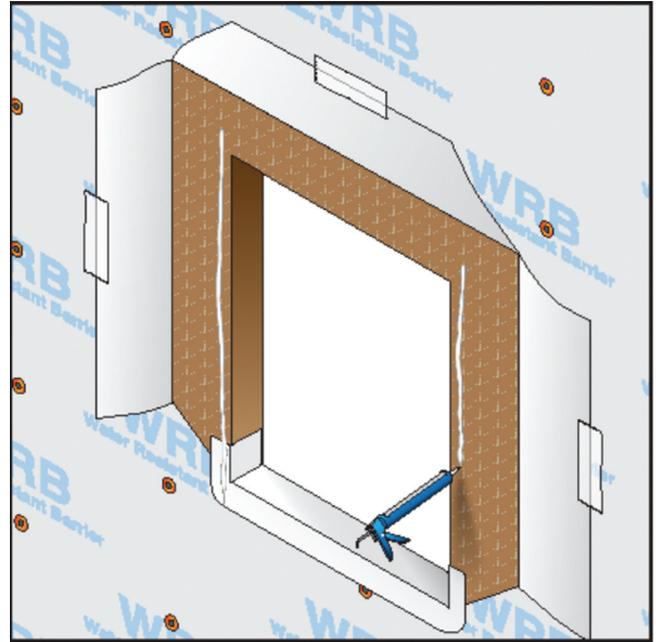


Figure 7 WRB wrap method C, step 2.

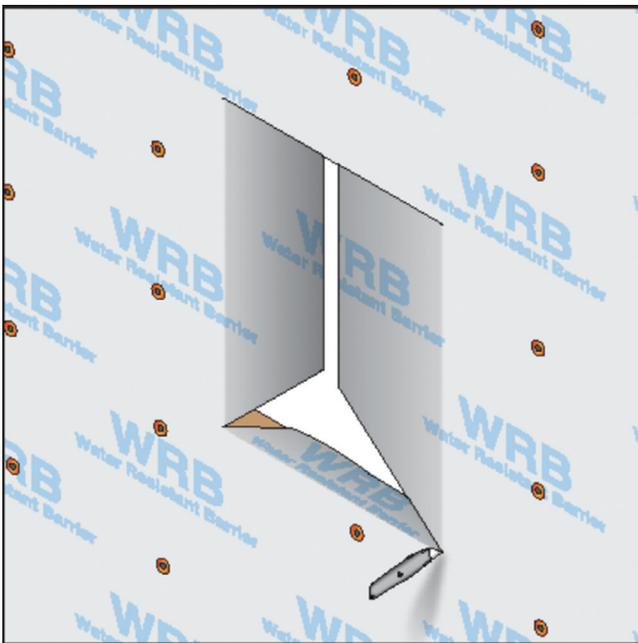


Figure 6b WRB wrap method C, step 1 alternative.

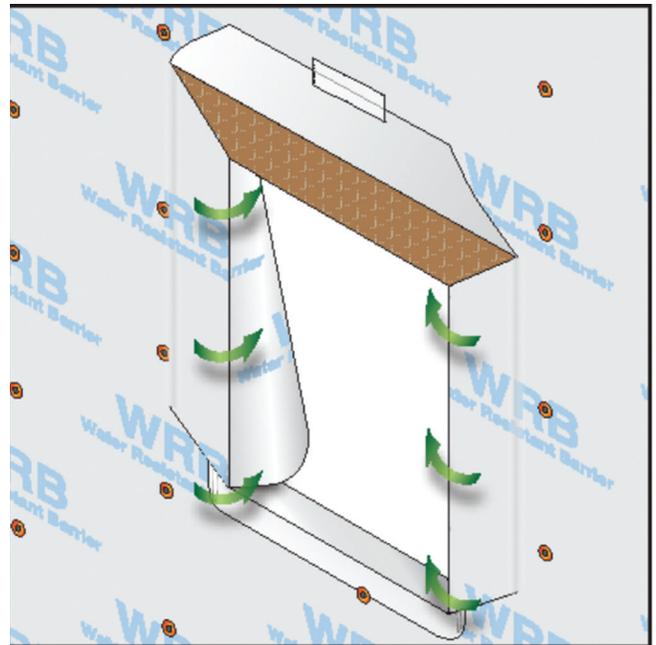


Figure 8 WRB wrap method C, step 3.

trapped at the sill corner of the rough opening, which is a leading cause of water damage in buildings (Figures 10 and 11). Note that while water damage at the sill of the rough opening is often perceived to be caused by a window leak, the source of the intrusion is often unrelated to the fenestration product. However, water intrusion may find its way to the sill of the rough opening due to a disruption in the continuity of the building envelope and thus be associated as a fenestration product water intrusion concern.

