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A Hurricane By Many Other Names

International Hurricane Glazing Standards and Systems Come of Age

by Valerie Block, Tom Kopec and Dave Rinehart

Hurricane, typhoon or cyclone— three terms for the same storm event, depending on its location in the world. In the Atlantic Ocean, Caribbean Sea, Gulf of Mexico and east of the International Date Line in the northern Pacific, the term used is "hurricane." West of the International Date Line in the northern Pacific Ocean it's "typhoon," and in the far southwest Pacific Ocean and in the Indian Ocean it's "cyclone."

Over the past few years, many different parts of the world have been hit by storms that have left significant casualties, both in terms of lives lost and homes, buildings and crops destroyed. One such storm, Typhoon Neoguri, hit the Chinese island of Hainan in April 2008 with such a force it caused 120,000 people to flee low-lying areas. Cyclone Nargis, a weak Category IV storm that hit Burma (Myanmar) in May 2008, had sufficient strength to produce a 12-foot-tall storm surge that flooded vast areas of farmland and killed thousands of people. In 2007, Cyclone Sidr made landfall in Bangladesh as a Category V storm with sustained winds of 160 mph. The cyclone caused widespread damage, especially to homes and schools.

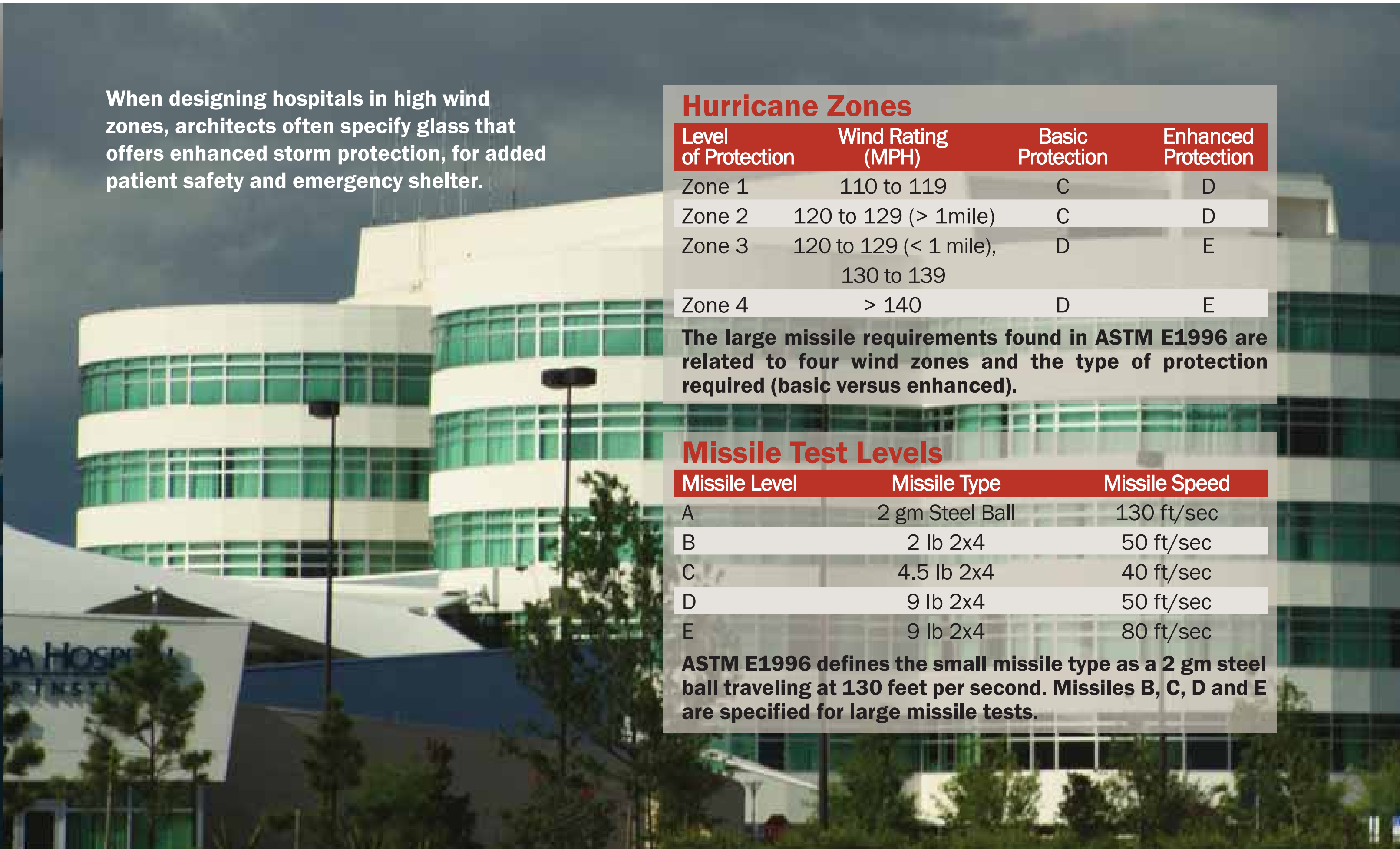
In 2007, the Caribbean felt the wrath of Hurricane Dean. More than 50,000 people were evacuated from coastal towns in Cuba, the Dominican Republic experienced a storm surge up to 20 feet and Jamaica was in a month-long state of emergency. In Mexico, Dean hit the Yucatan as a Category V storm, leaving 90,000 homes without power. Two years earlier, Hurricane Wilma hit the Yucatan Peninsula, causing extensive damage in the city of Cancun. Mexican insurance companies reported that Hurricane Wilma was likely to be the country's most costliest disaster ever—$7.5 billion USD.

