



Reducing Water Intrusion Through Windows and Doors

Recovery Advisory 3

August 2023



FEMA

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1. Purpose and Intended Audience

This Recovery Advisory outlines observations from Hurricane Ian in Florida, DR-4673-FL, that provide insights regarding building improvement opportunities. These recommendations are applicable to buildings experiencing similar issues and need not be limited to the state or disaster in which they were observed.

This Recovery Advisory provides important recommendations to reduce water intrusion through and around windows and doors due to wind-driven rain during extreme wind events. Water intrusion through and around windows and doors can damage interior finishes and interior contents. Water intrusion can also lead to algae and mold growth and may result in degradation or complete loss of building function, until adequate repairs are made. This Recovery Advisory addresses specific issues observed by the FEMA Hurricane Ian Mitigation Assessment Team (MAT) in Florida and provides recommended techniques to reduce water intrusion through windows and doors during extreme wind events. This advisory does not address water intrusion through windows and doors due to flooding.

The primary audience for this Recovery Advisory includes building owners, operators, and managers; design professionals; building officials; contractors; and municipal building and planning officials.

1.1. Key Issues

The key issues addressed in this advisory for consideration during rebuilding and mitigation activities are as follows:

- Water intrusion through and around windows and doors due to wind-driven rain can result in costly damage to interior finishes and furnishings.
- Water intrusion around window and door openings can cause dry rot and fastener corrosion that weaken the window or door frame or the wall itself.
- Window and door assemblies that are not tested for water penetration resistance, or are not tested to the required level can enable water to penetrate through the product and into the building, resulting in costly damage.
- Inadequate flashing techniques can enable water to enter the building around windows and doors, resulting in costly damage.
- The lack of proper product maintenance as specified by the manufacturer can result in poor water penetration resistance around windows and doors, resulting in costly damage.

1.2. This Recovery Advisory Addresses

This Recovery Advisory addresses the following:

- Performance Grade (PG) Ratings for Windows and Doors and Water Intrusion
- Florida Building Code Exceptions to Water Intrusion Testing for and Doors
- Installation, Flashing, and Sealing of Windows and Doors
- Maintenance of Windows and Doors
- Resources

This Recovery Advisory was developed primarily for the State of Florida as a result of observations from the FEMA Hurricane Ian MAT. However, the recommendations and issues addressed can be applied throughout the United States to minimize damage caused by water intrusion through windows and doors.

Florida Product Approval

The State of Florida requires product approval for the building envelope components addressed in this Recovery Advisory. A Florida Product Approval (Product Approval) certifies that the product has been designed or tested to the standards required in the building code. Although local product approval is permitted, most manufacturers opt for statewide Product Approval. The database of products approved through the statewide Product Approval system is available at www.floridabuilding.org. A Miami-Dade Notice of Acceptance (NOA) is a local product approval that is similar to a statewide Product Approval. Miami-Dade NOAs are product certifications offered by Miami-Dade County that certify that products have been designed or tested to the High-Velocity Hurricane Zone (HVHZ) requirements in the Florida Building Code. Because the HVHZ requirements typically meet or exceed the requirements in the rest of the state, most jurisdictions in Florida will also accept Miami-Dade NOAs as well as statewide Product Approvals. Manufacturers with products that also meet the HVHZ requirements can list their products as complying with the HVHZ requirements as part of their statewide Product Approval. Miami-Dade NOAs are available at <https://www.miamidade.gov/building/pc-searchapp.asp>. Windows and doors with statewide Product Approvals and/or NOAs can be relied upon by applicable stakeholders to provide a level of confidence of given standards of performance during wind events.

2. Performance Grade Ratings for Windows and Doors and Water Intrusion

Water intrusion through and around windows and doors as observed after Hurricane Ian, often occurs during the high winds and heavy rain that typically accompany hurricanes. Most windows and doors are required to be subjected to a series of tests that include air infiltration, wind pressure, and water penetration resistance in addition to other operability tests. (Note: American Architectural Manufacturers Association [AAMA] / Window and Door Manufacturers Association [WDMA] / CSA Group [CSA] 101/I.S.2/A440¹ characterizes a product's water intrusion resistance as water penetration resistance. In this section, where the term water penetration resistance is used, it refers to a product's resistance to water intrusion.) For windows and doors tested to AAMA/WDMA/CSA 101/I.S.2/A440, a product's performance grade (PG) rating correlates to the lowest outcome of

¹ AAMA/WDMA/CSA 101/I.S.2/A440 is the *North American Fenestration Standard/Specification for Windows, Doors, and Skylights*.

each of these applicable performance tests. A product with a higher PG rating will have better resistance to water infiltration.

