Purpose and Intended Audience

This Recovery Advisory presents important recommendations to reduce wind and water infiltration damage to new and existing residential buildings. The recommendations discussed are from existing Federal Emergency Management Agency (FEMA) Building Science resources, including recovery advisories published after Hurricane Irma, and also include new recommendations and best practices based on observations made by the Mitigation Assessment Team (MAT) after Hurricane Michael struck in 2018 (Figure 1 shows an example of observed damage).

This advisory describes specific issues observed in newer residential buildings after Hurricane Michael. The buildings observed were built after the adoption of the first edition of the Florida Building Code (FBC) (March 2002). The advisory provides key points for consideration during rebuilding and mitigation activities. The references cited in the advisory contain additional best practices and guidance for issues commonly observed after storm events.

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

Key Issues

- Widespread wind damage to envelope components (roof coverings, wall coverings, roof ventilation components, and windows and doors) resulted in extensive and costly water intrusion damage from wind-driven rain. Water intrusion occurred where there was roof covering damage, loss of roof ventilation components (i.e., ridge vents and soffits), damage to exterior wall coverings, and around windows and door openings.

- Water infiltration can saturate attic insulation, allow water seepage into exterior and interior wall systems, damage interior finishes and furnishings, and lead to algae and mold growth.

- Wind and water infiltration damage can lead to extensive operational impacts and loss of (or degraded) building usage over extended periods of time, until adequate repairs are made.

- There is a lot of existing guidance that can be used to reduce wind damage and water infiltration for residential buildings, which can make it difficult for users to find the best guidance.
This Recovery Advisory Addresses
- Roof coverings, underlayment, and vents
- Exterior wall coverings
- Soffits
- Glazed openings and doors

Roof Coverings, Underlayment, and Vents

Roof covering damage due to high winds has been noted by several MATs to be a primary source of water intrusion. The recommendations in this section provide for enhanced wind resistance of roof coverings (see ‘Wind Resistance’) and also include a secondary underlayment system designed to prevent water intrusion in the event that the primary roof covering is lost or punctured by wind-borne debris (see “Water Infiltration”). Recommendations are also provided for improved performance of roof ventilation products.

Wind Resistance

Wind-related damage was observed after Hurricane Michael on roof coverings, including asphalt shingles, concrete and clay roof tiles, and metal roof systems. Applying the following best practices will improve wind resistance for these systems. Information on ridge vents and off-ridge vents is also provided.

Asphalt shingles. The Hurricane Michael MAT noted widespread poor wind performance of asphalt shingles. While the reason for their poor performance is not fully understood, recent studies and post-hurricane observations point to a few issues. A recent study of existing homes of various ages in Florida (Masters et al., 2013) identified unsealed and partially unsealed shingles as sources of failures during high-wind events. Additionally, observations from Hurricane Michael and previous hurricanes have shown that incorrect fastener location for asphalt shingles also likely contributes to failure. Although the number of fasteners is important, the location of the fasteners is also important.

Table 1 provides guidance that will help to improve performance of asphalt shingles in high-wind areas. Table 2 identifies the required classification of asphalt shingles based on the basic wind speed. Figures 2 and 3 illustrate the correct and incorrect fastener location for asphalt shingles.

<table>
<thead>
<tr>
<th>Item</th>
<th>Key Points</th>
<th>Source for Information/Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing and labeling</td>
<td>Verify that asphalt shingle packages are labeled to indicate compliance with ASTM D7158.</td>
<td>· This advisory: Table 2, Classification of Asphalt Shingles</td>
</tr>
<tr>
<td></td>
<td>Asphalt shingles should have a classification that corresponds to the required basic (design) wind speed.</td>
<td></td>
</tr>
<tr>
<td>Installation</td>
<td>Install asphalt shingles in accordance with guidance (see right-hand column). Pay particular attention to the recommendations for installing shingles at rakes, eaves, hips, and ridges.</td>
<td>· Hurricane Harvey in Texas Recovery Advisory 2, Asphalt Shingle Roofing for High-Wind Regions (in FEMA P-2022, 2019)</td>
</tr>
<tr>
<td></td>
<td>Pay close attention to the fastener location.</td>
<td>· FEMA P-55 (2011): Section 11.5.1.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>· This advisory: Figures 5 and 6</td>
</tr>
<tr>
<td></td>
<td>For improved performance, use enhanced flashing techniques.</td>
<td>· Technical Fact Sheet No. 5.2, Roof-to-Wall and Deck-to-Wall Flashing (FEMA P-499, 2010)</td>
</tr>
</tbody>
</table>