Are Impact Protection Requirements Necessary?

Despite evidence that hurricanes can cause widespread damage, impact protection of buildings did not exist anywhere until the 1994 South Florida Building Code. Hurricane Andrew was the impetus for the building code changes. This 1992 hurricane claimed 65 lives, destroyed or severely damaged 600,000 homes and businesses and caused more than $25 billion in property damage. The primary cause of the property damage was windborne debris that penetrated doors and windows, leading in many cases, to an increase in internal pressures and, ultimately, the collapse of the structure.

The 2000 International Building Code (IBC) contained requirements for impact protection for hurricane-prone regions within one mile of the coastal mean high water line where the basic wind speed was 100 mph or greater, or where the basic wind speed was 120 mph. The IBC stated that glazed openings located within 30 feet of grade would be required to meet the large missile testing requirements, and glazed openings located more than 30 feet above grade would be required to meet small missile testing requirements.

Because state building code councils in the United States are responsible for reviewing proposed code changes at their level to determine if there are any conflicts with current building practices, administration and enforcement, not all states may choose to adopt requirements for impact



When designing hospitals in high wind zones, architects often specify glass that offers enhanced storm protection, for added patient safety and emergency shelter.

Hurricane Zones

Level of Protection	Wind Rating (MPH)	Basic Protection	Enhanced Protection
Zone 1	110 to 119	C	D
Zone 2	120 to 129 (> 1mile)	C	D
Zone 3	120 to 129 (< 1 mile), 130 to 139	D	E
Zone 4	> 140	D	E

The large missile requirements found in ASTM E1996 are related to four wind zones and the type of protection required (basic versus enhanced).

Missile Test Levels

Missile Level	Missile Type	Missile Speed
A	2 gm Steel Ball	130 ft/sec
B	2 lb 2x4	50 ft/sec
C	4.5 lb 2x4	40 ft/sec
D	9 lb 2x4	50 ft/sec
E	9 lb 2x4	80 ft/sec

ASTM E1996 defines the small missile type as a 2 gm steel ball traveling at 130 feet per second. Missiles B, C, D and E are specified for large missile tests.

protection. Florida, for example, granted the Panhandle an exemption from windborne debris protection requirements, and only recently reversed this exemption. No state building code council exists in Texas. The Texas legislature has adopted the 2003 IBC by statute, but local jurisdictions review and can modify the code. This makes for variations in the building code between cities and counties.

The other building code program in Texas is run through the Texas Department of Insurance (TDI). This program provides insurance when the national or regional carriers elect not to do so. This occurs along the coast where the threat of hurricanes making landfall is great. The windborne debris protection requirements follow what is required in the 2006 IBC. Residential construction has been the primary user of this coverage, but commercial projects can use this program as well. The other part of the TDI program is product registration. Door and window systems need to be listed in advance in order to be accepted during program inspection. The current TDI database, which is found on their website, www.tdi.state.tx.us, contains mostly residential products.

Florida, A Model for A Strong State Building Program

Empowered by the Florida legislature to promulgate and maintain the Florida Building Code (FBC), the Florida Building Commission is an example of a strong state building program. The 2006 IBC has been incorporated into the 2007 FBC, which is scheduled to go into effect in January 2009. The FBC contains impact protection requirements for the state and, in particular, calls out TAS 201, TAS 202, and TAS 203 for compliance in High Velocity Hurricane Zones, such as those found in South Florida.