2.1. Testing requirements for windows and sliding doors

Flashing and sealing methods are used to mitigate the effects of water intrusion around windows and doors. However, windows and doors should also be tested for water intrusion that may occur through the product or assembly. The resistance of water penetration through the product is determined by testing specified in AAMA/WDMA/CSA 101/I.S.2/A440 or TAS (Testing Application Standard) 202.²

The Florida Building Code, Building (FBCB) and Florida Building Code, Residential (FBCR) require windows and sliding doors to be tested and labeled to indicate compliance with AAMA/WDMA/CSA 101/I.S.2/A440 or TAS 202. In the HVHZ, all windows and doors are required to be tested to TAS 202. Although AAMA/WDMA/CSA 101/I.S.2/A440 and TAS 202 are similar tests, they differ somewhat in how water penetration resistance is qualified.

2.1.1. AAMA/WDMA/CSA 101/I.S.2/A440

AAMA/WDMA/CSA 101/I.S.2/A440 is a standard that certifies window and door products for air leakage resistance, wind pressure resistance, water penetration resistance and other performance tests as applicable. The water penetration resistance of products tested to AAMA/WDMA/CSA 101/I.S.2/A440 does not always directly correlate to the wind design pressure (DP) rating, and therefore, the DP rating is not always an indication of water penetration resistance. The important designation regarding water penetration resistance is the PG rating. This designator is well understood in the window industry but is not typically well understood outside the industry. The PG rating indicates that the product has met a specific set of performance tests that include wind pressure resistance and water penetration resistance. A product's PG rating correlates to the lowest outcome of each of the applicable performance tests.

A product with the PG rating of 60 has a minimum DP rating of 60 pounds per square foot (psf) and has passed the water penetration resistance test at 15% of the positive DP rating, 9 psf. The higher the PG rating, the more resistant the product is to water penetration. A PG 60 product has been tested for water penetration resistance at four times the pressure of a PG 15 product. Table 1 compares some common PG ratings and the water penetration resistance test pressures and shows how PG and DP ratings can diverge and affect the water penetration resistance test pressure. Using the rows below with the asterisks as an example, the positive DP ratings are same, but the one with a higher PG rating is tested to a higher water penetration resistance test pressure.

² TAS 202 is the *Criteria for Testing Impact & Non-impact Resistant Building Envelope Components Using Uniform Static Air Pressure*, which is contained in the *Florida Building Code Test Protocols for the High-Velocity Hurricane Zones* (ICC 2020).

Table 1: AAMA/WDMA/CSA 101/I.S.2/A440 PG Ratings – Wind Design Pressure and Water Penetration Resistance


PG Rating	Wind DP Rating (positive)	Water Penetration Resistance Test Pressure (15% of PG Rating)
15	15 psf	2.25 psf
30	30 psf	4.5 psf
40	40 psf	6 psf
40*	50 psf*	6 psf*
50*	50 psf*	7.5 psf*
60	60 psf	9 psf

psf = pounds per square foot
 *PG rating is less than DP rating

It is commonly assumed that windows and doors are tested for water penetration resistance at 15% of the positive DP rating. While that is true for products tested to TAS 202 (see TAS 202 section in this advisory), it is not necessarily true for products tested to AAMA/WDMA/CSA 101/I.S.2/A440, which specifically states that the positive DP rating is not an indicator of water penetration resistance performance. For the AAMA/WDMA/CSA 101/I.S.2/A440 standard, the water penetration resistance is tested at 15% of the PG, which may not always correspond to 15% of the positive DP rating.

The FBCB and FBCR require products to have a permanent label, marking, or etching that provides traceability to the manufacturer and product. They also require additional information about the product that includes the positive and negative DP rating, in addition to other items, to be on the permanent label or a temporary supplement label that can be removed after the final inspection (most manufacturers opt to put the additional information on the temporary supplemental label).