FEMA = Federal Emergency Management Agency

Roof Repair and Replacement in Accordance with Florida Building Code

The FBC limits how much of an existing roof can be repaired within a specific period of time before triggering the requirement to comply with the latest code. Additionally, when a roof covering system on a single-family dwelling is removed and replaced, the FBC requires the following components be investigated and subsequent measures taken if deficiencies are found:

- Roof deck attachment
- Enhanced underlayment (secondary water barriers)
- Roof-to-wall connections

Table 2: Classification of Asphalt Shingles

<table>
<thead>
<tr>
<th>Wind Speed, V(^{(1)})</th>
<th>ASTM D7158 Classification(^{(2)})</th>
</tr>
</thead>
<tbody>
<tr>
<td>V ≤ 116 mph</td>
<td>D, G, or H</td>
</tr>
<tr>
<td>116 mph &lt; V ≤ 155 mph</td>
<td>G or H</td>
</tr>
<tr>
<td>155 mph &lt; V ≤ 190 mph</td>
<td>H</td>
</tr>
</tbody>
</table>

mph = miles per hour

Table notes:

(1) Determine wind speeds (V) for a particular site using the International Residential Code (IRC), Florida Building Code, Residential (FBCR), or American Society of Civil Engineers (ASCE) 7.

(2) Classifications assume Exposure Categories B and C and mean roof heights of 60 feet or less. Additional calculations are required for conditions outside of these assumptions.

Table source: Adapted from Table R905.2.4.1 in the IRC and Table R905.2.6.2 in the Florida Building Code, Residential.

**Figure 2:**
Proper and improper locations of shingle fasteners
Source: Adapted from FEMA P-55 (Figure 11-36) and FEMA P-2023

When properly located, the nail engages the underlying shingle in the headlap area (center nail).

**Figure 3:**
Incorrect location of fasteners in an asphalt shingle
Source: Adapted from FEMA P-55 (Figure 11-36) and FEMA P-2023

Red circles show where fasteners were driven through the shingle. Yellow dotted lines show the approximate location of where fasteners should have been placed.
Concrete and clay roof tiles. While the use of concrete and clay roof tiles was not widely observed by the MAT in the areas impacted by Hurricane Michael, previous post-hurricane observations have indicated issues with concrete and clay roof tiles. Table 3 provides guidance that will help improve performance of concrete and clay roof tiles in high-wind areas.

**Table 3: Key Practices Related to Wind Performance of Concrete and Clay Roof Tiles**

<table>
<thead>
<tr>
<th>Item</th>
<th>Key Points</th>
<th>Source for Information/Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Determine appropriate design wind loads.</td>
<td>• IBC/FBC: Sections 1609.5.3 and 1504.2, using ASCE 7-16</td>
</tr>
</tbody>
</table>
| Installation  | Install in accordance with guidance using the most current edition (see right-hand column). | • TRI, *Concrete and Clay Roof Tile Installation Manual*  
• FRSA/TRI, *Florida High Wind Concrete and Clay Roof Tile Installation Manual*  
• Technical Fact Sheet No. 7.4, *Tile Roofing for High Wind Regions* (in FEMA P-499, 2010)  
• FEMA P-55 (2011): Section 11.5.4 |
|               | For improved performance, use enhanced installation techniques.           |                                  |

ASCE = American Society of Civil Engineers; FBC = Florida Building Code; FEMA = Federal Emergency Management Agency; FRSA = Florida Roofing, Sheet Metal & Air Conditioning Contractor’s Association; IBC = International Building Code; TRI = Tile Roofing Institute

**Metal roof systems.** While metal roof coverings appeared to perform better than other roof coverings on buildings built to the FBC, metal roof damage to some buildings was observed after Hurricane Michael. Table 4 provides guidance that will help improve performance of metal roof systems in high-wind areas.

