

Protection of Openings—Shutters and Glazing

Purpose: *To provide general information about the selection and installation of storm shutters and impact-resistant glazing and other types of opening protection in windborne debris regions.*

Opening Requirements in Codes and Standards

What Are “Hurricane-Prone Regions” and “Windborne Debris Regions”?

According to the 2009 International Building Code (IBC) and the 2009 International Residential Code (IRC), **hurricane-prone regions** are areas vulnerable to hurricanes such as:

1. The U.S. Atlantic Ocean and Gulf of Mexico coasts where the basic wind speed is greater than 90 mph¹ (40 m/s).
2. Hawaii, Puerto Rico, Guam, the U.S. Virgin Islands, and American Samoa.

Wind-borne debris regions are defined as areas within portions of hurricane-prone regions located within 1 mile (1.61 km) of the coastal mean high water line where the basic wind speed is 110 mph (48 m/s)¹ or greater; or portions of hurricane-prone regions where the basic wind speed is 120 mph (53 m/s)¹ or greater; or Hawaii.

Sections 1609.1.2 and R301.2.1.2, of the 2009 editions of the IBC and IRC, respectively, address the Protection of Openings. These sections state that in wind-borne debris regions, glazing in buildings shall be impact resistant or protected with an impact-resistant covering that meets the requirements of an approved impact-resistant standard or the American Society of Testing and Materials (ASTM) standards ASTM E 1996 and ASTM E 1886. Wood structural panels could be used as an alternative to provide protection so long as they meet local building code requirements. Panel attachment should be in accordance with Table 1609.1.2 (IBC) and Table R301.2.1.2 (IRC) and installed using corrosion-resistant attachment hardware and anchors permanently installed on the building. Under provisions of the IBC, wood structural panels are permitted for Group R-3 and R-4 buildings with a mean roof height of 45 feet (13,716 mm) or less where wind speeds do not exceed 140 mph (63 m/s). Under provisions of the



Figure 1. Wood structural panels installed in accordance with building code requirements are a cost-effective means of protection, but they should be adequately attached so they themselves do not become windborne debris.

IRC, wood structural panels are permitted for buildings with a mean roof height of 33 feet (10,058 mm) or less where wind speeds do not exceed 130 mph² (58 m/s). Figure 1 shows a house utilizing wood structural panels to provide opening protection.

ASCE/SEI 7-05 also discusses the protection of glazed openings in Section 6.5.9.3. The section states, “Glazing in buildings located in wind-borne debris regions shall be protected with an impact-protective system or be impact-resistant glazing according to the requirements specified in ASTM E1886 and ASTM E1996 or other approved test methods and performance criteria. The levels of impact resistance shall be a function of Missile Levels and Wind Zones specified in ASTM E 1886 and ASTM E 1996”. Exceptions to this are noted in Section 6.5.9.3.

¹ ASCE 7-05 wind speed – in order to recalculate this for ASCE 7-10 divide the ASCE 7-05 wind speed by 0.6^{0.5}



Anchorage

Window and door assemblies must be strong enough to withstand wind pressures acting on them and be fastened securely enough to transfer those wind pressures to the adjacent wall. Pressure failures of doors or windows can allow glazing to fracture or glazing frames or supports to fail. Anchorage failures can allow entire door or window units to be ripped from the walls. Either type of failure results in the failure of the building envelope and allows wind and water to enter the building.

Shutters

Why Are Storm Shutters Needed?

If glazing is not resistant to windborne debris, then shutters are an important part of a hurricane-resistant home. They provide protection for glass doors and windows against windborne debris, which is often present in hurricanes. Keeping the building envelope intact (i.e., no window or door breakage) is vital to the integrity of a home. If the envelope is breached, sudden pressurization of the interior may result in major structural or non-structural damage (e.g., roof loss) and will lead to significant interior and contents damage from wind-driven rain. The addition of shutters will not eliminate the potential for wind-driven rain entering the building, but will improve the building's resistance to it.