In the case of extreme exposure conditions, where the risk of water intrusion is greater than normal, the drainable installation option is mandated according to that given in FMA/AAMA 100 (2012). An essential feature that defines a drainable installation for a fenestration product is to maintain an unhindered exit path for any incidental water intrusion into the cavity of the rough opening. As illustrated in the schematic in Figure 12, taken from ASTM E2112, the drainable installation has three critical features (2007):

1. The application of durable, waterproof sill-pan flashing (either rigid or self-adhered flashing is acceptable) below the sill of the fenestration product,
2. Leaving drainage openings in the sealant bead below the sill flange of the window (FMA/AAMA 100 [2012] requires a minimum of two 50 mm (2 in.) openings within 100mm (4 in.) of each side jamb),
3. Application of a perimeter air and water seal around the interior perimeter of the gap between the fenestration product and WRB or rough opening.

A drainable installation adds complexity to the window installation when compared to a traditional full barrier installation (which features a continuous bead of sealant around entire exterior perimeter of fenestration product attachment), but the system is far more forgiving to water intrusion into the rough opening. As such, a second key element that was understood

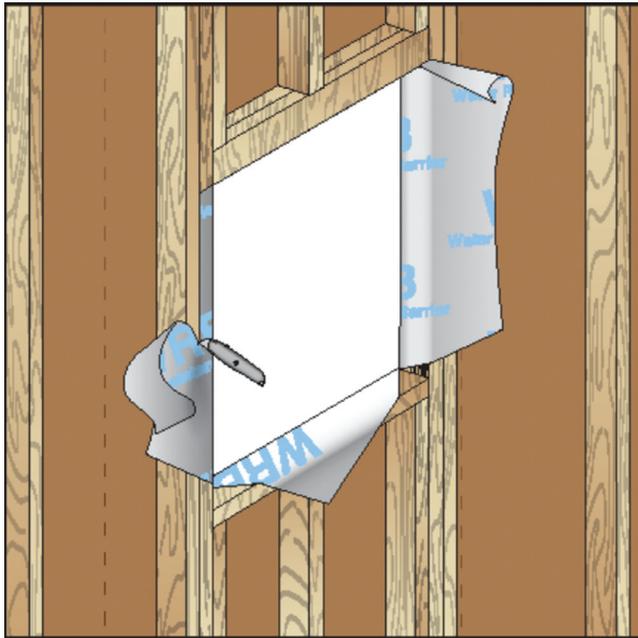
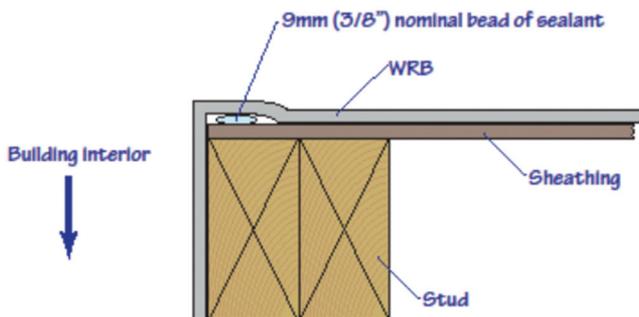


Figure 9 WRB wrap method C, step 4.



Schematic 3 WRB wrap method C.



APA photo

Figure 10 Moisture damage at window sill.



Figure 11 Moisture damage near window/wall interface.

from the results of representative wall testing undertaken for FMA/AAMA 100 (2012) and FMA/AAMA/WDMA 300 (2012) is that the interior seal (critical feature number 3 noted above) can often be the most complex and problematic preventative measure for extreme wind and water-exposure conditions. Achieving this continuous air and water seal around this perimeter can be challenging due to obstructive features of the installation, such as shims and anchors (Figure 13). In addition, even small dimensional variability can lead to irregularities in the gap distance between the fenestration product and the interior perimeter of the rough opening. As such, it is difficult to use standard air and water-seal materials such as foam backer rod or low expansion foam to continuously seal the rough-opening perimeter. Any discontinuity in the interior perimeter gap that results from these obstructions will increase the potential for air and water intrusion. Furthermore, even if there are no obstructions or irregularities in the gap, achieving an adequate sealant bond between the fenestration product and the sill flashing, WRB, and rough-opening cavity is critical, as well as careful workmanship in the application and tooling of the sealant. As was discovered in the FMA/AAMA 100 (2012) and FMA/AAMA/WDMA 300 (2012) wall testing, even tiny pin hole gaps under extreme exposure conditions could lead to water intrusion for drainable installations. As such, both documents make the following statement:

To ensure adequate protection against extreme wind-driven water, it is critical that the perimeter interior air and water seal between the window and the sill-pan flashing is able to withstand this pressure load without air and water leakage. Special caution needs to be used

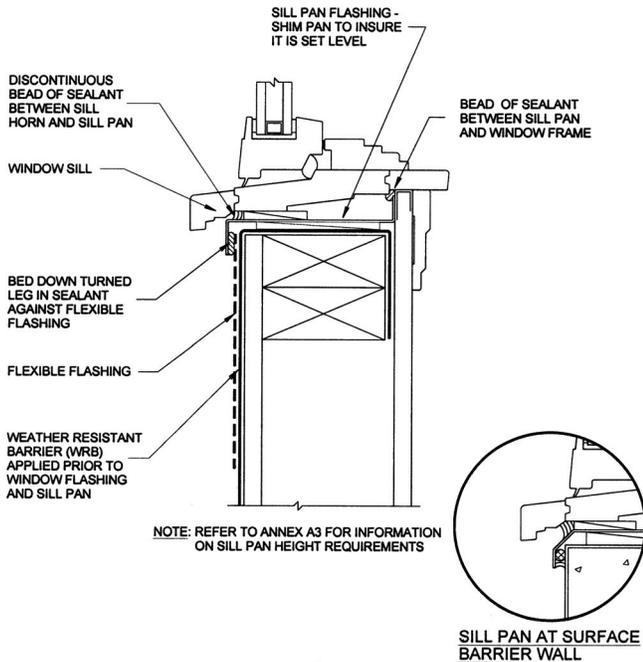


Figure 12 Taken from ASTM E2112, Standard Practice for Installation of Exterior Windows, Doors and Skylights. Figure 15.

when applying perimeter air and water seals to the interior corners (FMA/AAMA 100 [2012] Section 7.7.3).

Results from testing representative wall installations for FMA/AAMA 100 (2012) were provided in an earlier publication by Katsaros (2007).

FMA/AAMA/WDMA 300 (2012). A related document to FMA/AAMA 100 (2012) is FMA/AAMA/WDMA 300 (2012), for which the installation of doors subjected to extreme exposure conditions is addressed (note that WDMA joined the effort after the original window document was completed, for which there was a corresponding change in the document notation). There are two key differences between the FMA/AAMA 100 (2012) and FMA/AAMA/WDMA 300 (2012) documents. One is that three different attachment systems are addressed: mounting flanges (Section 7.6 per Figure 14), exterior casing/brick molding (Section 7.7 per Figure 15), and box frame/nonflanged (Section 7.8 per Figure 16). While these attachment systems can be found in window units, particularly with box frame in heavy commercial buildings, it is more common in residential buildings to find brick mold casing and box frame system with doors. However, the guidance provided in FMA/AAMA/WDMA 300 for these types of door systems can be applicable for any fenestration products (2012).

A second important difference between information provided in the FMA/AAMA/WDMA 300 (2012) and FMA/AAMA 100 (2012) guidelines is the sill detail. In the FMA/AAMA/WDMA 300 (2012) guideline, sill details for three types of flooring are described: wood floor (Figure 17), concrete flat/slab on grade (Figure 18), and concrete recessed

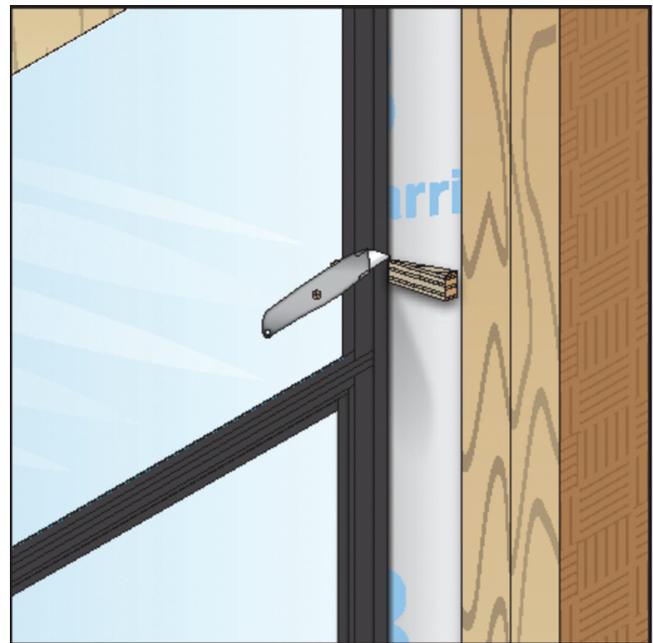


Figure 13 Removal of potential obstruction to interior air/water seal.