**Table 4: Key Practices to Improve Wind Performance of Metal Roof Systems**

<table>
<thead>
<tr>
<th>Item</th>
<th>Key Points</th>
<th>Source for Information/Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing and labeling</td>
<td>Verify metal panel roof systems were tested to meet appropriate wind pressures.</td>
<td>• ASTM E1592* (to meet the design wind pressures specified in ASCE 7-16)</td>
</tr>
</tbody>
</table>
| Installation             | For improved performance, use enhanced installation techniques for design and installation. | • Technical Fact Sheet No. 7.6, *Metal Roof Systems in High-Wind Regions* (in FEMA P-499, 2010)  
• FEMA P-55 (2011): Section 11.5.5  

* The IBC and FBC require metal panels to be installed over a solid or closely fitted deck to comply with ANSI/FM 4474, UL 580, or UL 1897. While FEMA recommends ASTM E1592 because it gives a better representation of the system’s uplift performance, the local jurisdiction should be consulted before specifying ASTM E1592 for metal roof coverings over solid or closely fitted decks.


Ridge vents and off-ridge vents. The loss of vents, particularly ridge vents, can expose large openings in the roof deck to water infiltration. The interior of the home shown in Figure 4 suffered extensive interior water damage due to the failure of ridge shingles and the ridge vent. The ceilings in several rooms were saturated with water and collapsed. According to the homeowner, roof damage was limited to the loss of ridge shingles and ridge vents. Table 5 provides guidance that will help improve performance of ridge vents and off-ridge vents in high-wind areas.

**Figure 4: House with significant interior damage from water intrusion (Panama City area)**

Interior damage occurred when ridge shingles and the ridge vent were blown off; the drywall on the ceiling collapsed and was removed.
Table 5: Key Practices to Improve Wind Performance of Ridge Vents and Off-Ridge Vents

<table>
<thead>
<tr>
<th>Item</th>
<th>Key Points</th>
<th>Source for Information/Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing and labeling</td>
<td>Verify that ridge vents were tested for resistance to wind and wind-driven rain.</td>
<td>• ICC™: TAS 100(A) of the Florida Building Code, Test Protocols for the High-Velocity Hurricane Zone</td>
</tr>
<tr>
<td>Installation</td>
<td>Attach roof ventilation products properly (see guidance in right-hand column).</td>
<td>• Technical Fact Sheet No. 7.5, Minimizing Water Intrusion Through Roof Vents in High-Wind Regions (in FEMA P-499, 2010)</td>
</tr>
<tr>
<td></td>
<td>Ensure fasteners for ridge vents are of a sufficient length to fully penetrate the roof sheathing below or into the roof framing where possible.</td>
<td>• FEMA P-55 (2011): Section 11.6</td>
</tr>
</tbody>
</table>

FEMA = Federal Emergency Management Agency; IBC = International Code Council; TAS = Testing Application Standard

Water Infiltration

Water infiltration can be reduced by applying a secondary barrier. A secondary roof sealing strategy using underlayment products can significantly reduce water infiltration through the roof when the primary roof covering is lost or damaged due to wind loads. This secondary roof sealing strategy is often referred to as a sealed roof deck.

Figures 5, 6, and 7 illustrate three options for installing a sealed roof deck under the primary roof covering. These sealed roof deck methods have been tested by IBHS and qualify for the FORTIFIED designation (see text box). Additional information on underlayment to reduce water intrusion can be found in FEMA P-499 (Technical Fact Sheet No. 7.2) and FEMA P-55 (Section 11.5.1.1).