Figure 2. Metal panel shutter . The shutter is installed in a track permanently mounted above and below the window frame. The shutter is placed in the track and secured with wing nuts to studs mounted on the track. This type of shutter is effective and quickly installed, and the wing nut and stud system provides a secure anchoring method. Track designs that have permanently mounted studs for the nuts have been shown to be more reliable than track designs using studs that slide into the track.

Note: When glazing protection is provided by shutters, screens, or other panel systems, the glazing and glazing frame should be designed and constructed to resist the full design loads (i.e., do not assume that the shutter will be decreasing the wind pressure on the glazing). Also note that it should be assumed that the shutter will not significantly decrease the wind-driven rain demand on the glazed assembly.

Where Are Storm Shutters Required and Recommended?

Model building codes, which incorporate wind provisions from ASCE 7 (1998 edition and later), require that buildings within the **windborne debris region** (see Figure 5 of this fact sheet), either (1) be equipped with shutters or impact-resistant glazing and designed as enclosed structures or (2) be designed as partially enclosed structures (as if the windows and doors are broken out). However it should be noted that the alternative to design a Risk Category II building (defined in ASCE 7-10) as a partially enclosed structure was removed from ASCE 7-10 and it now requires that all Risk Category II structures in the wind-borne debris region be designed to be enclosed structures with impact-resistant glazing or equipped with a shutter system. It is also recommended to give strong consideration to the use of opening protection in all hurricane-prone areas where the basic wind speed is 100 mph (3-second gust speed) or greater, even though the IBC and IRC building codes do not require it. Designers should check with the jurisdiction to determine whether state or local requirements for opening protection exceed those of the model code.



WARNING: A shutter may look like it is capable of withstanding windborne missiles; unless it is tested, however, its missile resistance is unknown.

What Types of Shutters Are Available?

A wide variety of shutter types are available, from the very expensive motor-driven, roll-up type, to the less expensive temporary wood structural panels. Designers can refer to Miami-Dade County, Florida, which has established a product approval mechanism for shutters and other building materials to ensure they are rated for particular wind and wind-borne debris loads (see the “Additional Resources” section). Figures 3 and 4 illustrate some of the shutter styles available.

Note: Many coastal homes have large and unusually shaped windows, which will require expensive, custom shutters. Alternatively, such windows can be fabricated with laminated (impact-resistant) glass.

Shutter Styles

Shutter styles include colonial, Bahama, roll-up, and accordion.