(Figure 19). For doors installed into a wood floor, the detail differs from the FMA/AAMA 100 guideline for windows in that a rigid sill pan with raised-leg back dam is utilized (2012). For concrete floors, both flat and recessed, a liquid-applied flashing is illustrated to prevent absorption of liquid water in the sill of the rough opening; although, a rigid sill pan can be used in these floor systems as well.

Each type of door mounting-flange system and sill detail were successfully tested for water intrusion up to 575 Pa (12 lb/ft²) pressure differential as installed by members of the FMA/AAMA/WDMA Installation Committee. Unlike the FMA/AAMA 100 (2012) testing reported in Katsaros (2007), these installations included the application of vinyl siding. The key findings from this testing led to the preventative measures described in the previous section.

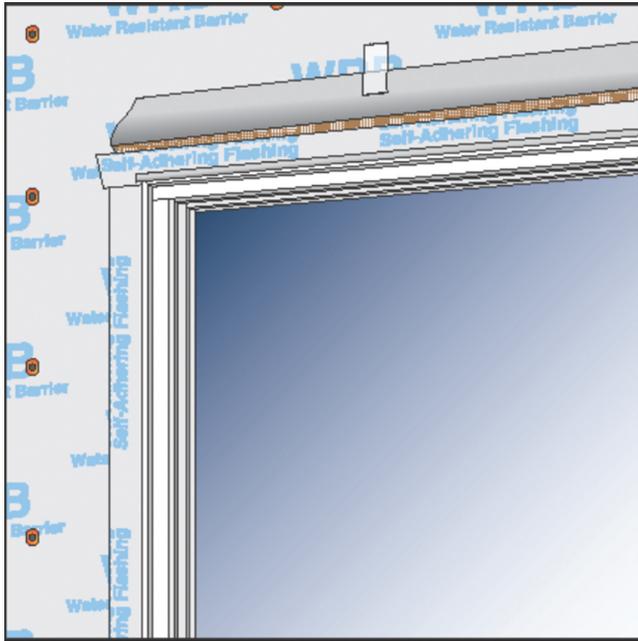


Figure 14 Mounting-flange door installation step.



Figure 16 Box-frame door-installation step.



Figure 15 Brick mold/exterior casing door-installation step.

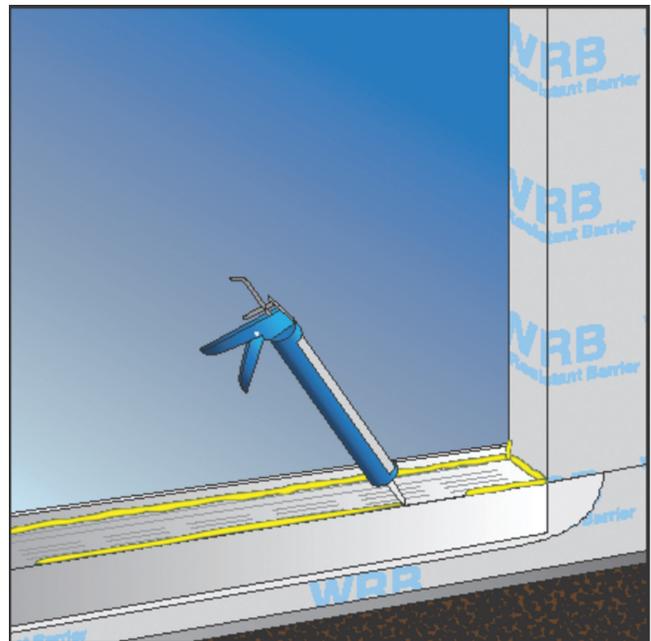


Figure 17 Sill detail for wood-floor door installation.

SURFACE-BARRIER CMU WALLS IN EXTREME EXPOSURE

The original FMA installation committee took on the challenge of developing a window installation guideline specific for surface barrier wall systems having direct-applied stucco, wall systems common to the southeastern U.S. In this system, a concrete masonry block wall typically incorporating



Figure 18 Sill detail for level-concrete sill-door installation.