FORTIFIED Homes™

A “beyond code” program developed by the Insurance Institute for Business and Home Safety (IBHS). The program was developed to help strengthen homes from high-wind events such as hurricanes.

For more information, see: https://disastersafety.org/fortified/fortified-home/

Figure 5: Option 1 for installing a sealed roof deck to reduce water infiltration through the roof

Source: Hurricane Irma in Florida Recovery Advisory 3, Mitigation Triggers for Roof Repair and Replacement in the 6th Edition (2017) Florida Building Code (Figure 4) (in FEMA P-2023, 2018)

*Self-Adhering Polymer Modified Bitumen Membranes:
Some oriented strand board (OSB) structural panels have a factory-applied coating that can interfere with the bonding of the self-adhering modified bitumen. To facilitate bonding, a field-applied primer is often needed. If self-adhering modified bitumen is applied to OSB, the OSB manufacturer should be contacted to determine whether a primer needs to be applied.
The benefits of a sealed roof deck were demonstrated in the residence shown in Figure 8. The metal roof covering of the home in the Panama City area was punctured by asphalt shingles that blew off an adjacent building during Hurricane Michael. Although the metal roof was damaged, the home had a sealed roof deck constructed in accordance with Option 1 shown in Figure 5 and did not suffer any interior water damage.
Exterior Wall Coverings

Exterior wall coverings are commonly blown off walls or damaged by high winds, often resulting in water intrusion due to wind-driven rain. Keeping exterior wall coverings in place and intact is a significant protection against water infiltration. Typical exterior wall covering materials used include vinyl, fiber-cement, and brick veneer.

Wind Resistance

Exterior wall coverings have to be designed or tested for compliance with the applicable design wind loads.

Vinyl siding. Vinyl siding performance depends particularly on proper installation. The Hurricane Michael MAT observed widespread damage to vinyl siding wall coverings in the areas assessed. Table 6 provides guidance that will help improve the performance of vinyl siding in high-wind areas.

Table 6: Key Practices to Improve Wind Performance of Vinyl Siding

<table>
<thead>
<tr>
<th>Item</th>
<th>Key Points</th>
<th>Source for Information/Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Verify that selected siding has a design wind pressure rating that equals or exceeds the required design wind pressure.</td>
<td>• ASTM D3679 (2017 Edition)</td>
</tr>
<tr>
<td></td>
<td>Design wind pressure ratings for vinyl siding vary by manufacturer and installation method. Typically, vinyl siding with a double or curled nail hem has the highest design wind pressure rating.</td>
<td>• Technical Fact Sheet No. 5.3, Siding Installation in High-Wind Regions (in FEMA P-499, 2010)</td>
</tr>
<tr>
<td>Installation</td>
<td>Use vinyl siding installers certified by VSI.</td>
<td>• VSI: Certified Installer Program</td>
</tr>
<tr>
<td></td>
<td>Installation pointers:</td>
<td>• Technical Fact Sheet No. 5.3, Siding Installation in High-Wind Regions (in FEMA P-499, 2010)</td>
</tr>
<tr>
<td></td>
<td>• Install vinyl siding in accordance with recommended methods (see right-hand column)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Install vinyl siding over wood structural panel sheathing such as plywood or OSB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Use utility trim at top of walls and under windows where the nail hem has to be cut</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Use proper starter strips at the first course of the siding</td>
<td></td>
</tr>
</tbody>
</table>

ASTM = ASTM International; FEMA = Federal Emergency Management Agency; VSI = Vinyl Siding Institute
Fiber-cement siding. The performance of fiber-cement siding varied in the areas assessed by the Hurricane Michael MAT. Table 7 provides guidance that will help improve the performance of fiber-cement siding in high-wind areas.