TAS 201 protocol covers the missile impact tests as required by Section 1626 of the Florida Building Code. The large missile impact test is required for elevations up to 30 feet. The impactor is a 9-pound 2-by-4 timber traveling at 50 feet per second. Small missile tests require 10 impacts from a two gram steel ball at 130 feet per second in the center, near an edge and near a corner for a total of 30 impacts for each of the three test specimens. Following large or small missile impacts, test specimens are subjected to a combination of 9,000 positive and negative cyclic pressure loading cycles per FBC and TAS 201. Additionally, TAS 202, a protocol for uniform static air pressure testing, also is required.

The Florida Building Commission also has established a product approval system for building envelope components. All door and window systems must be tested and certified. The Commission has all product reports reviewed for compliance to the current version of the code and lists all approved systems on its website. Although the initial concept was that this product testing program would be voluntary, it is now mandatory for all exterior products.

ASTM and ISO Standards Guide the Way

ASTM E1886 *Test Method for Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials* and ASTM E1996 *Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes* are the two stan-

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dards used for testing and specification guidance in the United States.

ASTM E1886 has both large and small missile requirements as well as pressure cycling requirements that follow after impact testing. In most areas, only one impact is required per specimen, and no impact is required on the mullion outside of the 140 mph wind zone. Failure is defined as an opening through which a 3-inch sphere can pass. Small missile impact resistance is required from 30 to 60 feet in height above grade. ASTM E1996 creates protection zones and additional missile types for users.

Specifiers seeking specific test requirements in the ASTM standards must first identify the applicable wind rating for the location from ASCE 7. Once the wind rating has been identified, the ASTM E1996 standard specifies the basic or enhanced protection requirements. In addition, the standard identifies the missile type and speed required for testing. Not restricted to use only in the United States, the ASTM standards have become a reference for specifiers and building owners in other areas, such as Mexico and the Caribbean, where windborne debris protection may be needed.

In 2006, the International Standards Organization (ISO) published its ISO 16932 *Glass in Building—Destructive Windstorm Resistant Security Glazing Test and Classification* standard. A working group of international experts participated in the development of this standard. Similar to the ASTM standards, the ISO standard contains methods for large and small missile impact testing, as well as air pressure cycling. While it is not a mandatory standard, it is available for adoption by a national building code or government agency in countries around the world.

Saffir-Simpson Hurricane Scale

Classification	Wind Speed (MPH)	Storm Surge (Feet)	Damage Level
Tropical depression	< 39	N/A	None or Minimal
Tropical storm	39 – 73	N/A	Minimal
Category 1	74 – 95	4 – 5	Minimal
Category 2	96 – 110	6 – 8	Moderate
Category 3	111 – 130	9 – 12	Extensive
Category 4	131 – 155	13 – 18	Extreme
Category 5	> 155	> 18	Catastrophic

The Saffir-Simpson Hurricane Scale is used worldwide to characterize the severity of a hurricane.

Expanding Choices

In the mid-1990s, manufacturers were beginning the process of designing and testing impact-resistant systems for commercial and residential buildings. As time progressed, it became clear that homebuilders, architectural specifiers and glazing contractors would have many options, including different glass types and coatings, laminated glass interlayers and frames.

One example of an "old" technology reviving itself in the impact glazing market is dry glazing. Prior to the development of impact requirements, storefronts, curtainwalls and doors were dry-glazed. With the advent of impact requirements, systems were wet-glazed in order to better secure the glass laminate in its frame after impact. By using a stiff ionoplast interlayer instead of PVB within the laminate, dry glazing is once again an option for large missile impact resistant systems up to +/- 90 psf. The benefits associated with dry glazing include a cost savings in terms of labor and materials, as well as a time savings replacing broken glass.

Impact-resistant systems are handling the challenges of more stringent energy requirements and better acoustical performance through laminates that incorporate tinted glass, interlayers or high performance coatings. Insulating glass units are often part of the window to help meet more requirements for lower U-values and solar heat gain coefficient requirements.

A new area for regulation in South Florida is exterior glass railings, where safety glazing is now required for glazing in-fill and missile impact testing is required for structural glass railings. While exterior railings do not need to protect a building from internal pressurization or wind and rain damage, the new requirements are designed to minimize collateral glass breakage due to falling glass from upper stories of buildings.

The bottom line is the number of product choices is increasing at a fast pace, and even expanding beyond standard vertical glass applications to canopies, skylights and glass railings on balconies.

What's Next?

There is no doubt the impact protection requirements found in the United States are finding their way into other regions. With the ASTM or ISO standards as guidelines for regulatory action in other regions, it is likely that we will see the continued growth of the hurricane protection outside of the United States. As this segment grows, manufacturers are likely to expand their product offering into the impact area. This has certainly been the trend in the United States, and several other areas are not far behind. ■

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