Figure 19 Sill detail for recessed-concrete sill-door installation

a precast concrete sill at the window openings (Figure 20) is finished with a layer of stucco that is directly applied to the CMU (Figure 21) and thereafter covered with a water resistant acrylic coating (Figure 22).

The water-management strategy for this wall system is completely different than for the membrane drainage wood



Figure 20 CMU wall with precast sill for residential construction.



Figure 21 Direct-applied stucco on CMU wall.

frame wall system described in FMA/AAMA 100 (2012) and FMA/AAMA/WDMA 300 (2012), as well as other installation guidelines such as ASTM E2112 (2007). In this case, the first line of defense against water intrusion is the acrylic coating, which typically has to be applied in several layers to effectively seal through the inevitable cracks that form in the stucco finish. As noted in the report by Lstiburek, “Highly textured surfaces are almost impossible to coat in a manner to seal microcracks” (2005). This report goes on to note:

The nature of stucco application, materials, and substrates make it impossible to construct crack free monolithic stucco renderings—in other words, shrinkage cracks and settlement cracks are to be expected. Based on the field observations, it is our belief that it is not possible to construct stucco assemblies without cracks. It is also our belief that paint coating systems—even the high build coatings—are unable to span the typical stucco cracks encountered, both from initial drying and from subsequent settlement (Lstiburek 2005).

Based on the above findings, it is expected that this surface-barrier CMU wall construction will encounter water intrusion through the exterior surface. In addition, since this CMU wall will often have a wood frame wall incorporating a drainage plane and sheathing membrane installed above it, drainage from the wall above is another possible source of water intrusion into this mass wall.



Figure 22 Acrylic finish on direct-applied stucco CMU wall.

So what happens to the water that gets into the CMU mass wall? For the most part, liquid water will be absorbed through cracks in the stucco into the masonry and will be driven into the building interior from heat derived from external exposure to this hot/humid climate. This moisture driven to the interior will be removed by the building HVAC system, adding to the HVAC loads, assuming there is no vapor barrier installed on the inside of the wall, such as foil-faced insulation in which case it will condense causing moisture along the interior of the building wall. When the moisture content exceeds the storage capacity of the CMU, it will flow down through the wall by gravity to the concrete floor where it is expected to be directed to the exterior by flashing located at the intersection between the wall and floor. To summarize, the water-management strategy for the direct-applied stucco surface barrier building envelope contains the following key features:

1. Use of the storage capacity of the masonry wall to contain moisture ingress;
2. Rely on HVAC to manage inward driven moisture given conditions of a hot and humid climate; and
3. Drain excess moisture out the bottom of the wall.

The common practice to prevent this moisture intrusion in this region is to fill cracks in the stucco and joints with paint or sealant (need to do this at least twice); although, Lstiburek found this to be an ineffective means of controlling surface moisture (2005).

Given that the scope of this study is extreme exposure of fenestration installations to wind and water loads, item number three above, “drain excess moisture to the bottom of the wall,” is the focus of further evaluation. This exit path for excess moisture is only suitable when there are no obstructions in the wall, or if there is a possible breach of the building envelope. As illustrated in Figure 23, excess liquid water in a CMU wall that drains through a continuous set of CMU blocks can escape at the bottom of the wall, but what happens when it finds a large opening in the wall, such as at a window or door? Water that reaches the head of the rough opening will either enter the building interior at the window head or migrate around the rough-opening cavity and perhaps enter the interior at the sill. Note that it is recognized that in such type of construction, the head of the rough opening typically consists of a dense concrete header that will be more water resistant than the standard CMU block. However, this header is not considered a waterproof element of construction.

Nonetheless, this latter scenario for water intrusion is especially likely if the path to the exterior is blocked by a fenestration product in the wall that acts as a disruption to the normal drainage path in the wall. In this case, the water intrusion into the interior at this disruption may be considered a leak of the fenestration product; thus, making the fenestration product manufacturer possibly responsible for the repair and potential damage to the interior. The realization of this scenario was a primary concern for the original FMA Installation Committee

and the ensuing standard practices, FMA/AAMA 200 (2012) and FMA/WDMA 250 (2010).

FMA/AAMA 200 (2012) and FMA/WDMA 250 (2010). As noted above, the original FMA Installation committee recognized the inherent challenges of developing guidelines of standard practices for fenestration product installations in barrier CMU walls systems having direct-applied stucco subject to extreme wind and water exposure.