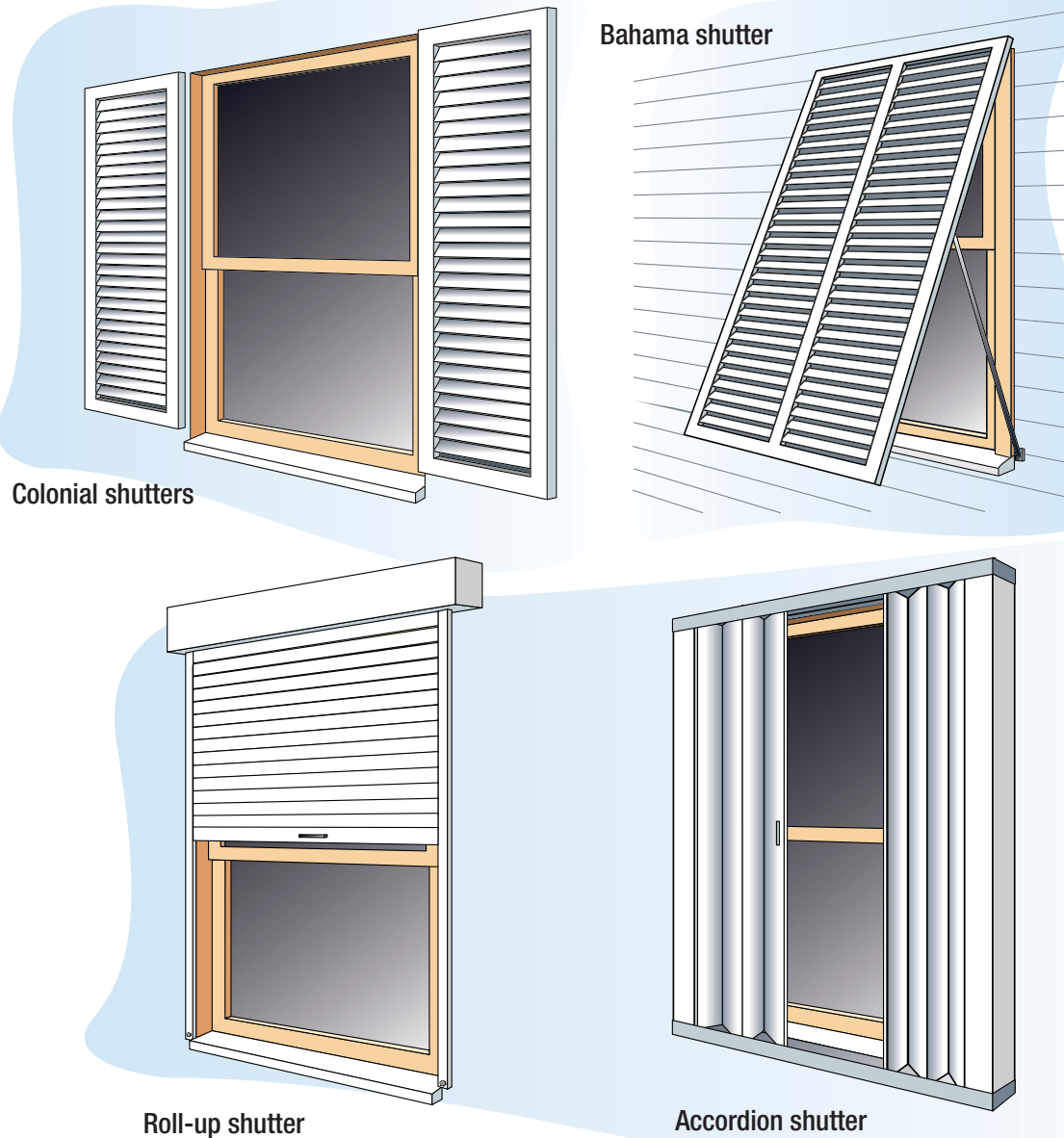