Although the FBCB and the FBCR require the positive and negative DP ratings to be shown on the product label, they do not specifically require the PG rating to be on the label. However, AAMA/WDMA/CSA 101/I.S. 2/A440 does require the product label to include the PG rating, in addition to the DP rating. Code enforcement personnel and others look at labels to ensure the product has met the required DP rating. For water penetration resistance, the PG rating is the most important designation. A product with a higher PG rating has been tested for water penetration resistance at a higher level. The PG rating should be on the product label alongside the positive and negative DP rating. Figure 1 shows a typical temporary supplemental window label and points out the PG rating and DP rating. **The PG rating should equal the positive DP rating.** The negative DP rating is not correlated to water penetration resistance and, therefore, its absolute value may exceed the PG rating.

		Licensee: 123-A-456 World's Best Window Co. Casement Window
Hallmark Certified www.wdma.com		Manufacturer stipulates Hallmark Certification as indicated below.
STANDARD	PG Rating	RATING
AAMA/WDMA/CSA 101/I.S.2/A440-11		Class LC-PG70 Size Tested 35.3" x 71.3" DP+70/-70
AAMA/WDMA/CSA 101/I.S.2/A440-08		Class LC-PG70 Size Tested 35.3" x 71.3" DP+70/-70
AAMA/WDMA/CSA 101/I.S.2/A440-08 A440S1-09		Class LC-PG70 - 895mm x 1803mm Positive/Negative Design Pressure (DP) = 3360 Pa/-3360 Pa Water Penetration Resistance Test Pressure = 510 Pa Canadian Air Infiltration/Exfiltration = A3
ASTM E1886/E1996		DP+70/-70 psf, Missile D, Wind Zone 4
FL 12345		
Glazing: 2.2mm AN outer/2.3mm HS inner		
		⚠ WARNING
		This product can expose you to chemicals including titanium dioxide, which is known in the state of California to cause cancer, and methanol, which is known to the state of California to cause birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

Meets or exceeds CEC & IECC Air Infiltration Requirements of 0.2 CFM/sq.ft. or lower.
 WDMA Hallmark Certification Program. Complies with HUD UM Bulletin No. 111.

Figure 1: Typical temporary supplement window label for a product tested to AAMA/WDMA/CSA 101/I.S.2/A440. Figure used with permission.

2.1.2. TAS 202

Windows and sliding doors are permitted to be tested in accordance with TAS 202 as an alternative to AAMA/WDMA/CSA 101/I.S.2/A440. In the HVHZ, all windows and doors are required to be tested to TAS 202. Figure 2 shows a typical temporary window label with the DP rating and TAS 202 testing standard. The performance tests in TAS 202 are similar to those in AAMA/WDMA/CSA 101/I.S.2/A440. However, TAS 202 specifically requires windows and doors to be tested for water penetration resistance at 15% of the positive DP rating. The water penetration test in TAS 202 directly correlates to the positive DP rating. Consequently, some products could actually qualify for a higher positive DP rating in TAS 202 but are limited to a lower positive DP rating because of the performance during the water penetration resistance part of the test. As in AAMA/WDMA/CSA 101/I.S.2/A440, the negative DP rating does not correlate with the water penetration resistance of the product.

Best Window Types for Water Penetration Resistance

Fixed windows and operable window and door products with compression seals provide the best resistance to water infiltration. Operable products include awning and casement type windows. These products seal directly against the frame and provide the best resistance to water penetration.

Examples of Windows with Most Effective Water Intrusion Resistance

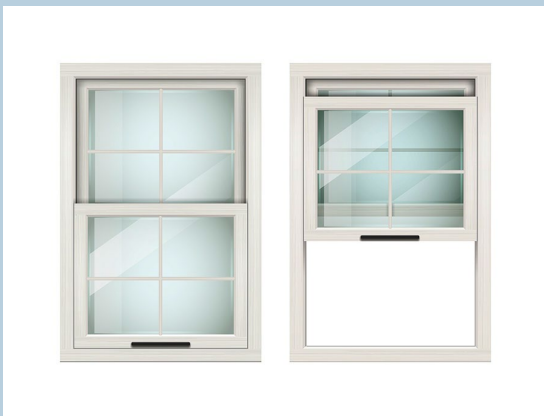


Casement Window



Fixed Window

Examples of Windows with Less Effective Water Intrusion Resistance



Double Hung Window



Sliding Window

Key Recommendation:

For products tested to AAMA/WDMA/CSA 101/I.S.2/A440, ensure all windows and sliding doors have a PG rating that equals the positive DP rating for the product. Alternatively, ensure all windows and doors have been tested to TAS 202.