As such, the committee resolved that addressing water-management concerns for the entire wall system was out of scope of the effort. Alternatively, the scope was set to focus only on the rough-opening area, where gravity-driven drainage within the wall system is disrupted by the discontinuity in the building envelope due to the window or door opening, and with this discontinuity, a potential exists to cause water intrusion into the building. As such, the committee selected the approach to protect the rough opening with a liquid-applied flashing, as specified in AAMA 714 (2011). In this approach it is proposed that when the head of the rough opening is exposed to water intrusion, the liquid-applied flashing will act as a water protective barrier that will divert water to the side jambs and subsequently drain to the bottom of the wall (Figure 24). The side jambs are also protected by liquid-applied flashing, thus not allowing water penetration along the jambs. In addition, any water intrusion into the rough-opening cavity from the exterior, either through the window joinery or attachment, will be managed by the liquid-applied flashing treatment of the rough opening. This includes water intrusion to the sill area where water tends to collect. As long as water at the sill is directed to the exterior through the use of weeps at the exterior sill and there exists an interior air and water seal located at the back of

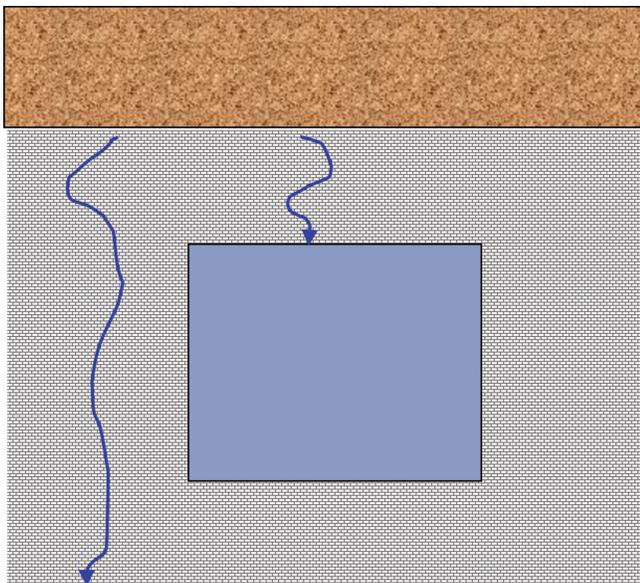


Figure 23 Potential excess water intrusion path in CMU wall due to excess water migration from above the wall assembly.

the sill as installed in accordance with the normal installation procedures that promote drainage, then the installation should perform adequately.

As a best practice, it is recommended that the liquid-applied flashing coating also be applied on the interior surface of the head, acting as an effective back dam for water intrusion that enters from above. In addition, treating the interior of the sill area is recommended.

The FMA/AAMA 200 (2012) and FMA/WDMA 250 (2010) documents are divided by type of fenestration attachment system for which: FMA/AAMA 200 (2012) addresses windows with frontal flanges (e.g. aluminum windows typically used in the southeastern U.S.); whereas, FMA/WDMA 250 (2010) addresses nonfrontal-flanged windows with mounting flanges (e.g. conventional wood windows). The key difference in the installation methods is with the design of the sill, in which the frontal flange window system (FMA/AAMA 200) typically utilizes a precast sill (both protruding and flush with the exterior wall), whereas the nonfrontal flange windows utilize an insert buck for attachment (2012). For the purpose of illustration the figures and steps shown below are taken from the FMA/AAMA 200 standard practice (2012).

The primary steps for installation of frontal-flanged windows into direct-applied surface-barrier CMU walls according to FMA/AAMA 200 are as follows (2012):

1. After checking tolerances, prepare the rough opening by applying a liquid-applied flashing to the rough-opening interior (Figure 25). Note: it is recommended not to coat the exterior surface of the CMU unless a durable bond between the liquid-applied flashing and the direct-applied stucco has been demonstrated.

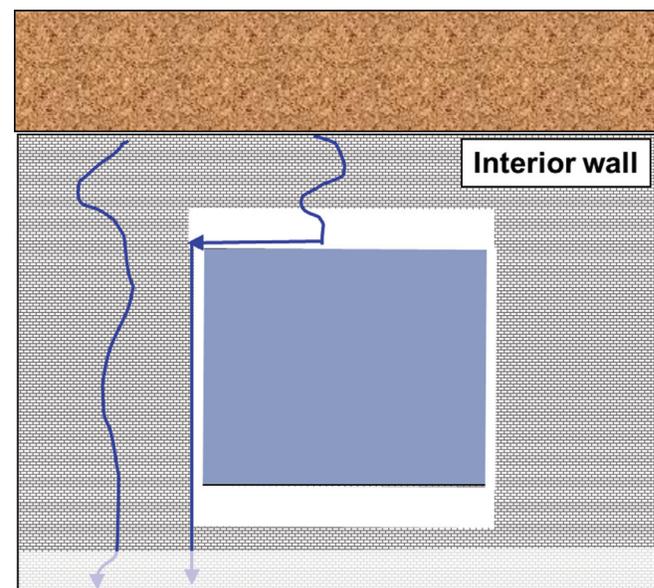


Figure 24 Application of liquid-applied flashing as moisture protection for CMU wall.