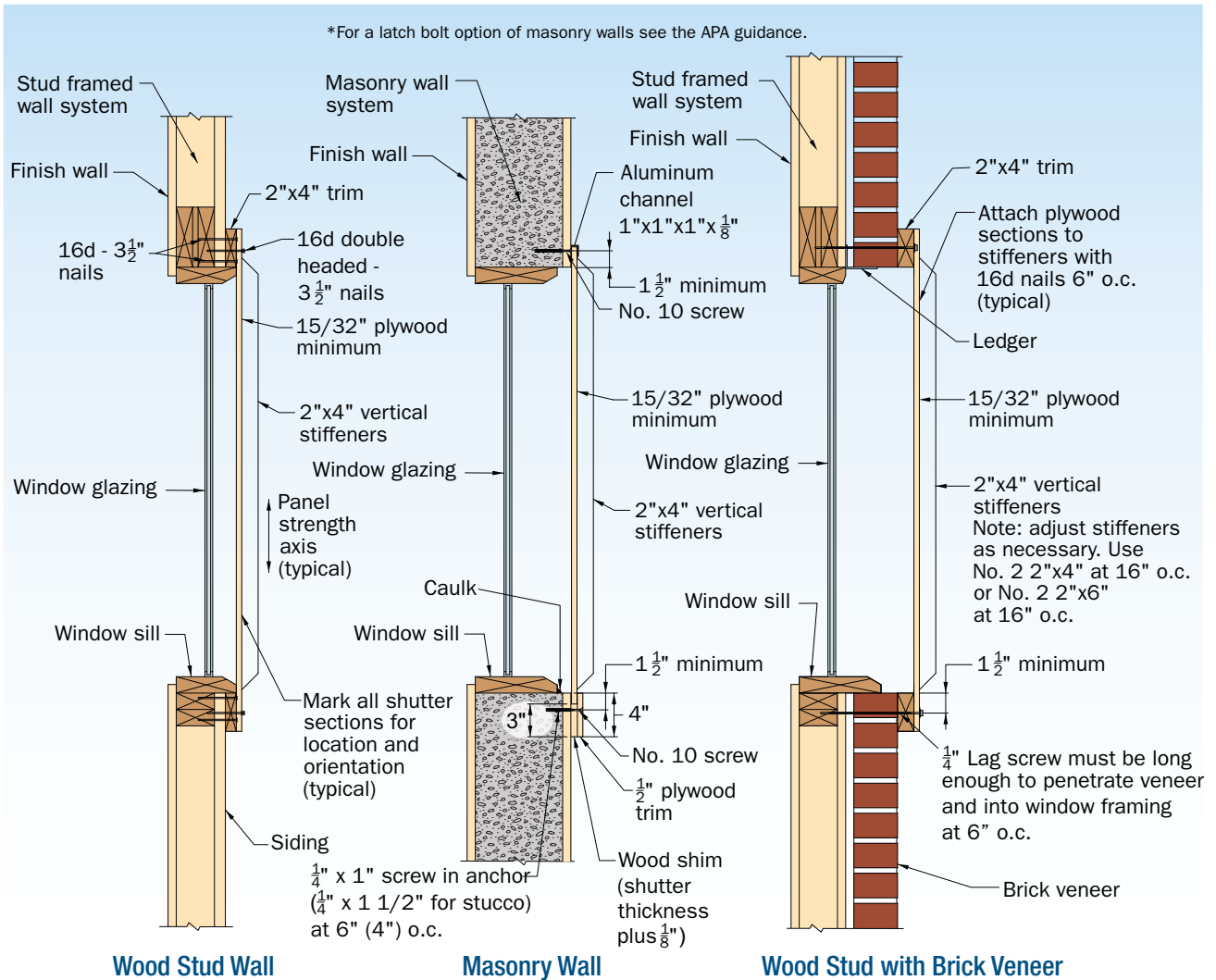