2.2. Testing requirements for side-hinged doors

In the HVHZ, all doors, including side-hinged doors, are required to be tested for water penetration resistance except windows and doors that meet the exceptions to water intrusion testing (see next section). Outside the HVHZ, side-hinged doors are not required to be tested for water penetration resistance but are required to have a DP rating determined using the uniform static air pressure test of ASTM International (ASTM) E330.³ Products that have not been tested for water penetration resistance will most likely not be effective in resisting wind-driven rain during a hurricane.

Table 2 provides a summary of water penetration testing requirements in the FBCB and FBCR.

Table 2: Summary of Water Penetration Testing Requirements in the FBCB and FBCR

Product	Requirement	Outside the HVHZ			HVHZ
Windows and Sliding Doors	Testing Standards	AAMA/WDMA/CSA 101/I.S.2/A440		TAS 202	TAS 202
	Water Penetration Resistance Test	15% of PG		15% of Positive DP Rating	15% of DP Pressure Rating
	Labeling Requirements	DP and PG		DP	DP
Side-swinging Doors	Testing Standards	AAMA/WDMA/CSA 101/I.S.2/A440	TAS 202	ASTM E330	TAS 202
	Water Penetration Resistance Test	15% of PG	15% of Positive DP Rating	None	15% of DP Pressure Rating
	Labeling Requirements	DP and PG	DP	DP	DP

Key Recommendation:

- Side-hinged doors should be tested for compliance with AAMA/WDMA/CSA 101/I.S.2/A440 or TAS 202. For products tested to AAMA/WDMA/CSA 101/I.S.2/A440, ensure all doors, including side-hinged doors, have a PG rating that equals the positive DP rating for the product. Alternatively, ensure all windows and doors have been tested to TAS 202.

³ ASTM E330 is the *Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference*.

3. Florida Building Code Exceptions to Water Intrusion Testing for Doors

The FBCB and FBCR provide a couple of exceptions to water testing for doors complying with AAMA/WDMA/CSA 101/I.S.2/A440 or TAS 202. These exceptions also apply in the HVHZ. Doors in the following locations are not required by the code to be tested for water penetration:

- Door assemblies installed in non-habitable areas where the door assembly and area are designed to accept water infiltration, and
- Door assemblies installed where the overhang ratio (OH ratio) (see Figure 3) is equal to 1 or more.

Non-habitable areas are areas not used for living, sleeping, eating, or cooking. They include but are not necessarily limited to bathrooms, toilet rooms, closets, halls, screen enclosures, and sunrooms. However, the phrase “areas that are designed to accept water infiltration,” is not well defined. Non-habitable areas have commonly been interpreted to also include doors that open to a foyer where a foyer is connected to a living area but is interpreted to be a non-habitable area. Although the code does not require doors in these areas to be tested for water penetration resistance, water infiltration in these areas can still cause damage to interior contents and finishes.

The overhang exception, shown in Figure 3, applies where the length of the overhang is greater than or equal to the overhang height (OH ratio equal to or greater than 1). While the overhang exception may provide sufficient protection in areas outside hurricane-prone regions, it will not protect doors from the wind-driven horizontal rain that commonly occurs during hurricanes.