**Table 7: Key Practices to Improve Wind Performance of Fiber-Cement Siding**

<table>
<thead>
<tr>
<th>Item</th>
<th>Key Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Verify that selected fiber cement siding is designed or tested to meet the design wind pressures in ASCE 7-16.</td>
</tr>
<tr>
<td>Installation</td>
<td>Although there are several installation techniques, face-nailing of fiber-cement siding is recommended in hurricane-prone regions.</td>
</tr>
</tbody>
</table>

**ASCE** = American Society of Civil Engineers; **FEMA** = Federal Emergency Management Agency

Brick veneer. When not adequately attached, brick veneer is frequently damaged from wind loading. Common failure modes include tie (anchor) corrosion, tie fastener pull-out, failure of masons to embed ties into the mortar, poor bonding between ties and mortar, and the use of poor quality mortar. While the Hurricane Michael MAT noted generally good performance of brick veneer on the buildings assessed, damage to brick veneer has been noted by previous MATs; Table 8 provides guidance that will help improve performance of brick veneer in high-wind areas.

**Table 8: Key Practices to Improve Wind Performance of Brick Veneer**

<table>
<thead>
<tr>
<th>Item</th>
<th>Key Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Improve wind performance by following appropriate guidance and criteria (see right-hand column).</td>
</tr>
<tr>
<td>Installation</td>
<td>Improve wind performance by following appropriate guidance (see right-hand column).</td>
</tr>
</tbody>
</table>

**FEMA** = Federal Emergency Management Agency; **TMS** = The Masonry Society

Water Infiltration

The most effective way to reduce water intrusion through walls is for the exterior wall covering to remain in place. Currently, there is no guidance for a secondary water barrier for walls that would be comparable to the sealed roof deck. However, a water-resistant barrier or “housewrap” is required by code for many wall assemblies and may reduce water infiltration. Water-resistant barriers function to prevent airflow through a wall and to stop and drain water that has penetrated the exterior wall covering. Recommended installation methods for water-resistant barriers are provided in FEMA P-499 (Technical Fact Sheet No. 5.1).

Soffits

Soffits have historically performed poorly in hurricanes and are commonly damaged in high-wind events. When soffits fail, the result is often significant water intrusion. While water infiltration also occurs at soffit vents even when there is no failure, keeping the soffit in place reduces the amount of water infiltration. Typical soffit materials used include vinyl, wood structural panels, fiber-cement, and aluminum.

Wind Resistance

Until recently, building codes provided little guidance on designing soffits for wind loads. The 2007 FBC was revised to require that soffits be capable of resisting the same wind loads required for walls. Both the 2015 IRC and ASCE 7-10 were also revised to require that soffits be capable of resisting the wind loads specified for walls. The Hurricane Michael MAT observed widespread damage to soffits in the areas assessed.

Table 9 provides guidance that will help improve performance of soffits in high-wind areas. Figure 9 illustrates proper installation for vinyl soffit panels.
### Table 9: Key Practices to Improve Wind Performance of Soffits

<table>
<thead>
<tr>
<th>Item</th>
<th>Key Points</th>
<th>Source for Information / Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Determine the required wind loads.</td>
<td>· Hurricane Irma in Florida Recovery Advisory 2, Soffit Installation in Florida (in FEMA P-2023, 2018)</td>
</tr>
<tr>
<td></td>
<td>Use soffits that were designed or tested for wind loads specified for the adjacent walls.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If appropriate, use a prescriptive option for wood structural panel soffits.</td>
<td></td>
</tr>
<tr>
<td>Testing</td>
<td>To reduce water intrusion, verify that soffit vents are tested for resistance to wind and wind-driven rain.</td>
<td>· ICC: TAS 100(A)</td>
</tr>
<tr>
<td>and labeling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation</td>
<td>At a minimum, fasten soffit panels at the wall and the fascia.</td>
<td>· Technical Fact Sheet No. 7.5, Minimizing Water Intrusion Through Roof Vents in High-Wind Regions (in FEMA P-499, 2010)</td>
</tr>
<tr>
<td></td>
<td>Be sure to install fascia coverings in accordance with the manufacturers’ installation instructions.</td>
<td>· This advisory: Figure 9, “Vinyl soffit panel installation”</td>
</tr>
</tbody>
</table>
**Water Infiltration**