2. Seal all corners and cracks around the rough opening with liquid-applied flashing or compatible sealant (Figure 26).
3. Apply sealant to the interior side of a buck to act as a structural element for the attachment of the window (Figure 27).



Figure 25 Treatment of rough opening with liquid-applied flashing.

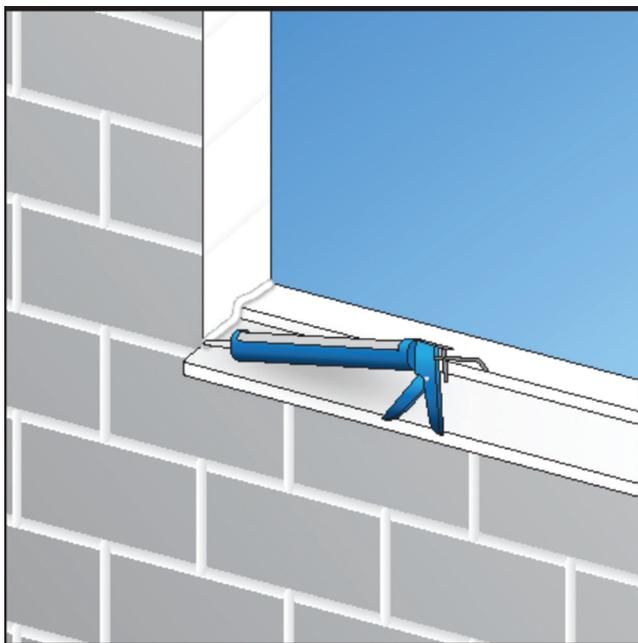


Figure 26 Corner and crack treatment with liquid-applied flashing or sealant.

4. Attached the buck per structural recommendations (Figure 28).
5. Treat the remaining, exposed portion of the buck with a liquid-applied flashing (Figure 29).
6. Apply sealant to the perimeter of the frontal-flanged window, leaving two 50 mm (2 in.) gaps at the sill for

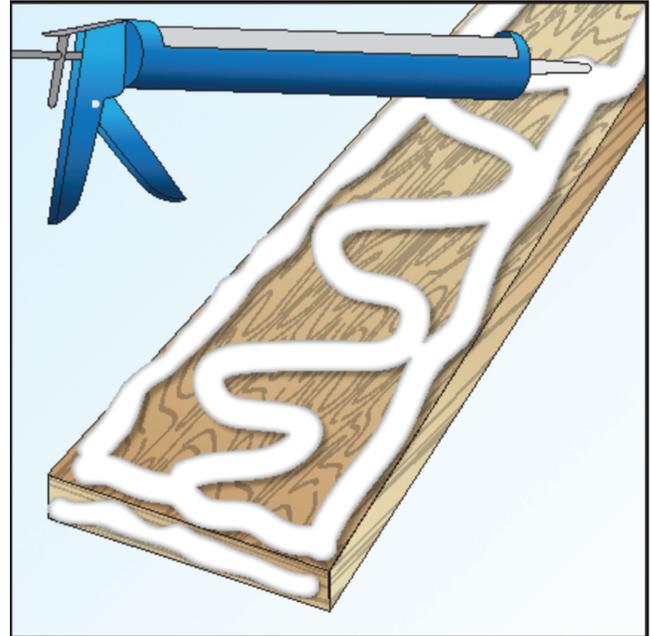


Figure 27 Sealant application on structural buck for rough opening.



Figure 28 Application of structural buck in rough opening.

drainable installations; barrier installations are also acceptable in this standard practice (Figure 30).

7. Install the window into the structural buck elements according to the manufacturer's recommendations (Figure 31).
8. Apply an interior air and water seal that is designed to resist the anticipated level of pressure differential from extreme exposure conditions (Figure 32).



Figure 29 Water-resistant treatment of structural buck in rough opening.

As given in detail in Katsaros (2007), representative installations from both FMA/AAMA 200 (2012) and FMA/WDMA 250 (2010) as installed by committee members were successfully tested for water intrusion according to the methods given in ASTM E457 (2009) up to 575 Pa (12 lb/ft²) water pressure differential to simulate exposure to extreme conditions (2009).