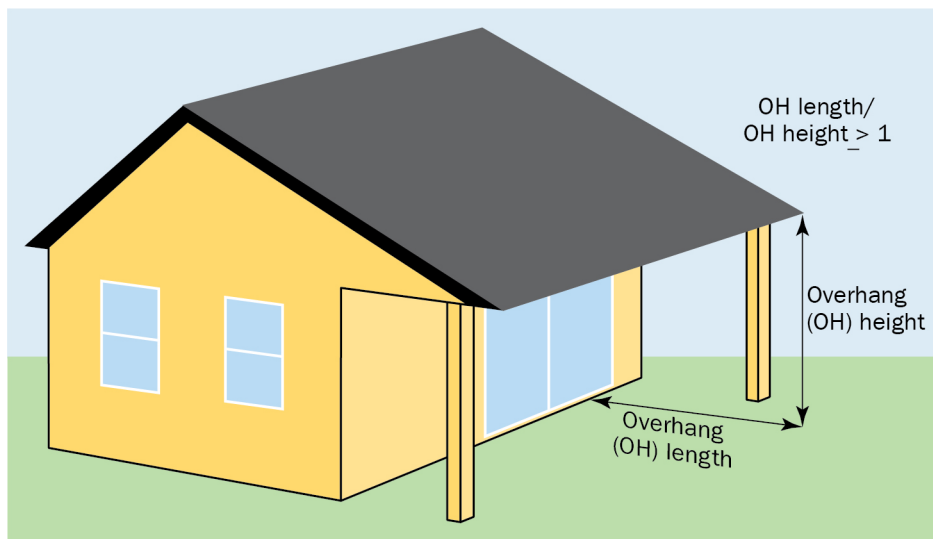


Figure 3: Overhang exception to water penetration testing for doors in the FBCB and FBCR.

Key Recommendations:

- As a best practice, do not apply the exceptions to water penetration resistance testing in the FBCB and FBCR. Ensure all doors have been tested for water penetration resistance even in areas where the FBCB and FBCR do not require it.
- For products tested to AAMA/WDMA/CSA 101/I.S.2/A440, ensure all doors have a PG rating that equals the positive DP rating for the product.
- Alternatively, ensure all doors have been tested to TAS 202 and include the water penetration resistance test.

4. Installation, Flashing, and Sealing of Windows and Doors

Windows and doors must be installed, flashed, and sealed as specified by the manufacturer and/or building code to provide the expected level of performance.

4.1. Installation/anchorage

Installation of windows and doors is not generic and is specific to each manufacturer to achieve the required performance ratings such as the design wind DP rating and water penetration resistance. Window and door manufacturers are required to provide installation instructions for their products with their Product Approval. See the Florida Product Approval text box on page 2 of this advisory for information on how to find Product Approvals for any product that has a Statewide Product Approval or a Miami-Dade NOA. The installation instructions will vary by manufacturer and can also vary for the same product depending on the required DP rating for the site-specific conditions where the product is being installed. Section R609.7 of the 7th Edition (2020) FBCR specifies minimum anchorage requirements, but primarily defers to the manufacturer's installation instructions. It is critical that windows and doors be installed as specified by the manufacturer.

4.2. Flashing and Sealing

Proper flashing and sealing of windows and doors is integral to preventing water infiltration due to wind-driven rain. The primary function of flashing is to prevent the entry of water into a building from a joint or opening. Flashing is required to be applied in shingle-like fashion, where the top layer laps over the bottom layer to direct water down and out of a structure. One of the more common window and door flashing mistakes is the failure to layer flashing in a shingle-like fashion. In addition, flashing must extend to the surface of the exterior wall or to the water-resistive barrier for subsequent drainage and/or to direct the water to weep holes.

Flashing for windows and doors generally falls into two categories: surface barrier method and drainage system method. The barrier method primarily relies on installation and sealants to prevent water penetration. The drainage system method permits water to enter but uses flashing, such as

metal/vinyl and self-adhered membranes and tapes, to direct water to the exterior of the building or the water-resistive barrier.

A common problem with the barrier method is that sealants can degrade over time and will need to be replaced once they exhibit signs of edge curling, cracking, and/or other breaks or delamination (see Section 5 in this advisory). FEMA P-499, *Homebuilders Guide to Coastal Construction* (2010) recommends that a removable “stop” be installed over exposed sealant to protect the sealant from direct exposure to weather and reduce the wind-driven rain demand on the sealant (see Figure 4).