Figure 3. Colonial shutters, Bahama style shutters, Roll-up style shutters, and Accordion style shutters.



See APA Guidance for additional details and nail specifications.
Only for use on residential structures with a mean roof height of 45 feet or less.

Figure 4. Common methods for plywood shutter attachment to wood-frame and masonry walls.
(For actual shutter design, refer to design drawings or see the APA, Engineered Wood Association guidelines for constructing plywood shutters.)

Shutter Type Cost Advantages

Shutter Type	Cost	Advantages	Disadvantages
Wood structural panels	Low	Inexpensive	Must be installed and taken down every time they are needed; must be adequately anchored to prevent blow-off; difficult to install on upper levels; storage space is needed.
Metal or polycarbonate panels	Low/ Medium	Easily installed on lower levels	Must be installed and taken down every time they are needed; difficult to install on upper levels; storage space is needed.
Accordion, manual closing	Medium/ High	Always in place; ready to be closed	Always in place; ready to be closed. Must be closed manually from the outside; difficult to access on upper levels.
Permanent, motor-driven	High	Easily opened and closed from the inside	Expensive. (It is important to find a motorized shutter that allows the shutter to be manually raised in order to allow the interior to vent following the storm and prior to electrical power restoration.)

Are There Special Requirements for Shutters in Coastal Areas?