Figure 31 Installation of window into CMU wall system.

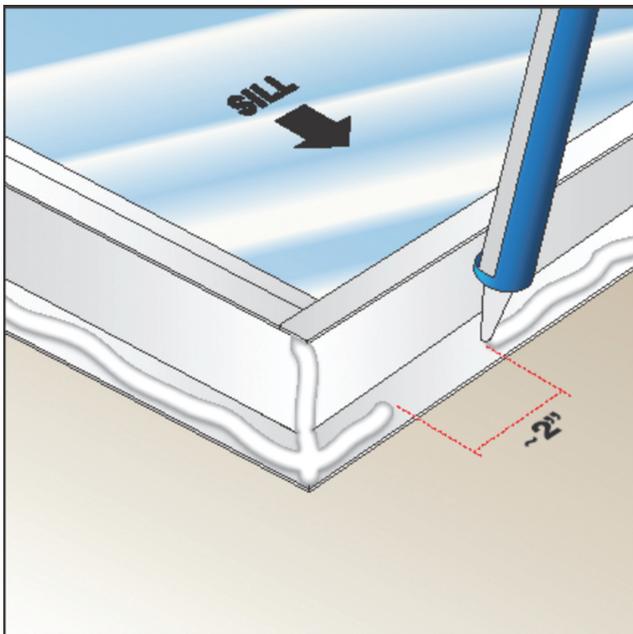


Figure 30 Application of sealant on window flange.



Figure 32 Application of interior air and water seal.

A version of the FMA/AAMA 200 (2012) document for door installations having the same mounting variations as given in the FMA/AAMA/WDMA 300 (2012) guideline, is now under development as FMA/AAMA/WDMA 400, and is expected to be published in 2013. Six installations, representing two flanged, two brick mold, and two nonflanged doors in a concrete flat and recessed sill (one for each attachment type), from FMA/AAMA/WDMA 400 were tested for water intrusion by members of the installation committee in May 2011. These walls, however, contained an additional important distinguishing feature from the FMA/AAMA 200 test walls for windows, in that a stucco finish was direct applied onto the exterior of the CMU wall (2012). After the doors were installed and the liquid-applied flashing and sealants were allowed to cure (roughly two weeks), the stucco with an acrylic paint finish was applied to the CMU wall. Water testing

began after a week of cure time for the stucco finish. Figures 33–38 provide an illustration of representative walls from this testing. Figure 33 illustrates the application of liquid-applied flashing around a recessed-concrete sill area; Figure 34 shows the rough-opening application, including the interior. Figure 35 illustrates a completed wall assembly from the exterior with stucco applied and Figure 36 shows the interior side of that wall. The water testing process is illustrated in Figure 37. All walls passed the ASTM E547 test protocol at 575 Pa (12 lb/ft²), run in three test pressure steps at 15 min. each up to 575 Pa (2009).

CONCLUSION

This report provides a summary of the efforts of members of the FMA/AAMA/WDMA installation committee, over the period from 2006–2012, to publish five installation standard practice documents representing specific window and door systems in both wood frame and CMU wall construction in extreme wind and water-exposure conditions. A key guiding principle applied to the development of each of these practices was the hands-on installation and water-intrusion testing of representative installations by committee members. This provided key insights in respect to the effectiveness and practical



Figure 33 Application of liquid-applied flashing on recessed-concrete sill.



Figure 34 Application of liquid-applied flashing in the rough opening and around the interior perimeter.



Figure 35 Exterior side of FMA/AAMA/WDMA 400 wall assembly with direct-applied stucco.

application of installation practices being developed, and in many cases influenced content changes in the documents.

FUTURE WORK

A new effort by the FMA/AAMA/WDMA installation committee has been initiated for the integration of windows



Figure 36 Interior side of FMA/AAMA/WDMA 400 wall assembly.



Figure 37 Water-testing process for FMA/AAMA/WDMA 400 wall assembly.

and doors into walls that include foam plastic-insulated sheathing (FPIS) in wood frame construction. This effort was initiated in order to address performance requirements set out in the new energy code starting in 2012. The committee has addressed three primary concerns: structural attachment to support the windows, maintaining proper water-management principles through integration with the building envelope, and finishing details with the façade or siding. In addition, a new FMA/AAMA/WDMA task group has been formed to address installation details for replacement window systems. As such, this committee will continue to develop valuable tools for the fenestration industry to enhance the effectiveness and practical application of the installation of fenestration products into a variety of wall and exposure conditions.

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