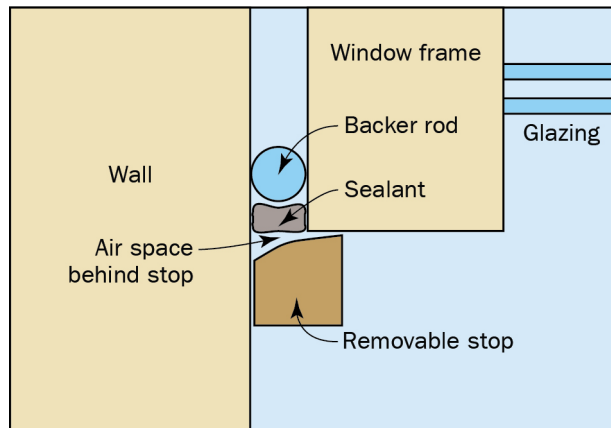


Figure 4: Using a removable stop to protect exposed sealants. Source: FEMA P-499

The FBCB and FBCR specify several methods for flashing windows and doors, including:

- The fenestration manufacturer’s installation and flashing instructions
- The flashing manufacturer’s instructions
- The flashing design or method developed by a registered design professional
- FMA/AAMA 100, FMA/AAMA 200, FMA/WDMA 250, FMA/AAMA/WDMA 300, or FMA/AAMA/WDMA 400⁴

The FMA, AAMA, and WDMA standards were developed by the window industry to address common installation methods in the State of Florida. The flashing/sealing methods in these standards have been tested by the industry and have been shown to be effective in preventing water intrusion.

Where flashing instructions or details are not provided, the FBCB and FBCR require pan flashing to be installed at the sill of exterior window and door openings. Pan flashing must be sealed or sloped in such a manner as to direct water to the surface of the exterior wall finish or to the water-resistive barrier for subsequent drainage. Pan flashing is required to incorporate flashing or protection at the head and sides (rear leg and end dam). Minimum recommended end dam and rear leg heights are addressed in Technical Fact Sheet No. 6.1 of FEMA P-499. See Figure 5.

⁴ FMA/AAMA 100, FMA/AAMA 200, FMA/WDMA 250, FMA/AAMA/WDMA 300, or FMA/AAMA/WDMA 400 are the Fenestration Manufacturers Association (FMA), American Architectural Manufacturers Association (AAMA), and Window & Door Manufacturers Association’s (WDMA’s) Installation Resources for Waterproofing.