The failure of soffits can expose the interior of the building to significant water intrusion due to wind-driven rain. Even when soffits do not fail, water infiltration can occur during high-wind events through soffits and soffit vents. However, keeping the soffit in place significantly reduces the amount of water infiltration through the soffit area. One method to reduce water infiltration through soffits is to place filter fabric (such as is used for HVAC system filters) above the vent openings. However, this approach must be custom designed (see Technical Fact Sheet No. 7.5, *Minimizing Water Intrusion Through Roof Vents in High-Wind Regions* [in FEMA P-499, 2010]).

**Glazed Openings and Doors**

Glazed openings include windows, skylights, and doors with glass. Doors include entry and garage doors. In addition to high wind pressures, windows and doors are exposed to wind-driven rain and impacts from wind-borne debris.

**Wind Resistance**

Wind damage can occur from both high wind pressures and wind-borne debris impacting the glazing. This type of damage was observed after Hurricane Michael, as well as past hurricanes.

Windows, skylights, and doors. The most critical factor for improving the wind resistance of exterior glazing and doors is to use products that have been tested, certified, and labeled for the applicable wind loads to indicate compliance. Product labeling, including the certification program to which the product is listed under, ensures that wind-resistance testing has been performed as required. Windows, skylights and doors should be tested and labeled in accordance with the following:

- Side-swinging doors: ASTM E330
- Garage doors: ANSI/DASMA 108

Additional recommendations for testing of exterior windows and doors are provided in Sections 11.2.1.1 and 11.3.1.1 of FEMA P-55 (2011).

**Protection from wind-borne debris.** When a glazed opening (windows and doors with glass) is not impact-resistant or not protected with an impact-protective device, wind-borne debris can impact the glazing and create a large opening in the building envelope, resulting in higher internal wind pressures and significant water intrusion. This type of wind-borne debris damage was observed after Hurricane Michael, and is a common observation made after many hurricanes. Table 10 provides guidance that can help reduce damage to glazed openings from wind-borne debris.

<table>
<thead>
<tr>
<th>Item</th>
<th>Key Points</th>
<th>Source for Information/ Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code requirement</td>
<td>Glazed openings in wind-borne debris regions* must be impact-resistant or be protected with an impact-protective device such as a shutter.</td>
<td>2017 FBCR/2018 IRC: Sections R202 and R301.2.1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FEMA P-55 (2011): Sections 11.2.1.2 and 11.3.1.3</td>
</tr>
</tbody>
</table>

* For information about wind-borne debris regions, see the text box in this advisory.

FBRC = Florida Building Code, Residential; FEMA = Federal Emergency Management Agency; IRC = International Residential Code
FBC Wind-Borne Debris Region

Wind-Borne Debris Regions are defined in Chapter 2 of the FBCR as follows:

“Areas within hurricane-prone regions located in accordance with one of the following:

- Within 1 mile (1.61 km) of the coastal mean high water line where the ultimate design wind speed, Vult’, is 130 mph (58 m/s) or greater
- In areas where the ultimate design wind speed, Vult’, is 140 mph (64.6 m/s) or greater; or Hawaii.”

Note: The definition of Wind-Borne Debris Region in the FBC is consistent with ASCE 7, the IBC, and the IRC. The definition is used with permission: Chapter 2, Excerpted from the 2017 Florida Building Code-Residential 6th Edition; Copyright 2017; Washington, D.C.: International Code Council. Reproduced with permission. All rights reserved. www.ICCSAFE.org.

Water Infiltration

Water infiltration in and around windows and doors can occur during the high winds and heavy rain that typically accompany hurricanes, and was observed after Hurricane Michael. Flashing and sealing methods are often used to mitigate the effect of water intrusion, but each method presents challenges.