When installing any type of shutter, follow the manufacturer's instructions and guidelines carefully. Be sure to attach the shutters to structurally adequate framing members (see shutter details in Figures 3 and 4 of this fact sheet). Avoid attaching the shutters to the window frame or brick veneer face. Always use hardware that is corrosive-resistant when installing shutters. Figure 5 is the ASCE 7-05 basic wind map for the East Coast of the United States. See page 1 of this fact sheet for the delineation of the areas where opening protection is required.



WARNING: According to the International Window Film Association, "It should be noted that the testing of commercial windows does not imply performance of residential windows." While post-manufacture applied window film may provide more protection than unprotected windows, in residential applications it is no substitute for shutters or impact-resistant glass.

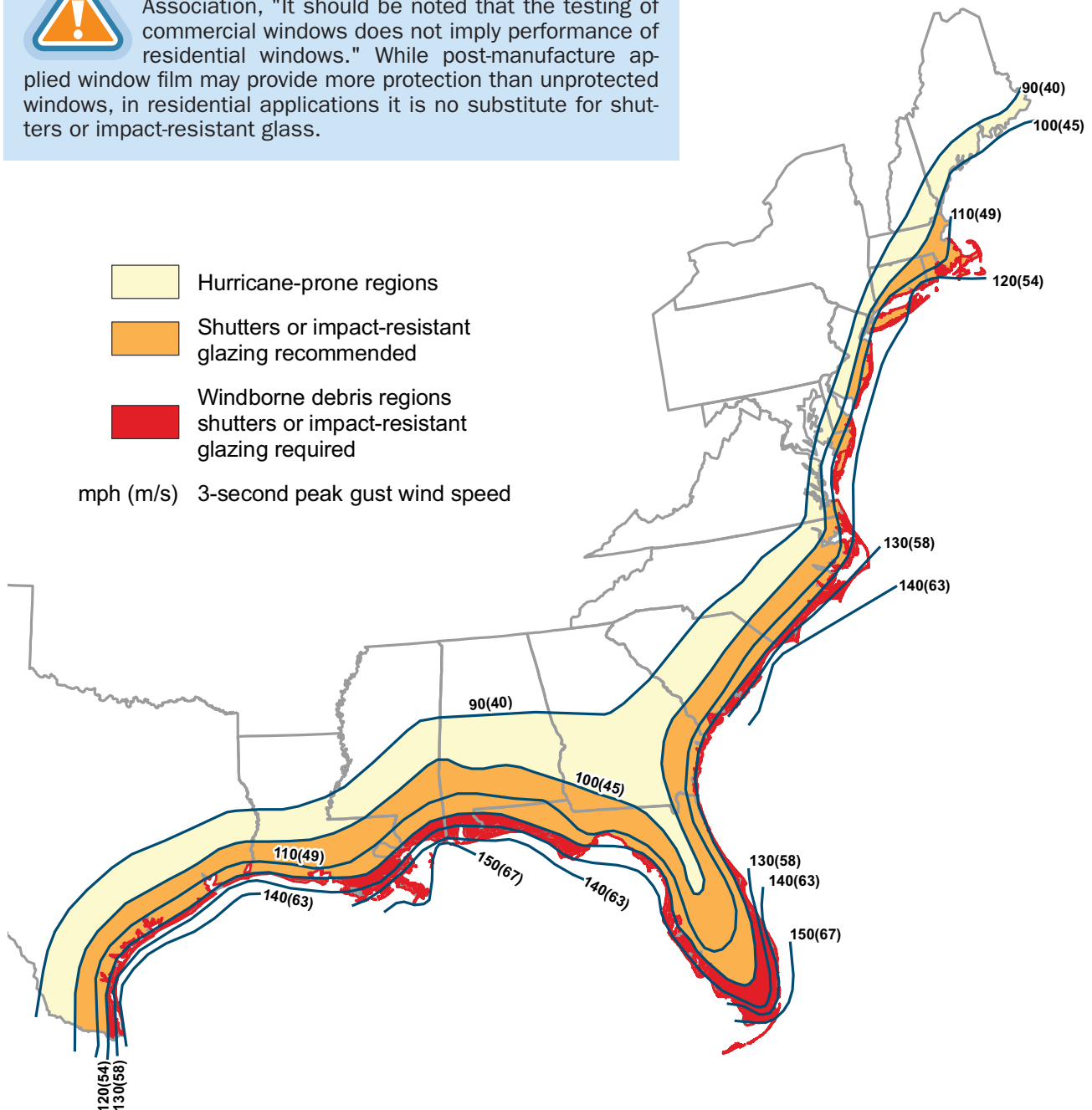


Figure 5. An illustration of the ASCE 7-05 wind speed contours and windborne debris region. See ASCE 7-05 Figure 6-1 for wind load design.

Windborne debris resistant glazing

Laminated glazing systems typically consist of assemblies fabricated with two (or more) panes of glass and an interlayer of a polyvinyl butyral (or equivalent) film laminated into a glazing assembly. During impact testing, the laminated glass in the system can fracture but the interlayer must remain intact to prevent water and wind from entering the building. These systems may also increase the energy efficiency of the building over standard glazing.

Polycarbonate systems typically consist of plastic resins that are molded into sheets, which provide lightweight, clear glazing panels with high impact-resistance qualities. The strength of the polycarbonate sheets is much higher than non-laminated glass (i.e., more than 200 times stronger) or acrylic sheets or panels (i.e., more than 30 times stronger).

Garage Doors

Garage doors many times represent large unreinforced openings. They are commonly damaged during high-wind events and could allow a building to be pressurized if they are breached. A garage door should meet the design wind speed requirements for the area or be retrofitted to withstand the design wind speed. However, the viability of a retrofit depends on the style and age of the door, and may not provide the same level of protection as a new door system.

The 2009 editions of IBC and IRC both comment on the glazing in garage doors in sections 1609.1.2.2 and R301.2.1.2, respectively. Any glazed opening protection on garage doors for wind-borne debris shall meet the requirements of an approved impact-resisting standard or ANSI/DASMA 115-2005.

While some manufacturers provide wind speed and exposure ratings for their products, labels on many garage doors do not include wind speed or wind pressure ratings. While not required to be included on the product labeling, ANSI/DASMA 108 does require that the positive and negative pressure used in testing be recorded on the ANSI/DASMA 108 Test Report Form. If the label attached to the door does not indicate the positive and negative pressure rating, consult the Test Report Form to verify it is an appropriate garage door for the area.

Additional Resources

American Society of Civil Engineers. *Minimum Design Loads for Buildings and Other Structures*, ASCE/SEI 7-10. (<http://www.asce.org>)

The Engineered Wood Association (APA). *Hurricane Shutter Designs Set 5 of 5*. Hurricane shutter designs for woodframe and masonry buildings. (<http://www.apawood.org>)

International Code Council. *International Building Code*. 2009. (<http://www.iccsafe.org>)

International Code Council. *International Residential Code*. 2009. (<http://www.iccsafe.org>)

Information about product testing and approval process for Miami-Dade County, Florida, available at <http://www.miamidade.gov/buildingcode/product-control.asp>

American Society for Testing and Materials:

ASTM E1886, *Performance of Exterior Windows, Curtain Walls, Doors, and Storm Shutters Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials*

ASTM E1996, *Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricane*

ASTM E2112, *Standard Practice for Installation of Exterior Windows, Doors and Skylights*

ASTM E330, *Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference*. (<http://www.astm.org>)

Door and Access Systems Manufacturers Association:

DASMA 108, *Standard Method for Testing Sectional Garage Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference*

Developed in association with the National Association of Home Builders Research Center