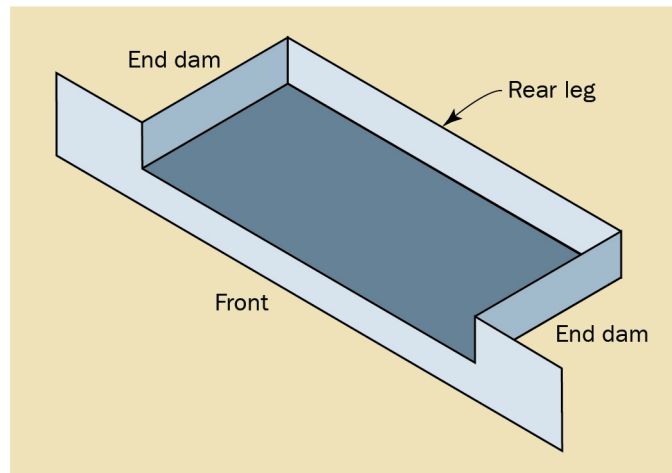


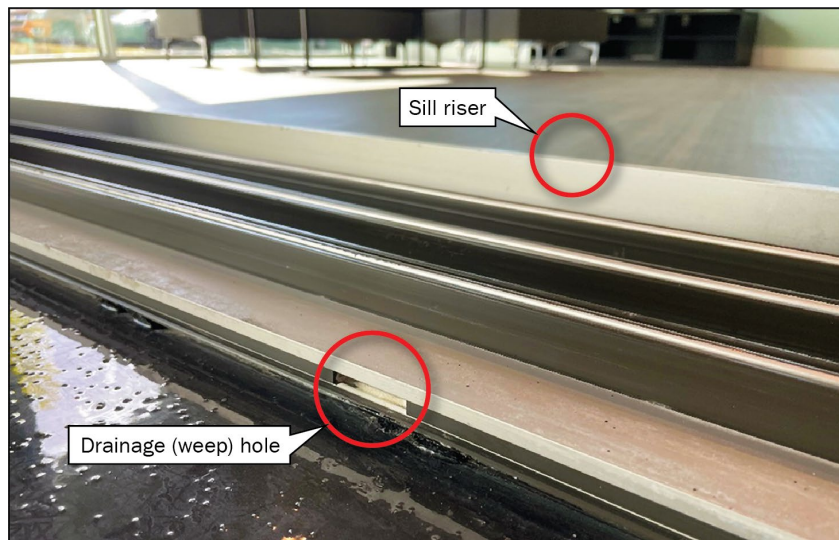
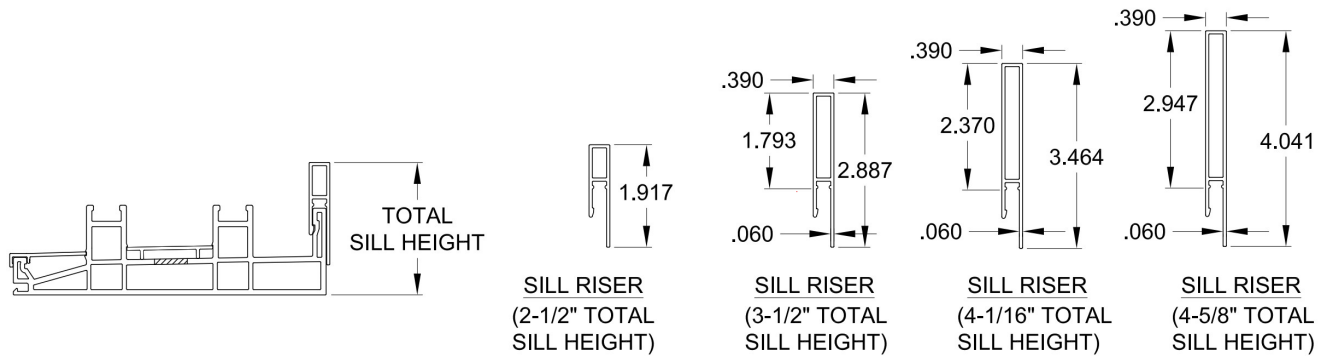
Figure 5: Pan flashing for window and door openings. Source: FEMA P-499

Additionally, while not specifically referenced in the FBCB or FBCR, ASTM E2112, *Standard Practice for Installation of Exterior Windows, Doors and Skylights*, also provides comprehensive details for window and door installation, including flashing techniques.

If the window and door assemblies are not anchored properly as specified by the Product Approval, flashings and sealants may be less effective during a windstorm, resulting in water intrusion.

4.3. Important Considerations for Sliding Doors

Sliding doors are prone to water infiltration because of the nature of their construction. Most sliding doors are considered “contain and drain” products in that they allow water penetration to occur but contain the water in an integral sill pan and allow the water to drain to the exterior. This integral sill pan includes a sill riser (sill dam) on the interior side of the door; see Figure 6 and Figure 7. The height of the sill riser depends on the water penetration resistance rating of the product. The higher the riser, the better the water penetration resistance. However, because the FBCB and FBCR provide some exceptions to water penetration testing (for example, the overhang exception previously discussed), some manufacturers may offer a “no riser” option on their products. Many homeowners do not understand the importance of this riser and consider it a trip hazard or unsightly attachment to their door and remove it. Without a riser or sill dam, sliding doors have little resistance to water infiltration. Additionally, the termination ends of the integral sill pan must be sealed with an approved sealant to the jambs at a height equal to the height of the sill riser.



Another key consideration for sliding doors is that the rough opening should be plumb and level. In addition to affecting door operability, an unlevel surface under the track can cause cracks and crevices under the track that enable water to infiltrate under the door. While wood shims can be used to plumb the door on the sides and top of the rough opening, wood shims should not be used to level the surface under the track. Wood shims will quickly rot and deteriorate if exposed to water. The bottom on the rough opening should be leveled with grout or a similar product. Grout can provide a solid level for the bottom track and impede water intrusion under the track.

5. Maintenance of Windows and Doors

Windows and doors require periodic maintenance to ensure their continued operability and ability to resist water infiltration.

5.1. Sealant Joints

Sealant joints require periodic inspection and replacement. If the sealant is cracked, discontinuous, or delaminated, or there is a gap between the window or door frame and the wall, the entire joint should be replaced. Two important things should be considered when replacing sealants:

- Always use sealants that comply with AAMA 800, ASTM C920 Class 25 Grade NS or greater, ASTM C1281, or AAMA 812.⁵ Check the product labeling to ensure that one of these standards is identified and the product is indicated for exterior use.
- Ensure the sealant is compatible with the material it will be adhered to (i.e., masonry, aluminum, wood, vinyl). Even a high-quality sealant will not remain in the joint if it is not compatible with the product to which it is being adhered.
- Ensure that the sealant does not block any weep holes and/or misdirect the path of water runoff.