Windows and sliding and hinged glass doors have to comply with AAMA/WDMA/CSA 101/I.S.2/A440 (see Table 11), which also includes a water infiltration test at 15 percent or 20 percent of the required positive design pressure rating depending on the product class. Products complying with AAMA/WDMA/CSA 101/I.S.2/A440 are assigned a Performance Grade (PG) rating correlating to the required design pressure based on the product’s performance under structural design pressure, water infiltration, and air leakage. For example, a PG40 window has a design pressure rating of ± 40 pounds per square foot (psf) and was tested for water infiltration at 6 psf (15 percent of 40 psf). The PG rating should be identified on the product label.

Table 11 provides guidance that will help reduce water infiltration in glazed openings and doors in high-wind areas.

Table 11: Key Practices to Reduce Water Infiltration at Glazed Openings and Doors

<table>
<thead>
<tr>
<th>Item</th>
<th>Key Points</th>
<th>Source for Information/ Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing and labeling</td>
<td>Review product labels to confirm that windows have a Performance Grade equal to or greater than the required design wind pressure.</td>
<td>• AAMA/WDMA/CSA 101/I.S.2/A440: North American Fenestration Standard/Specification for windows, doors, and skylights</td>
</tr>
<tr>
<td>Installation</td>
<td>Follow recommended installation and flashing methods for windows and doors.</td>
<td>• Technical Fact Sheet No. 6.1, Window and Door Installation (in FEMA P-499, 2010)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• FEMA P-55 (2011): Sections 11.2.1.4 and 11.3.1.4</td>
</tr>
</tbody>
</table>

AAMA = American Architectural Manufacturers Association; CSA = Canadian Standards Association; FEMA = Federal Emergency Management Agency; WDMA = Window & Door Manufacturers Association

References


- No. 5.2, Roof-to-Wall and Deck-to-Wall Flashing
- No. 5.3, Siding Installation in High-Wind Regions
- No. 5.4, Attachment of Brick Veneer in High-Wind Regions
- No. 6.1, Window and Door Installation
- No. 6.2, Protection of Openings – Shutters and Glazing
- No. 7.2, Roof Underlayment for Asphalt Shingle Roofs
- No. 7.4, Tile Roofing for High Wind Regions
- No. 7.5, Minimizing Water Intrusion Through Roof Vents in High-Wind Regions
- No. 7.6, Metal Roof Systems in High-Wind Regions


- FL-RA 1, Dry Floodproofing: Operational Considerations
- FL-RA 2, Soffit Installation in Florida
- FL-RA 3, Mitigation Triggers for Roof Repair and Replacement

- USVI-RA 3, Installation of Residential Corrugated Metal Roof Systems

- TX-RA 1, Dry Floodproofing: Planning and Design Considerations
- TX-RA 2, Asphalt Shingle Roofing for High-Wind Regions

FEMA. [to be published 2019]. Mitigation Assessment Team Report: Hurricane Michael. FEMA P-[TBD].


For more information, see the FEMA Building Science Frequently Asked Questions website at http://www.fema.gov/frequently-asked-questions-building-science.

If you have any additional questions on FEMA Building Science Publications, contact the helpline at FEMA-Buildingsciencehelp@fema.dhs.gov or 866-927-2104.

You may also sign up for the FEMA Building Science email subscription, which is updated with publication releases and FEMA Building Science activities. Subscribe at https://service.govdelivery.com/accounts/USDHSFEMA/subscriber/new?topic_id=USDHSFEMA_193.


To order publications, contact the FEMA Distribution Center:
Call: 1-800-480-2520
(Monday–Friday, 8 a.m.–5 p.m., EST)
Fax: 719-948-9724
Email: FEMApubs@GPO.gov

Additional FEMA documents can be found in the FEMA Library at https://www.fema.gov/media-library/resources.

Please scan this QR code to visit the FEMA Building Science web page.