5.2. Other Maintenance

Periodically clean weatherstripping with soap and water. If the weatherstripping is damaged, contact the window or door manufacturer for replacement.

Periodically inspect drainage openings (weep holes). As discussed previously in this Recovery Advisory, drainage holes are a key element of “contain and drain” products and should not be covered or plugged with caulk. They must be kept clean and free of debris to allow water that gets in the product to drain to the exterior of the building as shown in Figure 8.

⁵ These standards are AAMA 800, *Voluntary Specifications and Test Methods for Sealants*; ASTM C920, *Standard Specification for Elastomeric Joint Sealants*; ASTM C1281, *Standard Specification for Preformed Tape Sealants for Glazing Applications*; and AAMA 812, *Voluntary Practice for Assessment of Frame Deflection When Using One Component Polyurethane Foams for Air-Sealing Rough Openings of Fenestration Installations*.



Figure 8: Typical drainage weepholes (red circles). Photo used with permission.

Ensure all windows and doors close tightly and firmly latch. Windows and doors that do not close tightly may facilitate cracks and gaps between the window or door and the frame. These cracks and gaps can permit water to infiltrate through the window or door when exposed to wind-driven rain.

6. Resources

ASCE/SEI. 2022. *Minimum Design Loads for Buildings and Other Structures* (ASCE 7-22). ASCE Standard ASCE/SEI 7-22. [ASCE/SEI 7-2022 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures \(ansi.org\)](https://www.asce.org/standards-and-specifications/minimum-design-loads-for-buildings-and-other-structures)

AAMA/WDMA/CSA (American Architectural Manufacturers Association / Window & Door Manufacturers Association / CSA Group). 2017. *North American Fenestration Standard/Specification for Windows, Doors, and Skylights*. AAMA/WDMA/CSA 101/I.S.2/A440-17. [AAMAWDMACSA-101I.S.2A440-11-NAFS-windows-doors-skylights.pdf \(elitesafetyglass.com\)](https://www.elitesafetyglass.com/aamawdmacsa-101i.s.2a440-11-nafs-windows-doors-skylights.pdf)

AAMA (American Architectural Manufacturers Association). 2010. *Voluntary Practice for Assessment of Single Component Aerosol Expanding Polyurethane Foams for Sealing Rough Openings of Fenestration Installations*. AAMA 812-04(2010). [FGIA - AAMA Updates Standard for Assessing Frame Deflection When Using One Component Polyurethane Foams \(fgiaonline.org\)](https://www.fgiaonline.org/aama-812-04-2010)

AAMA. 2016. *Voluntary Specifications and Test Methods for Sealants*. AAMA 800-16. [AAMA 800-16 Voluntary specifications and test methods for sealants, American Architectural Manufacturers Association - Publication Index | NBS \(thenbs.com\)](https://www.thenbs.com/publication-index/aama-800-16)

ASTM (ASTM International). 2014. *Standard Specification for Elastomeric Joint Sealants*. ASTM C920-14A. [ASTM C920-14a - Standard Specification for Elastomeric Joint Sealants \(ansi.org\)](#)

ASTM. 2014. *Standard Specification for Preformed Tape Sealants*. ASTM C1281-2014. [ANSI Webstore](#)

ASTM. 2021. *Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference*. ASTM E330. [Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference \(ansi.org\)](#)

ASTM. 2023. *Standard Practice for Installation of Exterior Windows, Doors and Skylights*. ASTM E2112-23. [ASTM E2112-23 - Standard Practice for Installation of Exterior Windows, Doors and Skylights \(ansi.org\)](#)

FEMA (Federal Emergency Management Agency). 2010. *Home Builder's Guide to Coastal Construction* (FEMA P-499). <https://www.fema.gov/emergency-managers/risk-management/building-science/publications>

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Hurricanes Maria and Irma in Puerto Rico Recovery Advisory 5, *Protecting Windows and Openings in Buildings*.

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